I. G a m s

A NEW METHOD OF DETERMINING THE KARSTIC SOIL EROSION

In contradiction to the surface karst forms the research of subsoil forms in limestone was neglected in the karst geomorphology. Mycroforms were studied mostly in relation to organic activity /Cousin, 1957; Smyth-Drzal, 1965/, bigger forms mostly in gypsum karst /Haefke, 1926, Penck, 1924/ or under calcarenite /Jannings, 1968/.

Behind the quarries where the soil was stripped off, different typical subsoil forms can be found in homogeneous limestone. The most common form is the covered Karren /solution grooves, lapiés/ and between them the Rundkarren. The holes in the rock have a diameter of some decimetres and are one or more metres deep. Their longest axes run in all directions, even in the horizontal ones. In the limestone surface special types of scallops occur; these are irregular in diameter and depth and are deeper on the gently inclined slopes than in the vertical walls. The covered kamenitzas, a kind of lapiés wells /"Geologische Orgeln", germ./ and covered bogaz and covered dolines with a depth of 1-3 m occur also under the soil cover. Many ten metres deep potholes, full of loam or clay, are opened in the quarry walls /Gams, 1971, in print/.

If the soil is eroded, many of these forms appear on the surface, constituing a proof of soil erosion.

A common feature of these subsoil forms is their smovther surface in homogeneous limestone. This smooth surface is significant for all the limestone surface under the soil. The smoothness is in inverse proportion to mechanical weathering and is diminishing in the upward direction. The degree of smoothness is smaller in nonhomogeneous limestone with fossiles or with recrystalized calcite or with chert inlayers, etc., with thinly bedded and fractured limestone. In mountain karst under the rendzina soil the limestone on the steep slopes has no smooth surface.

Contrary to smoother limestone surface under the soil the isolated stones standing out of soil have a more fissured surface, transected by rills and grooves and etched due to mechanical weathering and lithological differences. The degree of smoothness of the subsoil surface in limestone moreover is different but it is in a stady relation to the more dissected limestone surface in the open air. This difference between the surface originated under soil und that originated in the open air is still obvious after many hundred years where the soil level was artificially lowered and the subsoil forms came to be surface forms. The transformation of the surfaces is faster in Mediterranean climate than in the continental Karst of Slovenia.

The mentioned differences can be used as a method of determining the soil erosion. To be exact, the contact between the lower, smoother surface and the higher, more dissected, surface on the isolated stones in the semi-covered karst is a mark of how much the soil level is lowered.

The lowering can be caused by sheet denudation, washing of the soil particles by percolating water into the rock fissures or through them into the water channels. In tilled areas it can result also from subsidence of the soil after the deforestation and decomposition of the tree roots. If the wood trees cease to hold the soil particles above the empty fissures in the rock a strong downward erosion can take place.

The study of the soil erosion according to this method in many lots in the continental and Mediterranean karstic regions of Slovenia /NW of the Yugoslav Dinaric Karst/ included also the slope angle and mechanical texture of soil. The cadastral maps, the oldest made in the year 1925 and 1826, were used. Summarising the results the following conclusions can be presented.

The most intensive soil erosion is in the vineyards on the steep slopes. There the isolated stones with smooth surface protrude many decimetres above the soil level and are usually on the top cut off. In some places this cutting off is done to this day during the trench-ploughing; this occurs in different depths below the soil surface, but even as deep as 70 cm. Therefore the exact rate of soil erosion in vineyards can not be stated. Beside the karstic erosion in vineyards also the sheet erosion take place.

On the fields abondoned in the second half of the last century or at the beginning of the present century, the average height of the isolated sutt-off stones with smooth surface is 25-35 cm. The cutting off occured as deep as the ploughshare reached, that is 20-30 cm below

the soil level. This work was done mostly in winter time, over a long period from the first settlement to the recent time. The last remnants of this work were observed in some villages in Dolenjsko in the first years after the World War II. The cutted-off stones were cleared away by building walls /Gams, 1967/, which are a typical features of the Mediterranean landscape. The stones were buried also in the bottom of the dolines, thrown into potholes or used for in building. In one particular case of the wall around an abondones field lot surrounded by uncleaned wood karst on classical /Trieste/ Karst it was established that 158 kg of limestone per 1 are were cleared eway from the soil the filde was being prepared for tilling /Gams, Lovrencak, Ingolic, 1971/.

In the fields where the cutting off took place 20 cm below the soil surface a century ago and where the cutt-off isolated stones protrude today 30 cm above the soil level, and where a rate of erosion of 0,5 cm per year must be reckoned with, are in the Slovene karst most frequent in the brown-to-red clay soil. This rate of erosion is lower than estimated by A. Horvat /1953, p. 50/ on the basis of old photos of the fields /1 cm per year/.

On meadows the stones were cutt off on the soil surface to make mowing possible. On the surfaces register in the cadastral map already in 1825 as meadows the cutt-off stones are today 12-22 cm high. Stones that are higher and were not outt off, have on the top a more dissected surface originated in the open air. It remains an unsettled question whether this erosion is due to older tilling or to the soil erosion taking place also under the grasscovered karst surface.

The smooth limestone surface originated below the soil but now in the open air have been found in many places also in the present-day woods. In such cases the soil erosion may be explained through the burning down of forests for gaining pastures in the Middle Ages or earlier. Destroyed along with the forest were also the whole rendzina and roots in it. In some wood lots the cutt-off stones prooves a abondoned meadow.

The following factors that influence the erosion intensity are obvious. The clay soil is subject to a more intensive erosion than the sandy soil. This is probably due to a more intensive fissuring during the dry summer. The clay soil of the terra rossa type has namely a high heat conductivity, and where it is without a vegetation cover its temperature is in the depth of 15 every month in the year higher than the mean daily value for the soil surface /Tommasini, 1971/. After heavy storms these fissures are filled with down-washed soil.

Outside the vineyards the slope angle has only a seeming role for the soil erosion in field terraces. On the slope between two terraces the soil was dug out and transported on the terrace below. There the isolated stones with smooth surface are the highest. On the other fields and meadows no correlation between slope angle and erosion intensity could be traced. This is in accordance with the absence of bigger accumulated forms below the meadows and fields on gently inclined slopes and with the absence of gully erosion forms. The lowering of the soil level is therefore presumably a consequence of the vertical downwash.

The results of our investigation provide an explanation for the numerous differences between the bare Mediterranean karst and the more covered, inland, karst in the limestones of Dinaric Karst. The differences are based also on the older and denser settlement and older agriculture in the Mediterranean karst. But the tilling of the shallow clay soil in the inland karst leads to the some fate: to the bare karst stage. The results of studying the soil erosion on the karst are interesting also for the conservation of soil and nature. If the annual rate of soil erosion in some soil type is half a centimetre per year, then the tilling or the soil has to be reduced in favour of other kinds of land use. As a matter of fact the diminishing of tilled surfaces in the Yugoslav dinaric countries is progressing rapidly and the soil erosion estableshed by our method is one the causes of this process. Even the local people know that in their fields the isolated stones "grow up", as they say.

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