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Soil erosion and mass movement processes on the loess covered areas of Hungary

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Introduction

About two-thirds of the total area of Hungary are covered by loose sediments, mainly by loess and loess like deposits, susceptible to soil erosion and mass movement processes in the hilly regions of the country. Soil erosion is the greatest environmental hazard on hillslopes under cultivation whereas mass movement processes occur on every land use type.

Soil erosion

In Hungary, as in many countries, soil is one of the most important natural resources, therefore soil erosion studies are of great importance (STEFANOVITS, P. 1977; VÁRALLYAY, GY. 1986).

Soil erosion can be considered to be one of the most significant *land degradation* processes in agricultural areas. Other land degradation processes, such as acidification and salinization per alkalization, compaction, destruction of soil structure, surface sealing and other chemical, physical and biological degradation processes (see VÁRALLYAY, GY.–LESZTÁK, M. 1990; KERTÉSZ, Á. 2001) are also important, but are not as extensive as soil erosion.

More than one-third of agricultural land (2.3 million hectares) is affected by water erosion (13.2 per cent slightly, 13.6 per cent moderately and 8.5 per cent severely eroded) and 1.5 million hectares by wind erosion (STEFANOVITS, P.–VÁRALLYAY, GY. 1992, see *Table 1*).

Land affected by moderate and strong water and wind erosion occupy more than 1.7 million hectares.

Figure 1 and *2* show the degree of erosion in Hungary.

Recognizing the significance of soil erosion, a map was constructed as early as 1964 by STEFANOVITS, P.–DUCK, T. covering, however, only improved farmland (ex-

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Table 1. Soil erosion in Hungary

Parameters	1000 hectares	Per cent of the total area	Per cent of the agricultural land	Per cent of the eroded land
Area of the country	9 303	100.0	-	-
Area of agricultural land	6 484	69.7	100.0	-
Arable land	4 713	50.7	73.0	-
Total eroded land	2 297	24.7	35.3	100.0
strongly eroded	554	6.0	8.5	24.1
moderately eroded	885	9.5	13.6	38.5
weakly eroded	852	9.2	13.2	37.4

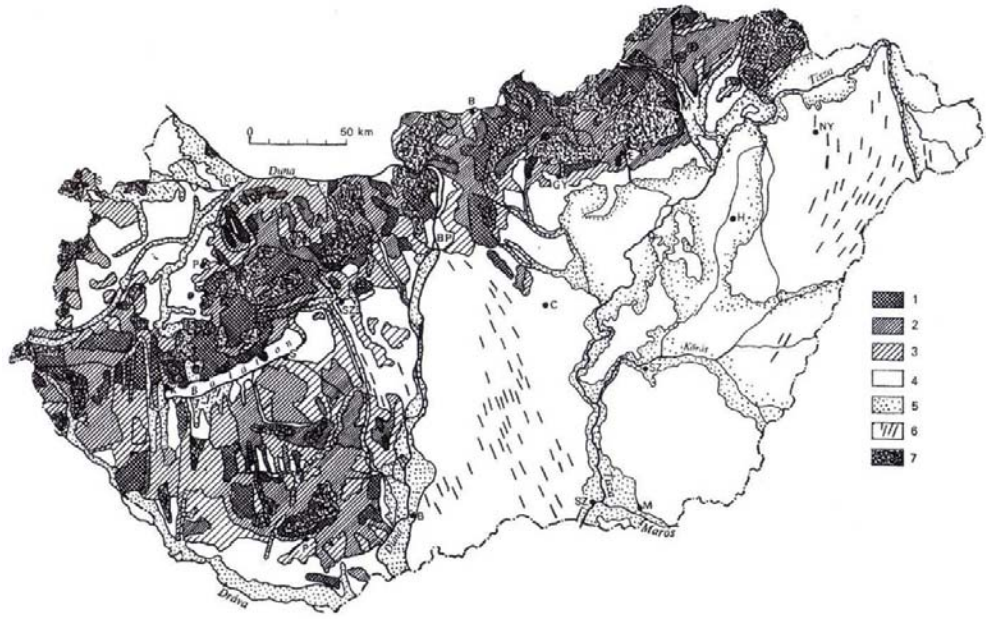

Fig. 1. Soil erosion in Hungary (after STEFANOVITS, P.–VÁRALLYAY, GY. 1992). – 1 = strongly eroded; 2 = medium; 3 = weakly eroded; 4 = not eroded; 5 = sediment area; 6 = areas affected by wind erosion; 7 = forests

cluding non agricultural uses, e.g. forests, urban and industrial areas, roads, etc.). As a result of the mapping (scale 1:75 000) it could be shown that 25 per cent of the total area of the country (2.3 million ha, see above) is affected by soil erosion processes. The mapping was based upon the analysis of soil profiles. First a soil profile not affected by soil erosion had to be found which was used as a basis for comparison in characterizing the soil profiles of the neighbouring area.

Three stages of erosion were defined: the soil was considered slightly eroded if 70 per cent of the basic profile could be detected. It was defined as medium eroded in case if 30–70 per cent was preserved and strongly eroded if less than 30 per cent of the basic profile was available. The compared soils were supposed to have

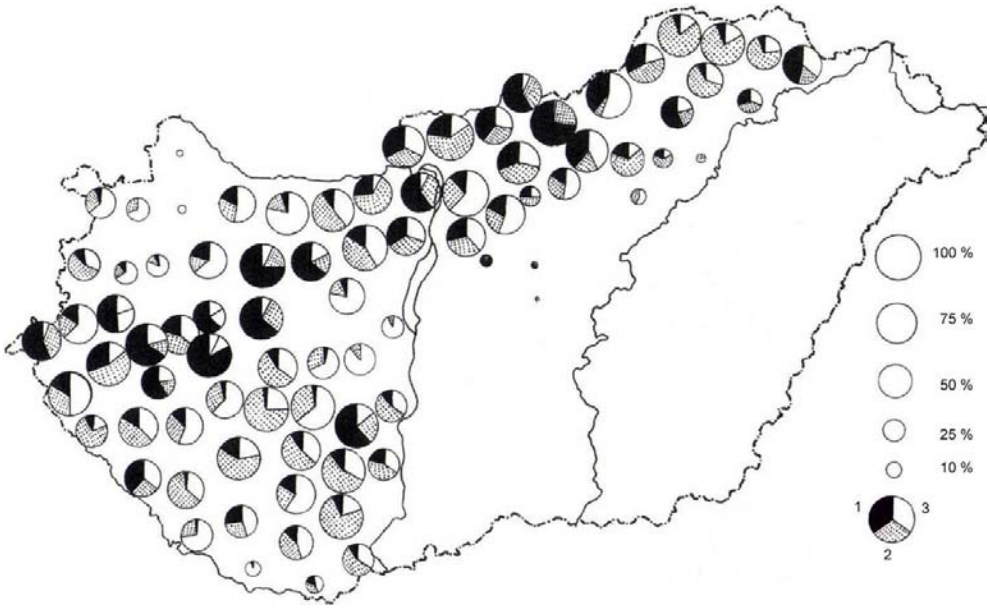

Fig. 2. Distribution of eroded agricultural land in the hilly adminstrative regions of Hungary (after STEFANOVITS, P.–VÁRALLYAY, GY. 1992). – Erosion classes: 1 = strong; 2 = medium; 3 = weak

the same bedrock and the same particle-size distribution as the basic profile. The map also represented areas affected by wind erosion.

The dimensions of soil erosion in Hungary have been estimated by many authors. According to ERŐDI, R. et al. (1965), the annual rate of erosion comes to about 50 million m^3 whilst some soil scientists calculate erosion of 90–100 million m^3 per year.

Water erosion

Due to its relief and drainage conditions Hungary is severely affected by processes of water erosion (see *photos 1, 2* and *3*). In the mountain and hill regions excess runoff, the loss of soil, nutrients and fertilizers and the accumulation of washed-down material present problems. The main factors of erosion by water will be reviewed shortly below.

a) The effect of *relief* on water erosion in Hungary is analysed according to the slope gradient categories used in Hungary. On slopes <5 per cent erosion hazard is negligible. As slopes >25 per cent are generally forested they do not give rise to a high risk of erosion (STEFANOVITS, P.–VÁRALLYAY, GY. 1992). The 17–25 per cent slopes are either under forest or were deforested in the recent past. Most of the 5–17 per cent slopes are used as cropland and degraded by soil erosion to a certain extent (KRISZTIÁN, J. 1992).

Photo 1. Sheet erosion on hillslopes in many cases reaches down to the C horizon

Photo 2. Gullying starts on arable land usually extends to the forested area downslope

Photo 3. Collapsible soils trigger rill and gully erosion

b) As for *rainfall characteristics,* from the point of view of erosion, 'erosion-sensitive days' characterized by >30 mm daily rainfall are of crucial importance (STEFANOVITS, P.–VÁRALLYAY, GY. 1992), and they occur 4–12-times per year. The percentage of atmospheric precipitation falling down as intense rain (>30 mm per day) during the vegetation period (March–October) is shown on *Figure 3.*

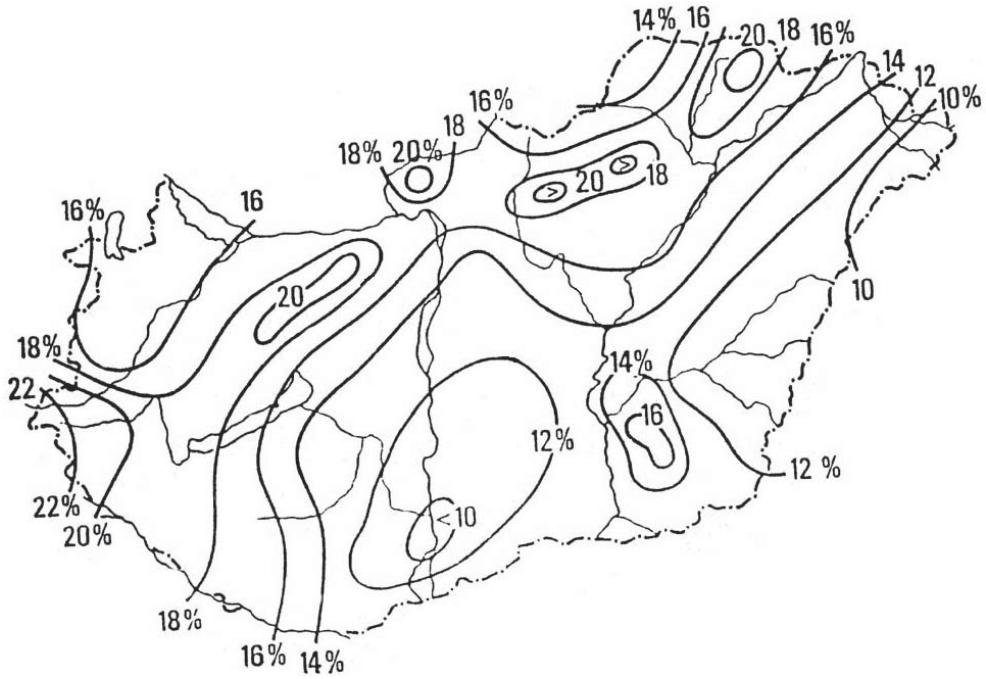

Fig. 3. The percentage of atmospheric precipitation falling down as intense rain (>30 mm per day) during the vegetation period in Hungary

The amount of snow, the duration of snow cover and the rate of snow melting show an extremely high spatial and time variability. After a cold winter when the soil is deeply frozen the quick snow melt may result in intense surface runoff and soil erosion.

c) Soils of the loess covered areas are generally highly erodible because the parent material of the soil is a loose sediment.

A great number of soil investigations have been carried out in Hungary to analyse and evaluate the influence of various soil characteristics on the rate, processes and consequences of water- and wind erosion (KARÁCSONY, J. 1991; KERTÉSZ, Á.–MEZŐSI, G. 1992; KERÉNYI, A. 1991; STEFANOVITS, P. 1963, 1964, 1971; VÁRALLYAY, GY. 1986, 1989).

After the review of the factors affecting water erosion, soil erosion processes will be dealt with briefly.

a) Sheet erosion. Sheet erosion is an important problem on most of arable land. Before the change of the regime in 1989 large arable fields were created allowing for an even bigger damage of sheet erosion. Most of the crop is harvested by the beginning of June leaving large surfaces without vegetation cover during the most sensitive period, i.e. between July–October. Sheet erosion processes are supported by micro- solifluction and by splash erosion (KERÉNYI, A. 1991).

b) Rill and gully erosion. The role of this group of processes was not properly recognized until lately and it was believed that it is mainly sheet erosion which causes damage on agricultural land. Nevertheless there is historical evidence (see e.g. GÁBRIS, GY. et al. 2003) that highly intense gully erosion took place in the nineteenth century when large areas covered by loose sediments were deforested and converted to arable farming.

Wind erosion

Soil erosion by wind affects 16 per cent of Hungary's surface. Areas of wind blown sand occupy about 20 per cent of the country's territory. Wind erosion is a major problem on the loess covered areas as well.

A method was proposed by KARÁCSONY, J. (1991) for the assessment of wind erosion. According to this estimation wind erosion endangers 30–40 per cent of arable land (more than 1.5 million hectares). Wind erosion has been increasing during the last 2–3 decades and has degraded not only the traditionally sensitive sandy soils and peats, but most fertile soils as well (STEFANOVITS, P.–VÁRALLYAY, GY. 1992).

There is a strong seasonality in deflation with peaks in early spring and in summer. Inappropriate farming practices may lead to a powdering of the soil surface or compaction, and ultimately to deflation.

Conclusions

The hilly countries of Hungary are mainly covered by unconsolidated sediments with loess and loess like sediments prevailing among them. Loess covered areas are prone to erosion and mass movements.

As a result of natural processes and human economic-technical activity the dynamic changes (stability, collapse, slide, compaction, dissolution and piping, gully erosion on loess etc.) with in loess forms and areas, present complex research task for environmental geomorphology. Engineering geomorphological investigations into the physical-mechanical, dynamic and even the seismic features of loess areas and layers are indispensable for planning and civil engineering.

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