FACTORS OF THE ENVIRONMENTAL SYSTEM OF KARST

Ilona BÁRÁNY-KEVEI

INTRODUCTION

The relevation of the environmental system plays on increasingly important rôle in geomorphological research. It is especially true for the ecological systems of karst regions, since karst is an open system.Here the changes in environmental effects are asserted rapidly. Chemical, organic and other materials are carried by seeping water without changes to the deeper karstic thereby rock modifying karst development. In spite of the fact that the limestone can reduce the effects of acid deposits by its buffer capacity, long-term unfavourable effects can also modify subsurface processes. Signs of this process can be found in several Central European caves in the form of characteristic dripstone degradation. This phenomenon is most frequent where the rock layer is very thin above the cave and there is not enough flow path to buffer the seeping water.

The quality of karstwater both in caves and karst springs has been investigated comprehensively by karst researchers. However, there are fewer investigations which define the quality of seeping waters. MAUCHA (1930) and JAKUCS (1986) investigated the quality of seeping water in a few Hungarian caves. According to Jakucs's measurement, the $S0_4$ content of seeping water has increased significantly in Baradla Cave in Hungary in the last few decades.

DISCUSSION

The investigations mentioned above have only strengthened the intention of the author to widen her examination to the whole karst system. The most important elements of the karst environmental system were summarized by Y. DAOXIAN (1988).

According to Daoxian, karst is a complex system of rock, soil, organisms as well as energy. A.S. GOUDIE (1986) deduced the development of the ecosystem of limestone surfaces back to the bedrock, climate, time of the effect of climate and human activity.

In my opinion, which is similar to opinion of the above mentioned authors, the karst-ecological system starts at the air layer near the surface as well as plants, which cover the karst surface and it finishes at the karst water system or karst springs (*Fig.1.*).

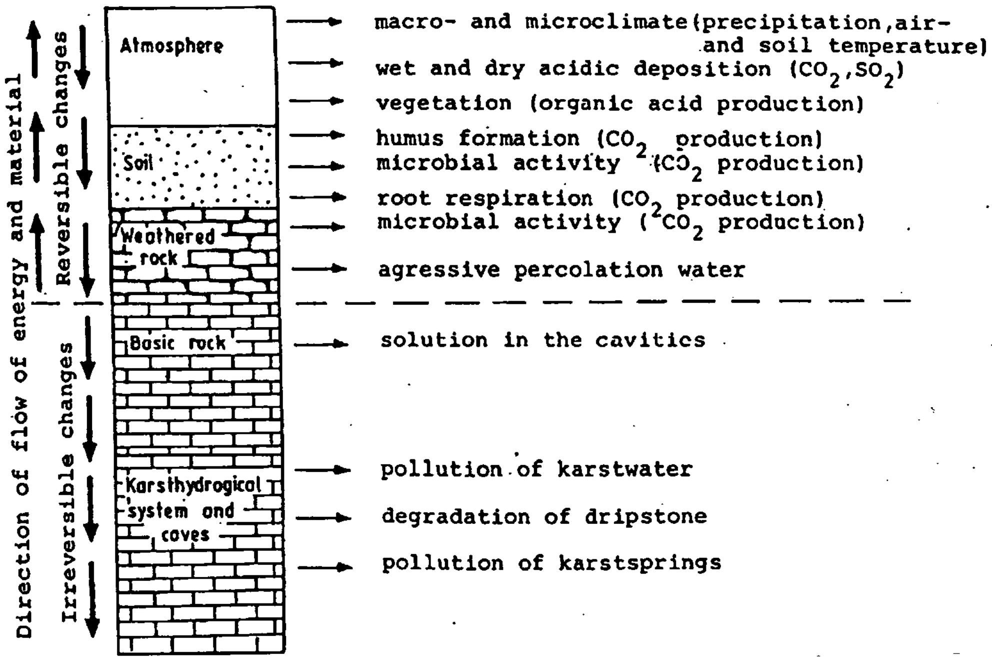

Figure 1 *Schema of karstecological system*

The water and energy pass into the rock body through the soil and can reach the caves where accumulation occurs. The seeping water, depositing its calcium, feeds the karst water system. During infiltration, the seeping water goes through significant changes. These changes (favourable or unfavourable) can be traced to the border with soil and rock. They are reversible to this border since after it there are only a few opportunities to modify the quality of karstwater in caves. The change in solution intensity can be so significant that it can be present in morphological aspects e.g. change in the development of dolines, dripstone degradation.

The investigation of karst-ecological system is very important because of the solution of limestone has biogenic character (Jakucs, 1988). The effect of the biosphere takes a more significant role in terrain evolution on limestone than on other rocks. Only of few researchers consider the phenomena of karst as a biogeomorphological phenomena (Viles,H.A.1988).For example the limestone may be coral limestone (biogenic origin), where the microflora take place directly in the formation of karstic phenomena e.g. root karren and travertine. Concerning to the above explanation, it may be considered ,that biogenic processes are very important in the development of karst surface because billions of microorganisms are active in karst soils (Kevei-Bárány,I.-Zámbó,L.1986). This is determined by considering the characteristics of karst soils,where microorganisms decompose organic materials in faintly acid conditions chemical properties of the soil are changed by metabolic products and CO_2 is formed in great quantities during decomposition. These processes determine the chemical property of seeping water and consequently, the intensity of karst corrosion.

The mentioned processes above are intensive near the karst surface and therefore their investigation at this level is a significant task. In my former studies a number of factors of the ecological system were examined in karst dolines; in fact solution dolines can be considered as most important landforms on Hungarian karst surfaces. In microregions, microclimate is the most significant ecological factor. The microclimate is effective on vegetation by the differences in rising hot air layer.

The extreme changes in temperature in karst dolines do not favour arborescent vegetation therefore the majority of dolines are covered by grassy vegetation. This type of vegetation increases the extremity of surface temperature which is turn effects the soil temperature. Differences of 10-12 °C can appear in the upper soil layer in the southern exposition of dolines. In the southern and western exposition, drought-resistance vegetation survive, in the eastern and northern exposition hydrophytone vegetation survives extreme conditions. The soil temperature differentiates between the number of soil bacteria on distinctive doline slopes (*Tab. 1*). These results prove the researchers must take these factors into consideration during the investigation of the karst ecological-system.

Number of aerob bacteria in a Bükk doline without forest (Million)						
Level	3 m	6 m	9 m	12 m	15 m	18 m
S slope	1,9	1,7	0,7	-	-	-
W slope	11,0	1,9	4,3	0,8	0,4	-
N slope	0,4	1,4	0,5	0,6	1,7	2,9
E slope	2,3	1,6	1,2	1,9	1,5	-
Number of aerob bacteria in a Bükk doline with forest (Million)						
Level	3 m	6 m	9 m	12 m	15 m	18 m
S slope	2,9	1,5	2,2	1,2	2,9	-
W slope	5,0	0,4	4,0	0,8	0,4	0,3
N slope	2,6	0,5	2,4	4,0	5,1	-
E slope	0,4	0,8	1,8	2,7	4,0	1,1

Table 1.

The soil is one of the most important ecological factors in the so called "hidden open karst" (I. Bárány and L. Jakucs 1984, hidden open karst=karst surface covered by soil). This thinner or thicker soil layer can strengthen or buffer the unfavourable exogenic effects. Therefore the physical quality and chemical property of soil are very important in karst processes. Both can be modified by the above detailed factors (microclimate, vegetation, bacterium activity). The permeability depends on the physical characteristics of the soil. Usually, clayey soil with low permeability is frequent in the investigated dolines. Chemical properties were characterized by pH value as well as the quantity of water soluble anions and cations (I. Bárány-Kevei 1992). With the help of the comparison of pH (H_2O) and pH (KCl) we can show the trend in the change in pH value. With the help of data the trend of acidification can be proved in Hungarian karst soils but the strength of acidification is different in distinctive soil types and regions. Former investigations of soil samples from the Aggtelek and Bükk Mountains were completed by the analysis of soil samples from Mecsek Mountains (situated in the southern part of Hungary) in 1992. In this region (Triassic limestone, 3-400 m above sea level) the tendency of soil acidification is stronger than in the Bükk Mountains. The difference between the pH values of the soil samples from doline slopes greater in the Mecsek Mountains (*Fig.2*).

The cause of this fact may be that at lower elevation more harmful materials can be found in the air and carried away from nearby industrial region to the limestone surfaces. Therefore, soil acidification can be related to the effect of human activity (industrial and human waste materials). During the imission of waste materials these materials are washed by precipitation into the upper soil layer and result in more intense weathering and soil acidification.

The quantity of water soluble anions and cations gives information about the ion composition of karst soils. In my former studies, detailed analyses can be found. In this study, analysis of samples from the bottom of dolines is presented. Comparing these data we can say that there are less water soluble cations in the soils of the Hungarian dolines than in the soils of dolines in Croatia (*Fig. 3*). This fact proves that soils of dolines are more basic in Hungary than in Croatia as a result of microclimate and human activity.

RESULTS

The differences mentioned above in microclimate, vegetation and soil take a very important role in the development of the karst-ecological system.

1. Extremities of surface temperature stunt the development of arborescent vegetation. The euryoecic grassy vegetation survives the extreme changes in temperature.

2. The air temperature affects the soil temperature and daily differences can be 8-10 °C in the upper soil layer.

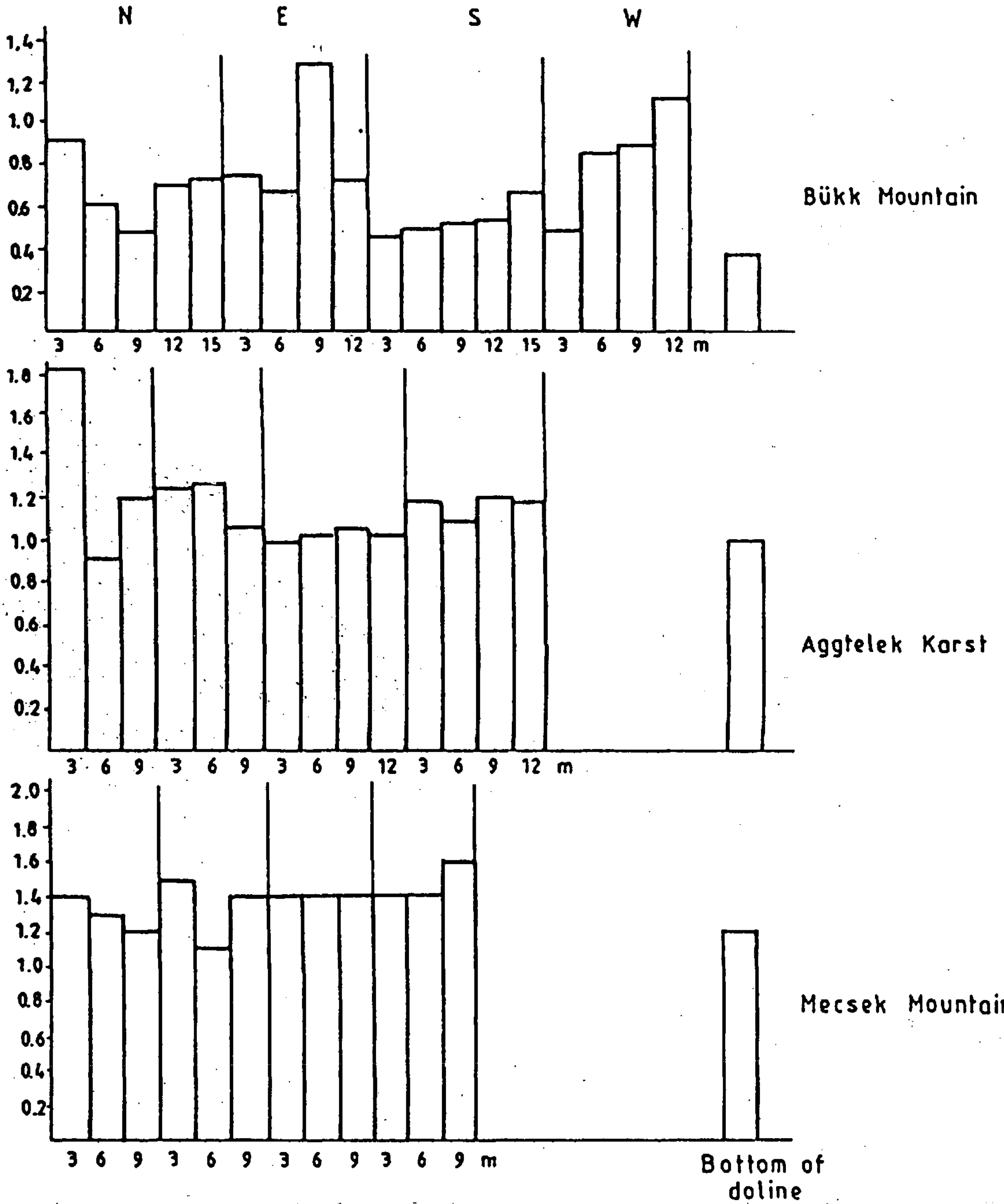

Figure 2 *Differences between soil pH values suspended in water and KCl at the depth of 5 cm on the different slopes*
3,6,9,12 m = relatively level in the dolina

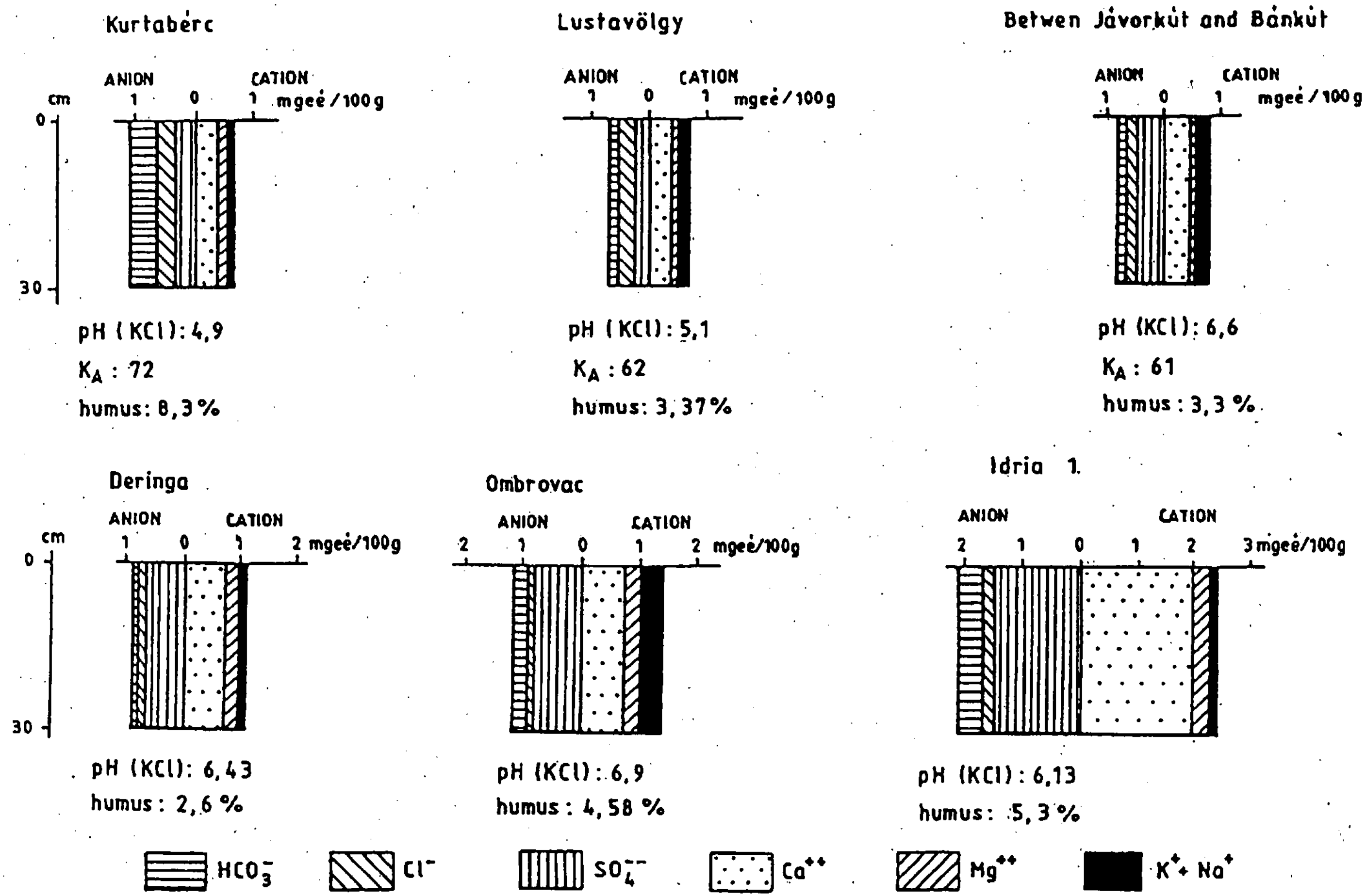

Figure 3 *Water soluble anions and cations in the bottom of dolina in the Bükk Mountain and in the Dinaric Karst*

3. The extremity of soil temperature differentiates the intensity of bacterial activity and consequently the quantity of the forming CO_2. Apart from temperature, humidity also has an influence on bacterial activity. The greatest population can be found in the upper soil layer and directly on the weathered surface of bedrock.

4. The chemical property of soil shifts toward acidification. This trend is stronger on lower elevations than lifted karst surfaces. At lower pH values soil erosion is also stronger. The chloride and sulphate anion content increases in the seeping water and strengthens the intensity of corrosion.

5. If the path of seeping water is short enough then it can be the cause of dripstone degradation. The phenomena can be observed in numerous caves.

With the help of the above mentioned facts I would like to suggest that further attention he given to the analytical investigation of the inner functions of the karst-ecological system.

REFERENCES

BÁRÁNY-KEVEI,I.(1992): A karsztökológiai rendszer vizsgálata bükki dolinák példáján (Investigation of karstecological system on the basis of Bükk dolines) A Bükk karsztja, vizei, barlangjai, Miskolc I. kötet pp. 25-38.

BÁRÁNY-KEVEI,I.-JAKUCS,L.(1984): Szempontok a karsztok felszíni formáinak rendszerezéséhez, különös tekintettel a dolinák tipusaira (Thesis of systematisation of karstlandform special attention to dolines) Földr. Ért. XXXIII.évf. 3. füzet. pp. 259-265.

BÁRÁNY-KEVEI,I.-ZÁMBÓ,L.(1988): Study of the relationship between bacteria activity in karstic soils and corrosion Annal. Univ. Sci. Budapestiensis de Rolando Eötvös Nom. Sectio Geographica. Tom. XX-XXII. pp. 325-333.

DAOXIAN,Y.(1988): Karst environmental systems. Proc. of IGU Study Group Man's Impact on Karst. Sydney pp.149-163.

GOUDIE,A.S.(1986): The human impact.Oxford; Basil Blackwell.

JAKUCS, L. (1986): A savas esők (ülepedések) hatásának nyomai a barlangi cseppkövek visszaoldódásában (Traces of acid deposition impact on the resolution of cave dripstones) Karszt és Barlang I. füzet pp.15-22.

MAUCHA,R.(1930): Az Aggteleki cseppkőbarlang vizeinek kémiai vizsgálata (Chemical investigation of waters of Aggtelek dripstone caves) Hidrol. Közl. X. kötet pp.201-207.

VILES,H.A.(1988): Organisms and karst geomorphology.in.: Biogeomorphology.Basil Blackwell.pp.319-350.

Address of author: Ilona BÁRÁNY-KEVEI
University of Szeged, Dept. of Physical Geography
Egyetem u. 2-6.
H-6722 Szeged
Hungary