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REGIONALIZATION OF ACCELERATED WATER EROSION IN THE LOWLAND RELIEF OF SOUTHWESTERN SLOWAKIA

Štefan Bučko: Régionalisation de l'érosion accélérée par l'eau dans le relief plat de la Slovaquie de sud-ouest. Geografický časopis, Bratislava 1972, XXIV, 2; 1 carte, 1 figure, 19 lit. cit.

L'objet de l'étude repose sur les aspects de la régionalisation de l'érosion accélérée par l'eau, en appliquant une classification typologique-régionale. Au premier degré de cette division, on tient compte des conditions morphographiques et climatiques-végétationales, au deuxième degré on prend en considération les critères régionaux et, aux degrés encore plus bas, on présente les facteurs importants qui conditionnent et influencent l'intensité différente des processus erosifs.

In the system of morphogenetic processes, an outstanding place is attributed to the accelerated water erosion which, by destruction of the soil cover and its substratum, effectively affects the development of the mostly deforested lowland relief hillsides. Since the course of water erosion processes is influenced by several natural and anthropogenous factors, in the regionalization of these phenomena, one must take in account a group of certain factors which mostly condition and affect the intensity of soil washing and scouring. When considering the intensity of these morphogenic processes and their spatial disposition in the landscape, one can use a combined typological-regional clasification.

With regard to morphographic, climatic and vegetational criteria, in the first degree of classification, we involve the type of predominating areal and local linear erosion in hilly relief, having temperate continental climate. For the second degree of classification, we use the regional standpoint by distinguishing two regional units. On the lowest taxonomical degrees, we take into consideration mainly the typological point of view, with respect to morphographico-morphometrical, soil, vegetational and agro-geographical criteria.

1. Prevailing areal erosion and local linear erosion of the soil in hilly relief with temperate continental climate.

This type of accelerated water erosion is characteristic for the flat relief, built of loose sediments, on which associations of lowland soil types have developed, in the conditions of relatively dry to moderately humind climate. These conditions mostly lead to the thermophilic vegetation of semisteppe flooded forests, forest-steppes or thermophilic oak-groves (xerothermic Pannonian vegetation of the higher morphographic degrees

and adjacent foothills). The flooded forests include growths of several sorts of willow (Salix), alder (Alnus glutinosa), poplars (Populus nigra, P. alba), elm (Ulmus sp.), maple (Acer pseudoplatanus), ash (Fraxinus excelsior) and others. The thermophilic oak-groves represent associations of pine-oak, oak and hornbeam-oak groves with principal representatives of woody plants, such as pine (Pinus silvestris), oak (Quercus robur, Q. cerris) and hornbeam (Carpinus betulus). With regard to some physico-geographical and partly cultural-geographical components, which in different ways condition and affect the kind and intensity of erosional processes, one can distinguish two further regional units.

1.1 The lowland of Záhorie with marked wind and locally widespread water erosion of the soil.

This region differs from other lowland regions by some physico-geographical components. Namely, by its particular morphological conditions (external river terraces, covers of drifted sand and powerful sand dunes), meadow soils developed on non-carbonaceous deposits and turf soils on drift sands, warm, moderately dry climate with temperate winters and a potential vegetation of thermophilic oak and pine stands with an undergrowth of xerothermic herbs and grasses. In the depressions with stagnant water, swampy vegetation grows (Sphagnum, Carex, Phragmites communis). From the agro-geographical and geonomical standpoints, in this region, there prevail the rye-maize and barley-maize types of agriculture in which, in lower depressions and moist places with heavy humous soils, beside the cultivation of cereals, that of early potatoes and other vegetables (cabbage, carrot, cucumber etc.) are widespread.

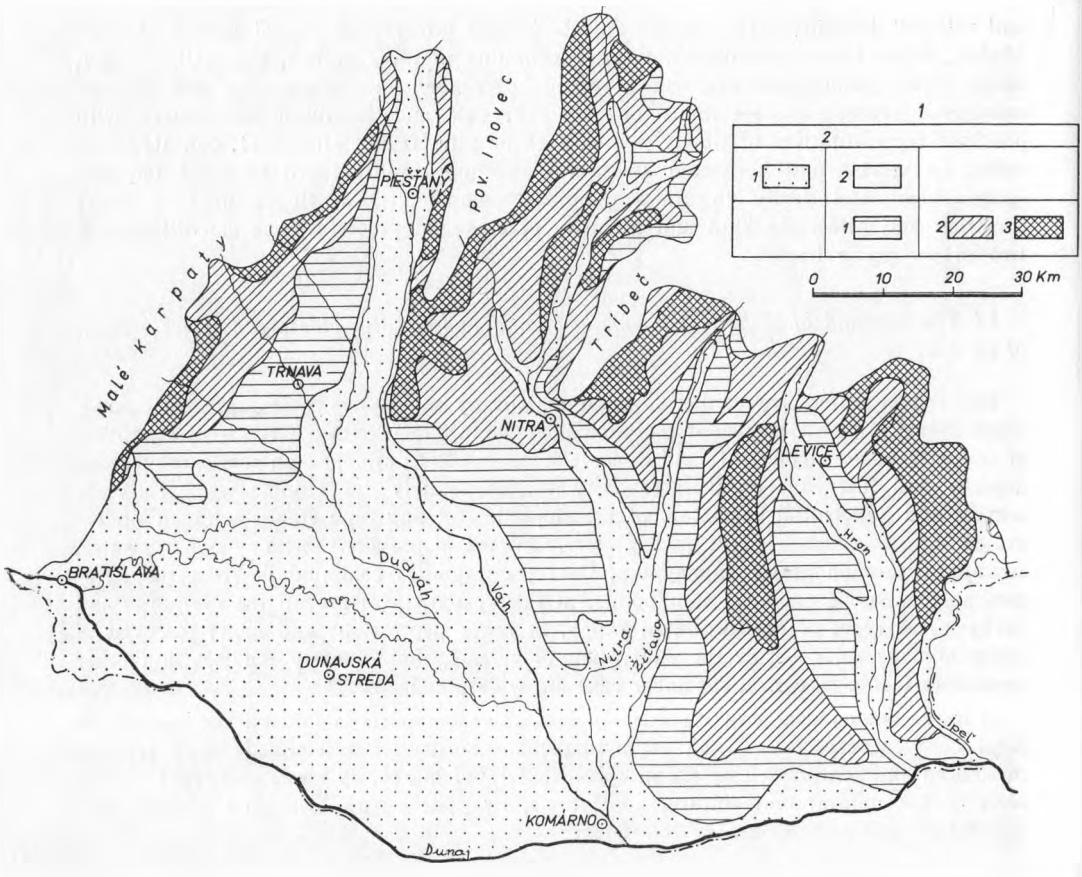
In lower taxonomical units of this division, more emphasis is laid on the typological point of view, especially when estimating the intensity of accelerated water erosion, influenced and conditioned by the morphometric relief marks, by kinds and types of soil, sorts of the natural and cultural vegetations, by hydrogeographical and climatic circumstances and anthropogenous interferences.

1.1.1 Slight or no areal and gully erosion.

Owing to the essential natural factors, unfavourable for the origin of soil erosion, such processes here are almost completely absent. According to the unfavourable factors having the prevailing influence on erosional processes, we distinguish two varieties of the soil erosion intensity.

1.1.1.1 The fluvial plains.

An extensive Recent plain (in the territory studied, its breadth is 3—4 km) is formed by the Morava river having in the lowland of Záhorie only two larger affluents, the Myjava and Rudava. Their river alluvions are narrow (1—2 km). The slight declivity (0—1°) of these fluvial plains prevents the surficial flow of precipitation waters and consequently soil erosion. Periodical floods, during high water levels in the mentioned rivers, deteriorate on places the topsoil by accumulated gravel and sand. The erosion of river banks, most effective during inundations, endamages the soil funds at the river bluffs unprotected by bank growths. By under-washing of overhanging high banks, occasionally earth blocks fall in the river stream. This river bank erosion occurs in sectors without flooded forests, between Devínska Nová Ves and Zohor, Záhorská



Map of the accelerated soil erosion regionalization in the Danubian lowland.

1. Prevailing areal erosion and local linear soil erosion in hilly relief with moderate continental climate.
1.2 Region of the Danubian lowland.
1.2.1 Slight to no accelerated water erosion.
1.2.2 Moderate to intensive accelerated water erosion.
1.2.2.1 Moderate soil erosion.
1.2.2.2 Medium strong soil erosion.
1.2.2.3 Intensive soil erosion.

Ves and Malé Leváre. On alluvial, in places gleyed and logged soils, grassland farming predominates, in relatively higher positions of the Recent alluvion, with meadow soils, vegetables eventually maize and rye are cultivated.

1.1.1.2 The afforested higher hill-country (pinery).

This extensive territory of higher hill-country is mostly covered with continuous forests containing pine stands (Pinus silvestris). Locally, at the forest borders, the locust

(Robinia pseudoacacia) occurs. The forest undergrowth is formed by xerophilous grass-herbal associations. The original pine-oak groves were replaced by the activity of man with secondary pines, which protect the soil against the movement of sand dunes and deflation. But against accelerated water erosion, especially at the forests borders, they don't protect the soil so well as did the original leaved trees. The original terrace--like plateau is partly covered by thick covers of drift sand with sand dunes. The relative heights of 30—100 m indicate a slightly to moderately undulated relief (12), characterized by turf soils on sand covers or grey-brown alluvial forest soils. The main factor preventing or retarding the erosional processes consist in the compact forest cover, which protects the soil both against wind and water erosion.

1.1.2 The moderate to intensive water erosion of soil.

Depending upon the essential factors of outwashing and linear soil erosion, we distinguish the varieties of moderate, medium and intensive soil erosion.

1.1.2.1—1.1.2.2 Plain or slightly undulated relief with moderate rill or medium strong areal erosion.

In morphogeographical sense, this relief is formed by low river terraces and alluvial cones, and by the foothill depression on the western side of Little Carpathians. Due to deflation and translocation of soil by the activity of precipitation water, the original surface of river terraces was transformed in a low hill-country with short slopes of small declivity (2—4°). The nature of mostly loose rocks (Pannonian and Pontian clays with islets of gravels and sands) conditioned the origin of soils sortally belonging to the sandy to loamy-sandy (light and medium heavy soils) or clay-loamy to clayey soils (heavy soils on the bottoms of depressions). Typologically they belong to meadow up to turf soils with various degrees of illimerization. The sandy soils on covers of drifted sands easily discharge precipitation water in lower horizons so that there usually do not occur concentrated flows of rain-water. On sandy-loamy soils, snow- and rain-water can concentrate in smaller streams and cause, on short slopes of moderate declivity, areal washing down or gully erosion. Considering that on slightly to moderately declivous hillsides (2—3°) the accelerated water erosion has little intesity, one may cultivate on such plots even hoed crops.

1.1.2.3 Intensive soil erosion on deforested parts of higher hill-country.

The morphographic degree of higher hill-country represents a more accentuated lowland relief, which originated by remodelling the surface of higher river terraces of the Morava by wind activity and river erosion of the left-side Morava affluents. This erosional accumulation relief is formed by river terraces, sand dunes and longitudinal dunes with intermediate depressions. The denivelations of 40—100 m characterize a moderately to medium undulated relief with predominating declivities of 3—4°. The steepest hillsides have declivities of 6—10°. On very extensive covers of drift sands and powerful sand dunes, mostly light soils have developed, while the inter-dune depressions have mostly heavy swamp soils. As we already mentioned, this area is usually covered with pine forests. On the higher hill-country deforested parts, during long lasting rains or strong downpours of short duration (15—30 min.), marked erosional processes in areal, rill or gully forms occur. Water erosion manifests itself in very dangerous

form on declivous plots covered with hoed cultures (maize, potatoes). Rill to gully erosion (line-forms deep 10—100 cm) originates on loose, little resistant substrata (Neogene sands, sandy limestones, grey-blue clays, fluvial gravel etc.), especially on longer hillsides (of more than 500 m) where, in small grooves and initial dell forms, concentrated streams of precipitation water originate. On the terraced and southern foothill part of the Záhorie lowland, in the summer season, soil translocations up to 35,0—400,0 m^3/ha have been ascertained (on sloping grounds with grain-maize or new orchards cultivated on deep loose soil). On the protruding parts of moderately concave hillsides, outwash and microlinear erosion result in a topsoil with poorly fertile B or C horizon. In case of intensive soil erosion, the change of cultivated crops has an important influence on the retardation of erosive processes. After sowing clover-grass mixtures on strongly eroded grounds, the soil erosion was essentially reduced up to minimum intensity.

1.2 The Danubian lowland with marked areal to gully erosion.

The Danubian lowland differs from that of Záhorie by some physico-geographical and partly agro-geographical marks. As a constituent of the sub-carpathian basins, it establishes the contact to the piedmonts of Western Carpathians. A whole system of longitudinal and transverse young faults separated it from the crystalline Secondary and volcanic mountains, so that the Neogene series of strata deeply sank beneath the foothills (10). From the previous region, it differs by its large extent of loess covers and the lack of river terraces. It also has dissimilar climatic and hydrogeographic conditions and soil cover. The large extent of soils with good physical and chemical properties, and the warm climate, enable a high productivity of excellent cereals, maize and sugar beet. In this region, the maize-wheat to beet-barley types of agriculture prevail. Due to deep interventions of man in the original oak stands and flooded forests, the vegetational conditions have also been strongly changed so that, in the actual cultural steppe, only shreds of the original forest associations remained conserved. The mostly favourable natural and cultural-geographical factors support the origin and course of accelerated erosional processes of various intensities.

1.2.1 Slight or no water erosion of the soil.

The very plain relief of Recent lowlands, the aggradation ramparts and depressions in the rift fault beneath the Little Carpathians have an insignificant slope (0—2°) and therefore, there occur no concentrated flows of precipitation water. The soil cover here is represented by alluvial and meadow soils, on which the maize type of agriculture prevails. During abundant downpours only, small erosional furrows of 1—5 cm depth originate on arable grounds poorly covered with vegetation. Scarce cases of accelerated water erosion here occur mostly on very short slopes of the former river arms or on longer but inconsiderably declined (1—2°) slopes of the depressions. Little intensive gully erosion was found in the environs of Bratislava on soils with cereals, and at Senec on soils with maize.

1.2.2 Moderate to intensive water erosion of the soil.

The higher morphological degrees of lowland relief exhibit — from the standpoint of its morphometrical properties (especially the slope and exposition of hillsides, of

greater horizontal and vertical articulation) and of its soil and vegetational cover — favourable conditions for the origin and course of areal and microlinear soil erosions. With regard to the intensity of erosional processes, we can define following taxonomical units.

1.2.2.1 Low hill-country with associations of meadow chernozems and carbonaceous chernozems, subjected to moderate soil erosion.

Insignificant rill and moderate areal erosion is characteristic for the low hill-country having moderate slopes (2—4°). On thick covers of typical loess (5—12 m), in the climatic conditions of forest-steppe to steppe, chernozem has developed with the soil subtypes of carbonaceous, meadow and degraded chernozems (4). The true chernozem represents a medium heavy clay soil with very good physical and chemical properties ensuring its relatively good resistance against washing out. Locally leached chernozems, in which the want of $CaCO_3$ causes deterioration of the structure of plough horizon and a slightly acid soil reaction, are somewhat less resistant against outwash and linear erosion. Washing down of the soil occurs on short slopes in inland drainage sinks or shallow valleys with permanent streams. In the slopes upper parts, we find the humous horizon thinner or completely outwashed. As far as potential fertility is concerned, the chernozems of Danubian lowland are soils of good quality, offering large production possibilities within the maize-wheat to maize-barley types of agriculture. With regard to their small water erodibility, one can successfullycultivate on them lucrative thermophilous hoed crops.

1.2.2.2 Higher hill-country with soil associations of leached chernozems and brown earths, subjected to medium strong erosion.

More expressive phenomena of sheet and specially gully erosion are observable on the slopes of higher hills in the Danubian lowland, with prevailling associations of leached chernozems and brown soils. They are mostly medium heavy loam soils which, on slopes of moderate to medium declivity (4—8°), are submitted to outwashing and linear erosion, mainly on grounds bearing hoed cultures (maize, sugar beet), to a lesser extent on those bearing cereals sown in spring. Since the somewhat more accentuated relief (denivelations here attain 40—80 m), than in the previous morphological degree, creates favourable conditions for water erosion; the processes of gully erosion are more frequent. The long hillsides on loose Neogene and polygenetic Quaternary deposits make possible the development of microforms of gully erosion. The density of grooves attains 0,5—3,0 km/km^2. The longitudinal profile of some old grooves approaches the equilibrium state. Their bottom does not deepen markedly and they successively transform into a glen form with broad bottoms and moderately declivous borders. The old grooves are already mostly stabilized by shrub and herbal vegetation (Robinia pseudoacacia, Quercus r., Rosa sp., Prunus avium, Prunus spinosa, Humulus lupulus, Rubus sp., Clematis vitalba a. o.). During extraordinarily strong rainfall when, on the bottoms of these grooves large amounts of water concentrate, then a certain erosion may be observed on their bottoms or banks uncovered by continuous herbal vegetation. Strong deep erosion occurs on the bottoms of short grooves and ditches which are branches of complicated groove systems. Sheet erosion on degraded chernozems and illimerized brown earths is mostly inconspicuous. It causes dislocation of fine particles of earth and plant nutrients. The results manifest themselves on fresh ploughed hillside grounds by lighter colour of the topsoil (the A horizon of which is fully washed down) and,

on the topsoil surface, covers of loess or Neogene sand and clay appear. Considerably outwashed soils may be seen mainly in the Trnavian hill-country northern part and in the south-western part of the Nitra hill-country. In these regions of the Danubian lowland, soil translocations of 24,0—180,0 m^3/ha have been found on plots with cereals and hoed crops. Within the predominating maize-barley to beet-barley agricultural types and the given position of grounds and elaborated rotation plans, one must take in consideration such dispositions of plots and crops, which comply with the given relief and antierosional soil protection.

1.2.2.3 Higher hill-country with associations of illimerized brown earths and illimerized soils — intensive soil erosion.

A moderately to medium cut relief exhibiting relative heights of 50—100 m and medial slopes, is symptomatic for the higher hill-coutry which has, in places, a moderately mountainous character. The mostly little resistant rocks are represented by Pannonian clays, gravels, sands or freshwater limestones in which, in covers of various thickness, Quaternary sediments are deposited, such as loess, loessial loam, deluvial mantle or gravel in extensive alluvial cones. The successively increasing humidity, towards the mountains (650—700 mm yearly), conditions processes of leaching in the soil horizons or shifting of the colloids downwards. In the highest degrees of genetic soil types, within the so-called submountain zonality (13), we distinguish illimerized brownearths and illimerized soils (sol lessivé) which, in positions logged with groundwater, pass into illimerized gleyed soils. The humous eluvial horizon of illimerized soils contains little humus, of worse quality, and signs of acid soil reaction. Due to undifferentiated vertical transfer of clay particles and their accumulation in the illuvial horizon, these soils become less permeable for precipitation water. They have an altered structure, that is relatively little resistant against accelerated water erosion. On larger hillsides (more than 1 km) of 5—10° declivity, all forms of water erosion may develop. In some places, an expressive linear soil erosion appears, creating erosional furrows, gaps or even valleys. The development of deep grooves was iniciated during centuries by fieldpaths on hillsides which, on loose rocks, gradually deepened into ravines. The density of grooves and ravines is considerable and attains 1,0—4,0 km/km^2. The grooves are mostly grown over with shrubby and grass-herbal vegetation retarding deep erosion. On the sides and bottoms of some ravines, cut in thick loess covers, tunnel erosion and suffosion takes place. Ravines of 2—10 m depths do not allow direct transition with cultivating machines and must be by-passed. Extensive branch systems of ravines depreciate large areas of arable land, because the small surfaces between ravine branches, due to bad accessibility for large cultivation machines, remain usually unploughed as fallows. These plots become then covered by herbal, grass or sporadic shrub vegetation exhibiting antierosional influence, since it prevents the formation of new branches through the ravine pattern.

On illimerized soils of higher hill-country of the lowland relief, during snow melting in spring associated with rainfall, there frequently occurs gully erosion, in form of small furrows up to smaller ditches of 5—50 cm depth. Gully (rill) erosion endamages the soil cover on relatively large areas of hillside grounds. It mostly manifests itself in spring, on surfaces uncovered with vegetation, and in summer on grounds with hoed crops. On the higher degree of the hill-countries of Trnava and Nitra, from grounds with (winter) cereals or root crops (in the environs of Kráľová, Vrbové, Čachtice and Kľačany), the removal of 100,0—240,0 m^3/ha soil particles has been ascertained.

The outlined regionalization of accelerated water erosion in the lowland relief can still be precised by further detailed research in the terrain and by studying the different essential factors of soil erosion. For this goal. it is also necessary to elaborate a map of areal erosion, and to use further morphometric maps, being elaborated by other authors (dissection of the relief and mean declivity of the relief).

From the Slovak translated by J. Belaj

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REGIONALIZÁCIA ZRÝCHLENEJ VODNEJ ERÓZIE V NÍŽINNOM RELIÉFE JUHOZÁPADNÉHO SLOVENSKA

Regionalizácia zrýchlenej vodnej erózie na študovanom území spočíva na typologicko-regionálnom princípe členenia.

1. Na prvom stupni členenia sa vychádza z prevládajúceho druhu vodnej areálovej a miestne rozloženej líniovej (ryhovej a výmoľovej) erózie na pahorkatinnom reliéfe v podmienkach relatívne suchej až mierne vlhkej klímy (ročný úhrn zrážok 500—700 mm). Na sypkých neogénnych a kvartérnych sedimentoch sa vyvinula pôdna pokrývka charakterizovaná nížinnými typmi pôd. V týchto pomeroch pred zásahom človeka prevládala teplomilná vegetácia lužných lesov a dúbrav. Z nej sa dodnes zachovali len malé útržky.

Na druhom stupni členenia sa používa regionálne hľadisko. Rozlišujú sa dve regionálne jednotky, odlišujúce sa nielen fyzickogeografickými komponentmi, ale aj prevládajúcim druhom zrýchlenej erózie a plošnou rozlohou erodovaných pôd.

1.1 Záhorská nížina sa vyznačuje rozsiahlou sústavou riečnych terás, rozľahlými pokrovmi viatych pieskov a mierne suchou klímou, potenciálnou vegetáciou borodúbrav a xerofilných bylinnotrávnatých asociácií.

Na nižších stupňoch členenia sa na základe typologických kritérií rozlišuje rôzna intenzita erózie pôdy (1.1.1 — nepatrná až nijaká plošná a výmoľová erózia; 1.1.2 — mierna až intenzívna vodná erózia).

1.2 Podunajská nížina sa od predošlej oblasti odlišuje veľkou rozlohou sprašových pokrovov a nedostatkom riečnych terás. Má odlišné hydrogeografické pomery a pôdnu pokrývku. Z pôvodnej vegetácie sa prenikavou poľnohospodárskou činnosťou človeka zachovali len malé ostrovčeky lesa. Celý komplex priaznivých činiteľov ovplyvňuje procesy vodnej erózie, ktoré prebiehajú v rôznej intenzite a forme.

1.2.1 Nepatrná až nijaká vodná erózia pôdy charakterizuje veľmi plochý reliéf (sklon 0—2°) holocénnych rovín a agradačných valov.

1.2.2 Mierna až intenzívna vodná erózia pôdy prebieha na pahorkatinnom reliéfe s prevládajúcim sklonom povrchu 2—5°. Pri členení na nižšie jednotky (1.2.2.1 až 1.2.2.3) sa brali do úvahy najmä asociácie pôdnych typov a morfometrické vlastnosti reliéfu.

Mapa regionalizácie zrýchlenej vodnej erózie v Podunajskej nížine.

1. Prevládajúca areálová erózia a miestna líniová erózia pôdy v pahorkatinnom reliéfe s miernou kontinentálnou klímou.
1.2 Oblasť Podunajskej nížiny.
1.2.1 Nepatrná až nijaká zrýchlená vodná erózia.
1.2.2 Mierna až intenzívna zrýchlená vodná erózia.
1.2.2.1 Mierna erózia pôdy.
1.2.2.2 Stredne silná erózia pôdy.
1.2.2.3 Intenzívna erózia pôdy.