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THE RECENT AND PRESENT-DAY GEOMORPHIC PROCESSES IN SLOVAK CARPATHIANS
STATE OF THE ART REVIEW

INTRODUCTION

The aim of the contribution is to characterize the state of the art of investigation of the recent and present-day geomorphic processes taking part in shaping the relief of the Slovak Carpathians. Attention is paid to the research realized in the period of the last 10–15 years. The results of older investigations of selected groups of processes are summarized in an exhaustive manner in well known book monographs by Nemčok (1982) on landslides, Zachar (1982) on soil erosion and Midriak (1983) on geomorphic processes operating in high mountains. The trends of investigation of the geomorphic processes in the Slovak scientific, research and pedagogic institutions were summed up by Stankoviansky (1983, 1984a).

The contribution is divided into two parts, characterizing the operation of geomorphic processes in two basic altitudinal climatic morphogenetic systems, identified in the Carpathians by Kotarba and Starkel (1972). These are lower and much more extensive temperate forest system and the higher but little extensive cryonival system. Their boundary is represented in fact by the upper timber line which is identical here roughly with the contour line of 1,500 m a.s.l. The above morphogenetic systems are characteristic by markedly different geo-ecological conditions resulting also in differences in the occurrence and course of the geomorphic processes.

In the sense of the classification of exogenic geomorphic processes by Stankoviansky (1983), the investigation of the processes in the territory of the Slovak Carpathians was focused above all on the gravitational, water-induced (namely runoff, fluvial, standing water), cryogenic, nival and eolian processes.

THE RECENT AND PRESENT-DAY GEOMORPHIC PROCESSES IN TEMPERATE FOREST MORPHOGENETIC SYSTEM

This part is devoted to the results of study of the recent and present-day geomorphic processes and landforms shaped by these processes in the given morphogenetic system. From among the above mentioned groups of geomorphic processes, attention is paid mainly to the operation of gravitational and water-induced processes.

The gravitational processes represent the most serious geomorphic hazard in Slovakia. The partial gravitational processes as creep, sliding, flowing and falling result in the creation of the slope deformations as creep deformations, landslides, slope flows and rock falls (Malgot et al. 1994). It was not possible to distinguish the older gravitational deformations from the recent and present–day ones in the contribution. Nemčok (1982) quotes the total 9,194 slope failures in Slovakia, affecting roughly 1,500 km^2, i.e. approximately 3% of its territory. By Modlitba and Klukanová (1996) 4,447 new localities were registered during another stage of systematic investigation of gravitational deformations in the 1980s. The research found out that the regional extent of the gravitational deformations depends on the geologic structure, geomorphic and climatic conditions. The most affected areas are that built by flysch rocks, the intermountain basins and young volcanic mountains. Specific types of slope failures originated in the core mountains, above all in high ones, built by the crystalline and Mesozoic sedimentary rocks (Malgot and Baliak 1996). The gravitational deformations damage the forests, meadows, pastures and arable land. Approximately 90% of new deformations originate by reactivation of older ones due to negative anthropic interventions (Malgot and Baliak 1993). In connection with high degree of hazard of gravitational processes, the systematic long-term monitoring of their activity is realized, focused on selected localities of primary economic interest (Wagner et al. 1996b, 1997).

The most complex publication on gravitational deformations is that of Wagner et al. (1996a), summarizing the present results of research of these phenomena from the Slovakia wide viewpoint and introducing selected examples of contemporary regional investigations. From among other numerous regional works on this topic we present only the ones concerning the flysch regions (e.g. Kováciková et al. 1989, Kováčik and Ondrášik 1991, Kováčik 1992, Harčár 1993) and the volcanic mountains (e.g. Dzurovcin 1990, Harčár and Krippel 1994).

The study of the water-induced geomorphic processes was focused above all on the runoff and fluvial processes, as well as on the processes of standing waters. Under “runoff processes”, the geomorphic processes initiated by surface runoff, i.e. by water flowing down the slope surface during extreme rainfalls and snow melt (cf. Stankoviansky 1995, 1997b), named by the pedologists “water erosion”, are meant. The runoff processes were studied in disparate landscape types (woodland, farmland) but also in mixed woodland-farmland types in the framework of drainage basins or parts of mountains. Various approaches were used namely the measurement of the rate of the present-day processes, mapping of their spatial distribution, assessment of geomorphic effect of present-day and recent processes, as well as the evaluation of transformations in operation of the processes due to land use changes.

The measurements of the rate of runoff processes using a deluometric method were realized exclusively in woodland, namely in the spruce and beech ecosystems, partially also in the fir, pine, larch, oak and hornbeam ecosystems (Midriak 1993b). Absolute and relative soil losses were distinguished while the first case represents the actual removal of material to hydrographical network, the second its redistribution limited to the slope. The measured values of the absolute soil losses in woodland in Slovakia are in fact very low, they reach 18 kg/ha/year in average in coniferous forest and 24 kg/ha/year in deciduous forest. However, these values fluctuate in particular localities, they range from 1 to 61 kg/ha/year. The lowest absolute soil losses are typical for the fir and spruce forests, the average soil losses for the beech forests and above the average for the oak and pine forests. The relative soil losses are represented by the redistribution of the inorganic as well as organic material, while the displacement of inorganic matter is more significant. The annual redistribution of inorganic material reaches 8–891 kg/ha (109–323 kg/ha in average), depending on the specific conditions of particular stand. The amount of redistributed organic particles is 15–544 kg/ha/year (132–255 kg/ha/year in average).

In general, the presented results testify the high anti-erosional effectiveness of forests. However, this function of forest is on many places markedly weakened, namely by the large scale forest clearance, incorrect skidding technologies, construction of forest unpaved roads, ski run tracks and ski lifts (Midriak 1988). The influence of anthropic activities on the runoff processes in woodland was studied in the locality Komárnik situated in the Laborec Upland, built by flysch rocks, covered by mixed fir-beach forest and in the locality Biely Váh in the part of the Kozie chrbty Mts, built by carbonate rocks, covered by spruce forest (Midriak 1989, 1994). In the first case, the absolute soil losses are 13–20 kg/ha/year, the relative losses are 333–1,000 kg/ha/year, in the second case it is 22–51 kg/ha/year and 423–688 kg/ha/year respectively. The highest values in both localities were associated with clear-cut areas (Midriak 1989).

The measurements of the rate of runoff processes were realized also in the East Carpathian Biosphere Reserve, built by flysch rocks (Midriak 1995a, 1995b). The measured values of the absolute soil losses by areal runoff processes are relatively low (16–81 kg/ha/year), but the total losses (i.e. absolute plus relative ones) on clear-cut areas reach up to 1,570 kg/ha/year. Much higher soil losses are initiated by the linear runoff processes controlled by tractor wheel tracks, logging tracks, forest roads, etc. Such soil losses are almost 100-times higher than the losses initiated by areal erosion (4.4–14 m^3/ha/year). The average removal from one meter of length of unpaved skidding roads due to both the mechanical scraping of the road surface by logged trees and the successive operation of concentrated flow erosion, ranges from 0.13 to 0.61 m^3/year (Midriak 1995b).

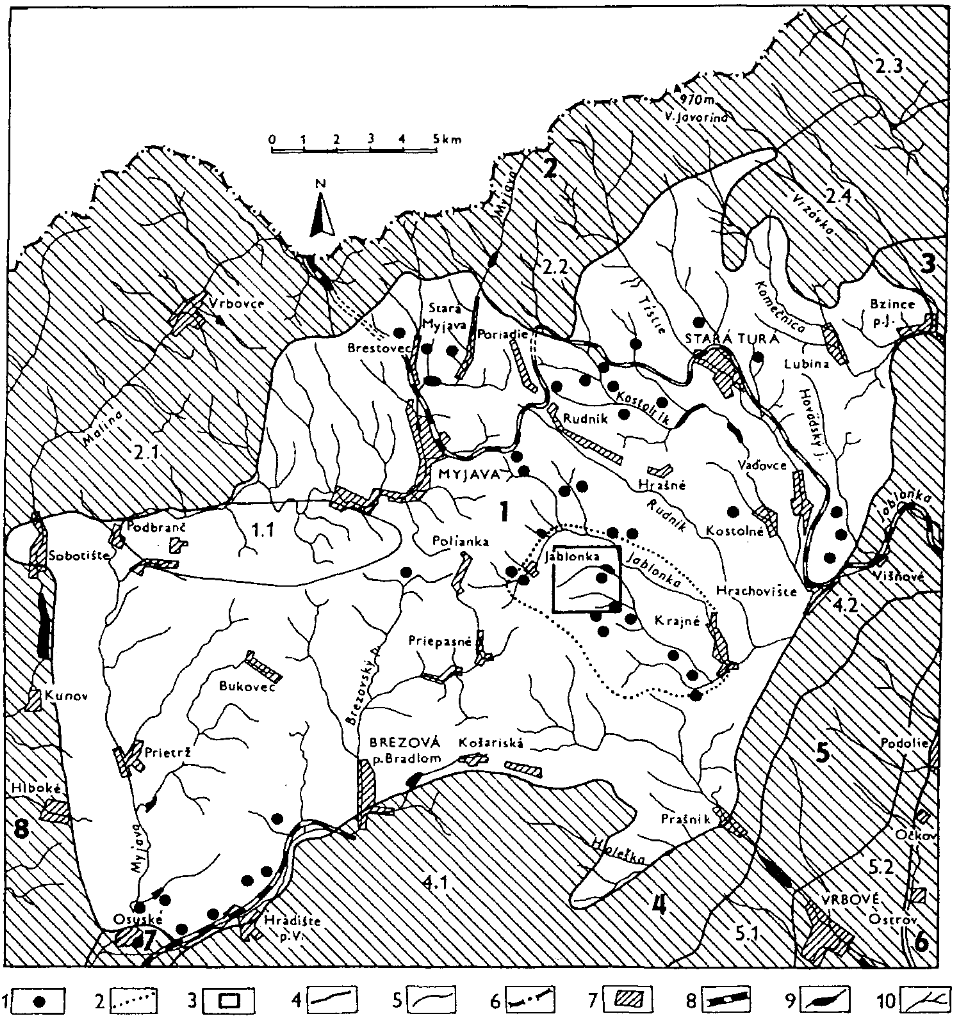
Contrary to the woodland, the runoff processes in farmland were studied from the viewpoint of their geomorphic effect, under which above all the geometric transformations of relief and changes in operation of the given processes are meant. The research was focused on the intensively cultivated areas of the Myjava Hill Land, mainly in the Jablonka Catchment (Fig. 1). An immediate, operative effect of the particular and documented erosion-accumulation events, as well as the medium-term to long-term effect of sequence of anonymous consecutive events during the period of anthropically influenced relief shaping were distinguished (Stankoviansky 1998). The immediate geomorphic effect of areal and linear runoff processes was studied on the basis of successive detailed map documentation of manifestations of single events, either extreme rainfalls (Stankoviansky 1997d) or snow melt (Stankoviansky 1995), namely for the purpose of understanding the regulations of spatial distribution of the rills and ephemeral gullies in relation to relief, land use and tillage practices (Figs. 2 and 3, Photo 1).

The evaluation of long-term geomorphic effect of relief-forming processes in the territory of the Myjava Hill Land resulted in the identification of the stages of its relief shaping in the Holocene with characteristic sets of processes and their geomorphic manifestations (Stankoviansky 1994a). In the framework of the evaluation of medium-term geomorphic effect of runoff processes during relatively short, only seven centuries lasting period of anthropic transformation of original forested landscape, attention was paid to the lowering of the surface

Fig. 1. The situation sketch of the Myjava Hill Land — the model teritory for the investigation of geomorphic effect of the runoff processes in farmland: 1 — sites of study of extreme rainfall effects, 2 — boundary of area under study of snow melt effect, 3 — selected part of this area, see Fig. 3 for comparison, 4 — boundaries of geomorphological units, 5 — boundaries of geomorphological subunits, 6 — state boundary of the Slovak and Czech Republics, 7 — settlements, 8 — railway roads, 9 — water reservoirs, 10 — water courses. Geomorphological units: 1 — Myjava Hill Land: 1.1 — Branč Klippes; 2 — White Carpathians: 2.1 — Žalostiná Upland, 2.2 — Javorina Highland, 2.3 — Beštiny, 2.4 — Bošáca Klippes; 3 — Považie Basin; 4 — Little Carpathians: 4.1 — Brezová Carpathians, 4.2 — Čachtice Carpathians; 5 — Trnava Hill Land: 5.1 — Sublittlecarpathian Hill Land, 5.2 — Trnava Loessy Plain; 7 — Bor Lowland; 8 — Chvojnica Hill Land

Ryc. 1. Szkic sytuacyjny Wysoczyzny Myjawskiej — obszar modelowy do badań geomorficznych skutków erozji gleb na obszarze rolniczym. Przedstawione główne jednostki geomorfologiczne i lokalizacja obszaru objętego badaniami skutków roztopów, 3 — część obszaru pokazana na ryc. 3.; 1 — miejsca badania skutków opadów ekstremalnych, 2 — granica obszaru pokazana na ryc. 3, 4 — granice jednostek geomorfologicznych, 5 — granice podjednostek geomorfologicznych, 6 — granica pomiędzy Słowacją i Czechami, 7 — miejscowości, 8 — linie kolejowe, 9 — zbiorniki wodne, 10 — cieki wodne. Jednostki geomorfologiczne: 1 — Pogórze Myjawskie: 1.1 — Skałki Branč; 2 — Białe Karpaty: 2.1 wyżyna Žalostiná, 2.2 — góry Javorina, 2.3 — Beštiny, 2.4 — Skałki Bošáca; 3 — Dolina Wagu; 4 — Małe Karpaty: 4.1 — Karpaty Brezowskie, 4.2 — Karpaty Czachtickie; 5 — Pogórze Trnawskie: 5.1 — pogórza Małych Karpat (Podmalokarpatska pahorkatina), 5.2 — równina lessowa Trnavy; 7 — nizina Boru; 8 — wzgórza Chvojnicy of ridges and slopes (Stankoviansky 1997a, 1998), to the rising of dell and valley bottoms (Stankoviansky 1997b), to the generation of permanent gullies (Stankoviansky 1997c) and of washed furrows (Stankoviansky 1998). The slope lowering is a result of combination of runoff and tillage erosion. The dense network of permanent gullies is conditioned predominantly anthropically, while the greatest increase of gully erosion is connected with the culmination of the kopanitse colonization at the end of the 18th and at the beginning of the 19th centuries, corresponding with the last stage of the so called Little Ice Age (Stankoviansky 1997c).

In the framework of evaluation of medium-term geomorphic effect of runoff processes attention was paid mainly to the period after collectivization



in farming. Using buried in situ scales there were found out approximately 1 m thick sediment beds, accumulated by the obstacles in the valley bottoms and below the slopes, corresponding with the period from the beginnings of collectivization till now (Stankoviansky 1996). Comparing the character of runoff processes before and after collectivization there were found out

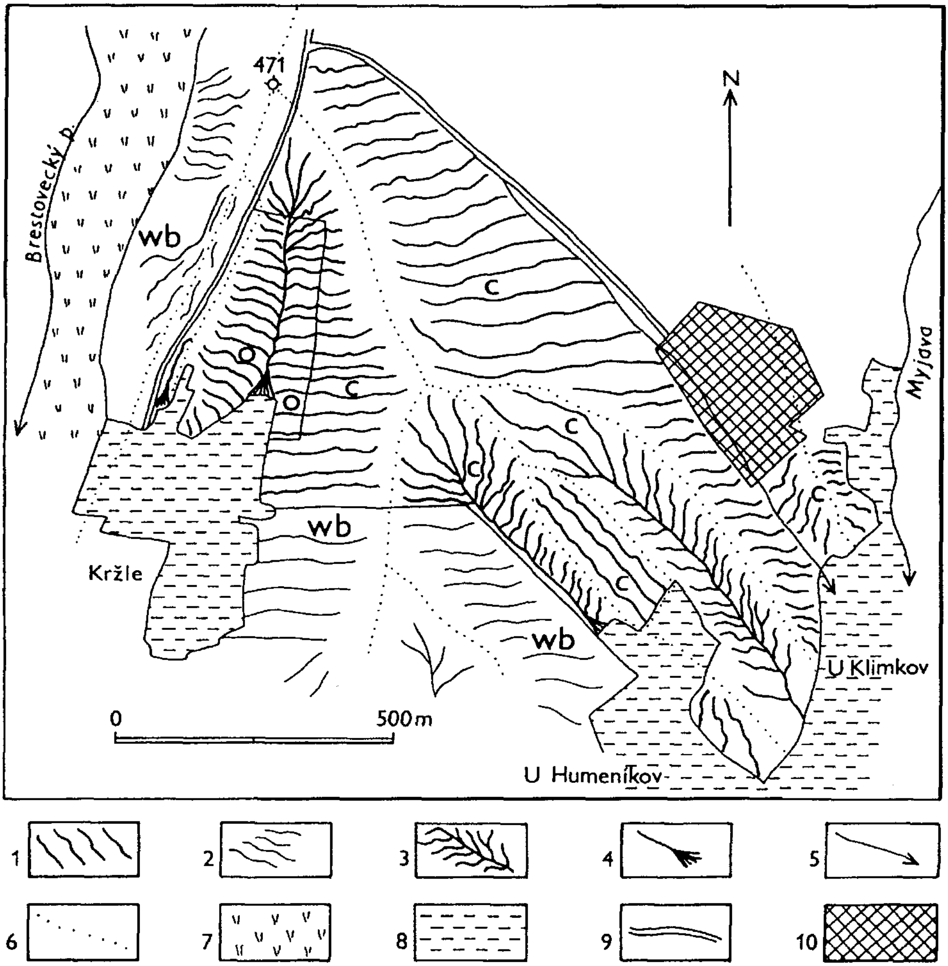


Fig. 2. The example of documentation of geomorphic effect of the runoff processes (rill and concentrated flow erosion) during the extreme rainfalls in May 1993 between the villages Brestovec and Stará Myjava, the Myjava Hill Land: 1 — marked rills, 2 — less distinct rills, 3 — ephemeral gullies, 4 — colluvial fans, 5 — water courses, 6 — divides of microcatchments, 7 — meadows, 8 — hamlets, 9 — roads, 10 — collective farm Stará Myjava, wb — winter barley, o — oats, c — corn

Ryc. 2. Przykład geomorfologicznej dokumentacji efektów geomorficznych (erozji żłobinowej i linijnej) podczas ekstremalnych opadów w maju 1993 roku pomiędzy wioskami Brestovec i Stará Myjava: 1 — wyraźne żłobiny, 2 — mniej wyraźne żłobiny, 3 — okresowe rynny, 4 — stożki koluwialne, 5 — cieki, 6 — wododziały mikrozlewni, 7 — łąki, 8 — wioski, 9 — drogi, 10 — spółdzielnia rolnicza Stará Myjava, wb — jęczmień zimowy, o — owies, c — kukurydza

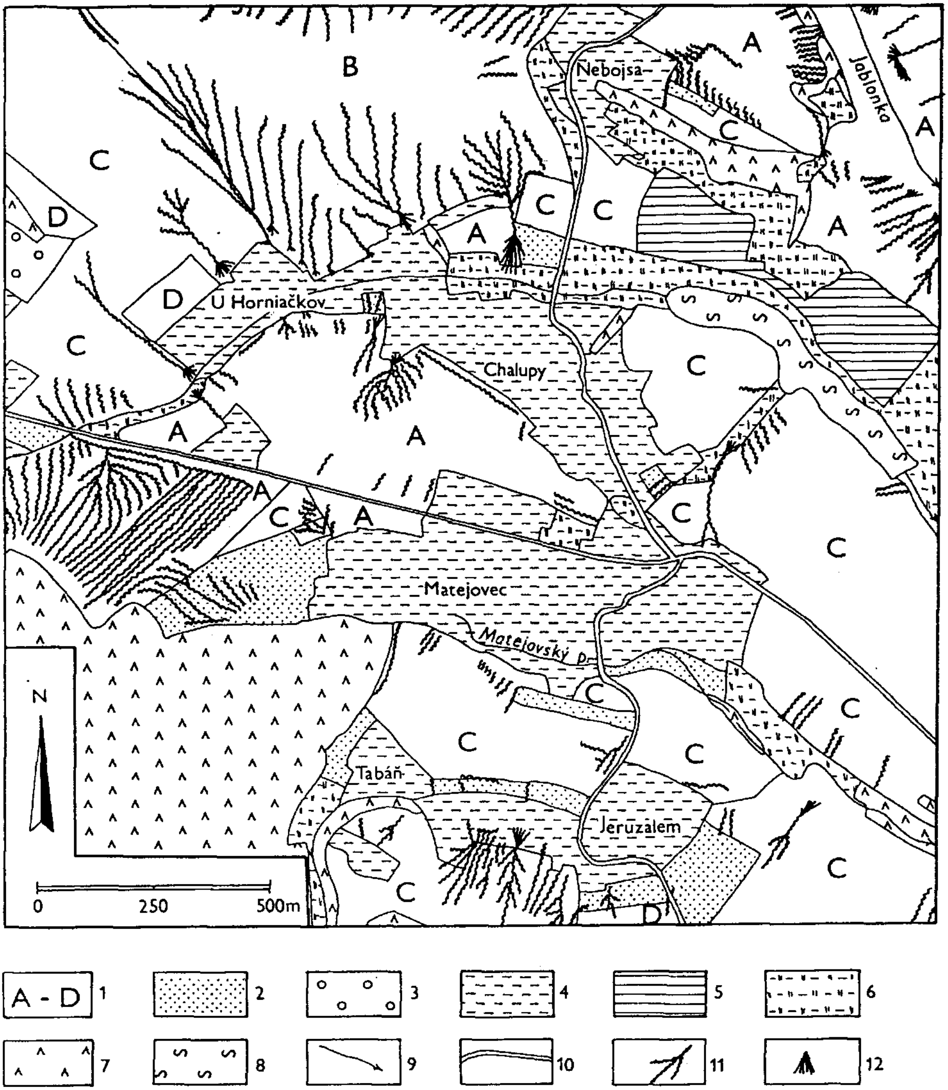


Fig. 3. The example of documentation of geomorphological effect of the runoff processes (rill erosion) during the snowmelt in March 1993 in the Upper Jablonka catchment between the villages Jablonka and Krajné, the Myjava Hill Land: 1 — cooperative fields (A — winter wheat, B — oil rape, C — ploughed fields, D — clover, alfalfa, grass), 2 — private plots, 3 — large scale orchards, 4 — hamlets, 5 — collective farm (Matejovec), 6 — meadows and shrubberies, 7 — forest and belts of trees, 8 — water reservoirs, 9 — water courses, 10 — roads, 11 — rills, 12 — fans below rills

Ryc. 3. Przykład geomorfologicznej dokumentacji efektów geomorficznych (erozji żłobinowej) podczas roztopów w marcu 1993 roku w zlewni Górnej Jabłonki pomiędzy wioskami Jablonka i Krajné, Wysoczyzna Myjawska: 1 — pola spółdzielni rolniczej (A — zimowa pszenica, B — rzepak, C — pola orne, D — koniczyna, lucerna, trawa), 2 — pola prywatne, 3 — rozległe sady, 4 — wioski, 5 — spółdzielnia rolnicza (Matejovec), 6 — łąki i krzewy, 7 — łasy i pasy drzew, 8 — zbiorniki wodne, 9 — cieki, 10 — drogi, 11 — żłobiny, 12 — stożki u podnóży żłobin

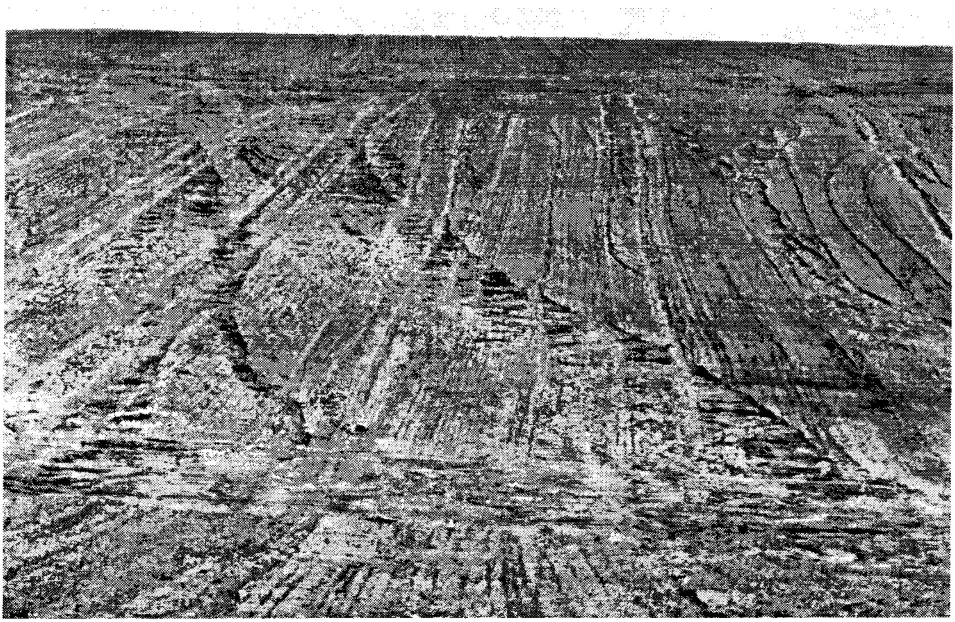


Photo 1. The geomorphic effect of the rill and concentrated flow erosion provoked by the extreme rainfalls in May 1993 on the slope and bottom of the dry valley near the village Brestovec, Myjava Hill Land

Fot. 1. Skutki geomorficzne erozji żłobinowej i linijnej wywołanych ekstremalnymi opadami w maju 1993 roku na stokach i w dnie suchej doliny koło wsi Brestovec, Wysoczyzna Myjawska

marked differences in their course. For the older land use type the predominantly linear character of processes was typical. Linearly directed, concentrated flow erosion, was controlled mainly by artificial linear landscape elements. For the postcollectivization way of the land use the predominantly areal character of operation of runoff processes is typical (Stankoviansky 1998) (Photo 2).

In the neighbouring Považie Basin the ^{137}Cs method was used for the evaluation of geomorphic effect of joint operation of runoff and tillage erosion during the postcollectivization period. The geomorphic effect of above processes was assessed in the dell hollows deepened in slopes in the localities Horné Srnie and L'uborča (Lehotský and Stankoviansky 1992) and on straight slope in the locality Bzince pod Javorinou (Lehotský et al. 1993). The total lowering of the soil surface found out on the steepest slope portions in all three localities was approximately 5 cm, the total raising of the surface of the lowest and the least inclined relief portions ranged from 10 to 15 cm.

The geomorphic effect of runoff and eolian processes, accelerated in conditions of agricultural utilization of southern slopes of the carbonate massif of the Slovak Karst during the last three centuries with culmination in the years 1870–1970

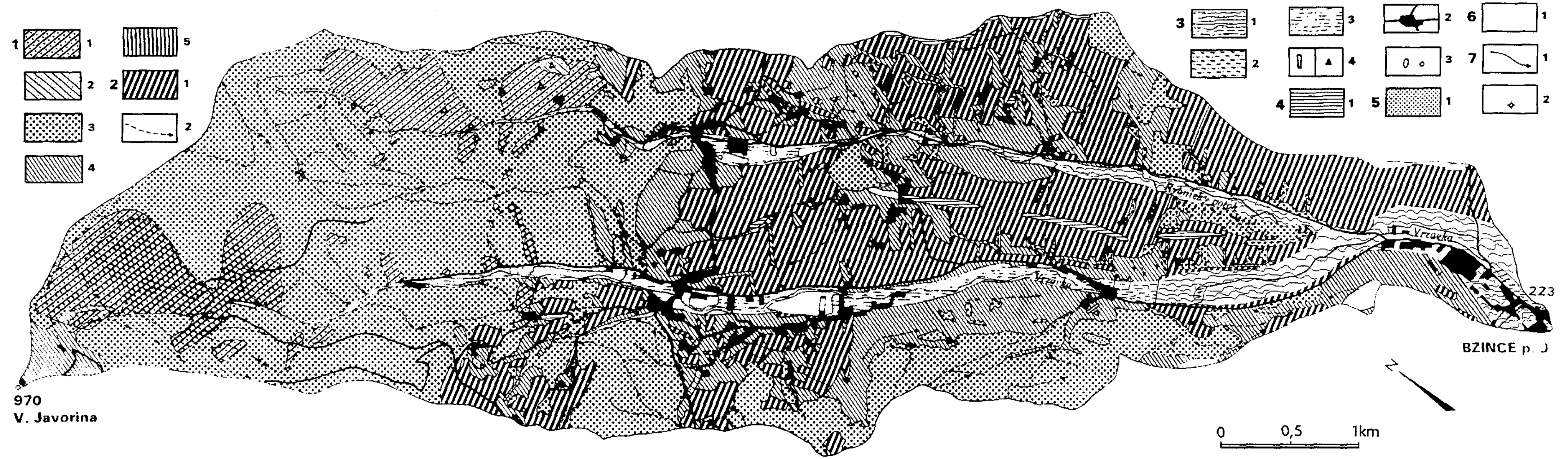


Fig. 4. The map of spatial distribution of recent and present-day exogenic geomorphic processes in the Vrzavka catchment, the White Carpathians. 1 — Dominant gravitational processes: 1.1 — deep and surface creep, landslides, earth flows, overthrowing of trees, 1.2 — deep and surface creep, landslides and earth flows, 1.3 — surface creep, overthrowing of trees, 1.4 — surface creep, 1.5 — falling, 2 — Dominant runoff processes: 2.1 — sheet wash, rill erosion, splash erosion, surface creep, agricultural anthropical processes, 2.2 — gully erosion, 3 — Dominant fluvial processes: 3.1 — fluvial processes, splash erosion, agricultural anthropical processes, 3.2 — fluvial processes, overthrowing of trees, 3.3 — fluvial processes, 3.4 — fluvial limestone precipitation (a. at the bottom of the valleys, b. on the slopes), 4 — Dominant anthropical processes: 4.1 — agricultural processes, splash erosion, 4.2 — building processes, 4.3 — exploitation processes, 5 — Organogenic processes: 5.1 — overthrowing of tr ees, 6 — Areas free of the above-mentioned processes, 7 — Other symbols: 7.1— water courses, 7.2 — elevation spots

Ryc. 4. Mapa przestrzennego zróżnicowania współczesnych procesów egzogenicznych w zlewni Vrzavka w Białych Karpatach. 1 — Dominacja procesów grawitacyjnych: 1.1 — wgłębne i powierzchniowe spełzywanie, osuwanie, spływy ziemne i przewracanie drzew, 1.2 — wgłębne i powierzchniowe speływanie, osuwanie i spływy ziemne, 1.3 — speływanie powierzchniowe i przewracanie drzew, 1.4 — spełzywanie powierzchniowe, 1.5 — odpadanie, 2 — Dominacja procesów zmywowych: 2.1 — spłukowanie powierzchniowe, erozja żłobinowa, erozja rozbryzgowa, spełzywanie powierzchniowe, procesy związane z uprawą ziemi, 2.2 — erozja wąwozowa, 3 — Dominacja procesów fluwialnych: 3.1 — procesy fluwialne, erozja rozbryzgowa, procesy związane z uprawą ziemi, 3.2 — procesy fluwialne, przewracanie drzew, 3.3 — procesy fluwialne, 3.4 — proces wytrącania martwic wapiennych (a. w dnie dolin, b. na stokach), 4 — Dominacja procesów antropogenicznych: 4.1 — procesy rolnicze, erozja rozbryzgowa, 4.2 — procesy związane z budownictwem, 4.3 — procesy związane z eksploatacją surowców naturalnych, 5 — Procesy organogeniczne: 5.1 — przewracanie drzew, 6 — Obszary nie objęte procesami wymienionymi powyżej, 7 — Inne symbole: 7.1 — cieki, 7.2 — punkty wysokościowe

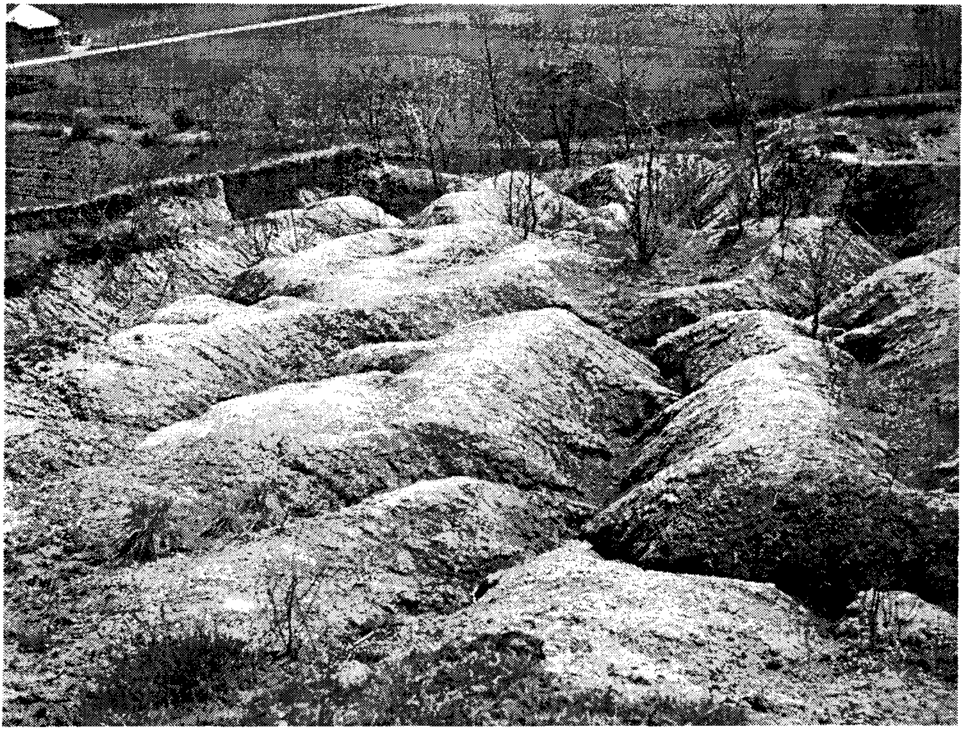


Photo 2. Erosive gully in the Koşice's-gravel-formation, East Slovakia (by R. Midriak)
Fot. 2. Żłobiny erozyjne w utworach żwirów koszyckich, Wschodnia Słowacja (fot. R. Midriak)

leading to their devastation as well as the influence of successive forestation on the course of runoff processes is discussed by Midriak and Lipták (1995).

The summarizing data on the rate, extent and temporal changes of runoff processes (water erosion by quoted authors) from the Slovakia wide viewpoint are presented by Šály and Midriak (1995).

On the example of the Vrzavka Catchment at the junction of the White Carpathians, Považie Basin and Myjava Hill Land a set of geomorphic processes taking part in the relief shaping in the recent and present-day period was characterize (Stankoviansky 1988). Also the map of spatial distribution of processes operating in this catchment (Fig. 4) was elaborated in the scale 1 : 10,000 (Stankoviansky 1994b). The relationships between the chemical denudation on one side and the runoff velocity, the value of specific runoff and the areal share of forest on the other in the part of the Vrzavka Catchment were studied by Hanušin (1993).

The operation of geomorphic processes in the southern part of the Little Carpathians was described by Urbánek (1989), in the Levoca Upland by Novodomec (1995), in the Poloniny region by Dzurovčin (1997) and Chomaničová (1997). The relationship of the gullies to geological structure and relief in the Nízke Beskydy Mts is discussed by Harčár (1995).

The investigation of fluvial processes as well as of processes of standing waters in reservoirs in the mountainous part of Slovakia in the given period was focused mainly on geometric changes of the river channels due to activity of fluvial erosion and accumulation, on suspended load transport, on reservoir silting and on wave abrasion. The morphological changes in the course of channels were evaluated on the basis of repeated interpretation of aerial photographs, the changes in channel bottoms on the basis of echo sounding in the selected profiles. The major results of this investigation are represented by the atlases of the individual rivers, out of which the atlases of rivers Nitra and Hron were elaborated so far (Holubová 1997).

The systematic measurements of suspended load in selected rivers (Váh, Hron, Kysuca, Nitra, Hornád, Bodrog, Uh, Laborec) were realized in 1955–1972, later only in intervals of 5–10 years. Suspended load plays a decisive role in water reservoir silting. The annual sedimentation of the suspended load in Slovak reservoirs is 8–10 times higher than sedimentation of the bed load (Holubová 1997). The water reservoir silting in Slovakia is discussed in numerous publications, we refer to the summarizing work by Holubová (1997) including the exhaustive review of bibliography. The problem of intensive reservoir silting is characteristic above all for the middle and upper reaches of the Váh River cascade what is connected with high rate of erosion processes in environment built by rocks of medium to low resistance. Due to the silting the reservoir Krpel'any lost 58%, Hričov 25% and Nosice 22% of their original volume. The total amount of the material accumulated in above reservoirs during the period from their construction till 1992 represents more than 12.7 milions m^3 of sediments what means in average approximately 35% reduction of their original volume (Holubová and Lukáč jr. 1997).

In the framework of investigation of the water reservoirs, attention was paid, beside the silting, also to the wave abrasion. Lukác (1988) and Lukáč and Lukáč jr. (1996) generalize the results of research of this phenomenon from the Slovakia wide viewpoint. Other works are dedicated to the particular reservoirs, namely to Domaşa (Harčár 1986) and Vihorlat (Lukáč and Kozuch 1989). Harčár and Trávniček (1992) studied the influence of abrasion in the Domaša reservoir on the initiation of landslides in the village Nová Kelča.

Beside the water reservoirs on the bigger rivers, attention was devoted also to the small reservoirs with the irrigation function. Janský (1992) assessed the rate of silting in 27 reservoirs by means of a volumetric method and regression analysis. A half of above reservoirs is situated in the mountainous part of Slovakia. The area of individual reservoirs ranges from 1 to 20 ha. The calculations showed that the amount of sediments represented 4.8–83.6 % of the total storage capacity of the reservoirs. The annual deposits ranged from 188 to 7,554 m^3, meaning an annual reduction of their storage volume of 0.32–9.30%. For the majority of reservoirs it was estimated, that the sedimentation would fill them much sooner than is anticipated or designed period of use (100 years). Annual sediment yield calculated by means of measured sediment volume, period of sedimentation, and the catchment area, ranges from 10.4 to 442.2 m^3/km^2 in individual reservoirs. The author states that the silting is mostly affected by the proportion and distribution of the forested and forestless areas in the catchments, but the effect of the total area of the catchment must also be considered.

THE PRESENT-DAY GEOMORPHIC PROCESSES IN CRYONIVAL MORPHOGENETIC SYSTEM

This part is devoted to the results of the study of geomorphic processes operating at present in the cryonival morphogenetic system. It corresponds with the occurrence of the highest parts of high mountains or more precisely with the territory above the upper timber line. Though the cryonival system represents only approximately 2% of the total Slovakian area, it influences significantly the extensive territories of mountains and basins, lying lower. In the framework of the Western Carpathians the following geomorphic units belong to the group of high mountains: Tatra Mts, Low Tatra Mts, Malá Fatra Mts, Veľká Fatra Mts, Choč Mts, and massifs of Babia hora and Pilsko in the Oravské Beskydy Mts. The cryonival morphogenetic system comprises the subalpine and alpine belts (the later is situated in an altitudinal span 1,800–1,900 up to 2,300 m a.s.l.), in case of the Tatra Mts it is also the atypically developed subnival belt above 2,300 m a.s.l. (Photo 3).

The investigation of present-day geomorphic processes above the timber line was focused not only on processes which are specific for the cryonival system, namely cryogenic and nival processes, but also on runoff, gravitational and eolian processes (Photo 3). The study of the manifestations of the present-day geomorphic processes and the assessment of their rates was realized almost exclucively by Midriak (e.g. 1983, 1990, 1991, 1992, 1993a, 1995c, 1996a, 1996b, 1996c, Midriak and Zaušková 1993). The geomorphic effect of the recent and present-day processes in the Low Tatra Mts were described by Stankoviansky (1984b). Hreško (1994, 1996) paid attention to the dynamics of the present-day processes in the selected part of the West Tatra Mts (Figs. 5, 6).

The most significant result of long-term field work, based on the use of numerous methods, mainly the micro-levelling, terrestrial stereo-photogrammetry, deluometric and volumetric methods, is the assessment of rate of the present-day geomorphic processes expressed by the values of the slope surface lowering. The calculated value of surface lowering by complex set of geomorphic processes operating in the regions above the upper timber line in the individual high mountains ranges from 0.10 to 0.72 mm/year (0.27 mm/year in average) (Midriak 1983, 1993a). However, it is necessary to state that the removal

Photo 3. Nivation above the timber line in the West Tatra Mts (by R. Midriak)
Fot. 3. Niwacja powyżej górnej granicy lasu w Tatrach Zachodnich (Fot. R. Midriak)

leading to the slope lowering is not areawide but it is concentrated above all to the bare or destroyed slope portions (approximately 8% of the total area). Average values of surface lowering due to the operation of geomorphic processes are quoted by this author as follows:

— low to high rate of the runoff processes (in the woodland below the upper timber line and in dwarf pine and grassland stands above it 0.001–0.007 mm/year, on bare and destructed surfaces 3.4 mm/year, maximum up to ten-fold value of an average),

— negligible to medium rate of the surface gravitational processes (due to the falling the fragments from the rocky walls 0.01–3.00, in average 0.3 mm/year, due

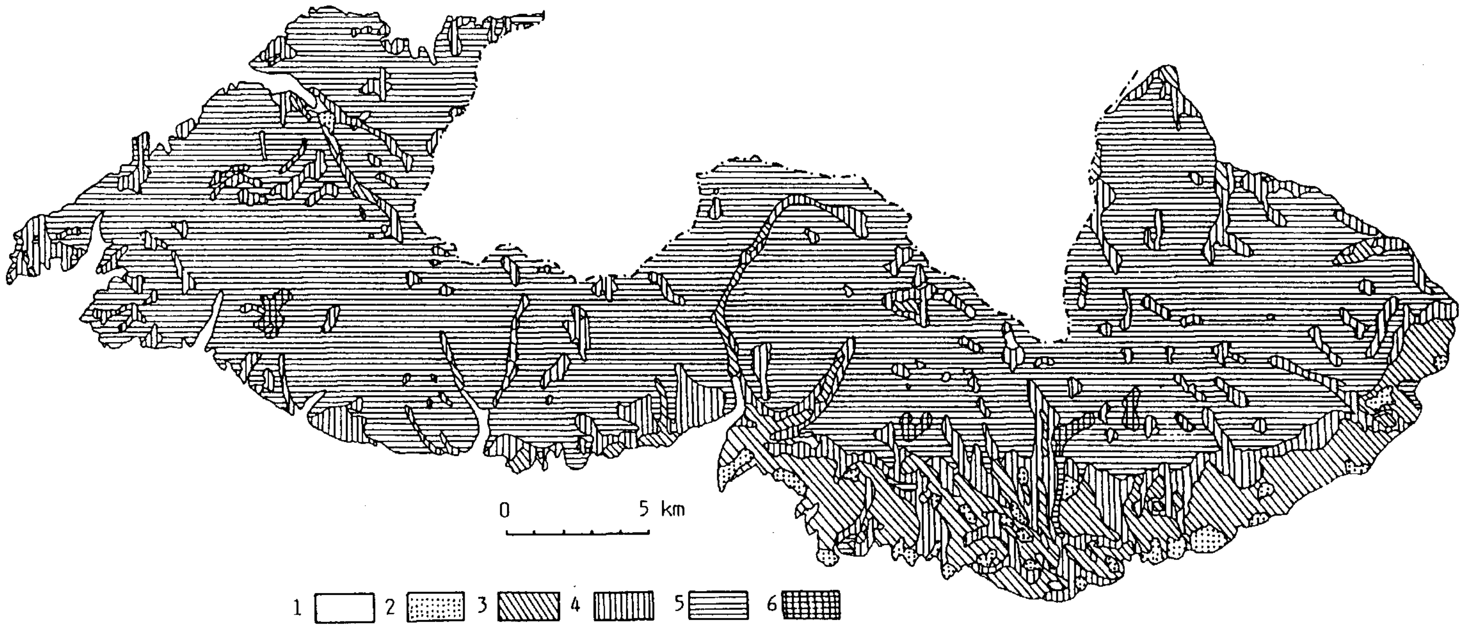


Fig. 5. Potential erosion of soil cover by surface runoff in the Slovak part of the Tatra Mts territory from the isohypse of 1,000 m to the highest parts (according to Midriak). Potential intensity (rate) of soil loss: 1 — slight (to 0.05 mm yr^{-1}), 2 — weak (0.06–0.5 mm yr^{-1}), 3 — medium (0.51–1.5 mm yr^{-1}), 4 — strong (1.51–5.0 mm yr^{-1}), 5 — very strong (5.01–15.0 mm yr^{-1}), 6 — catastrophic (more than 15.0 mm yr^{-1})

Ryc. 5. Potencjalna erozja gleb pod wpływem spłukiwania w słowackiej części Tatr od poziomicy 1000 m po najwyższe szczyty (według Midriaka). Potencjalne rozmiary usuwania gleby: 1 — nieznaczne (do 0,05 mm/rok), 2 — słabe (0,06–0,5 mm/rok), 3 — średnie (0,51–1,5 mm/rok), 4 — silne (1,51–5,0 mm/rok), 5 — bardzo silne (5,01–15,0 mm/rok), 6 — katastrofalne (ponad 15,0 mm/rok)

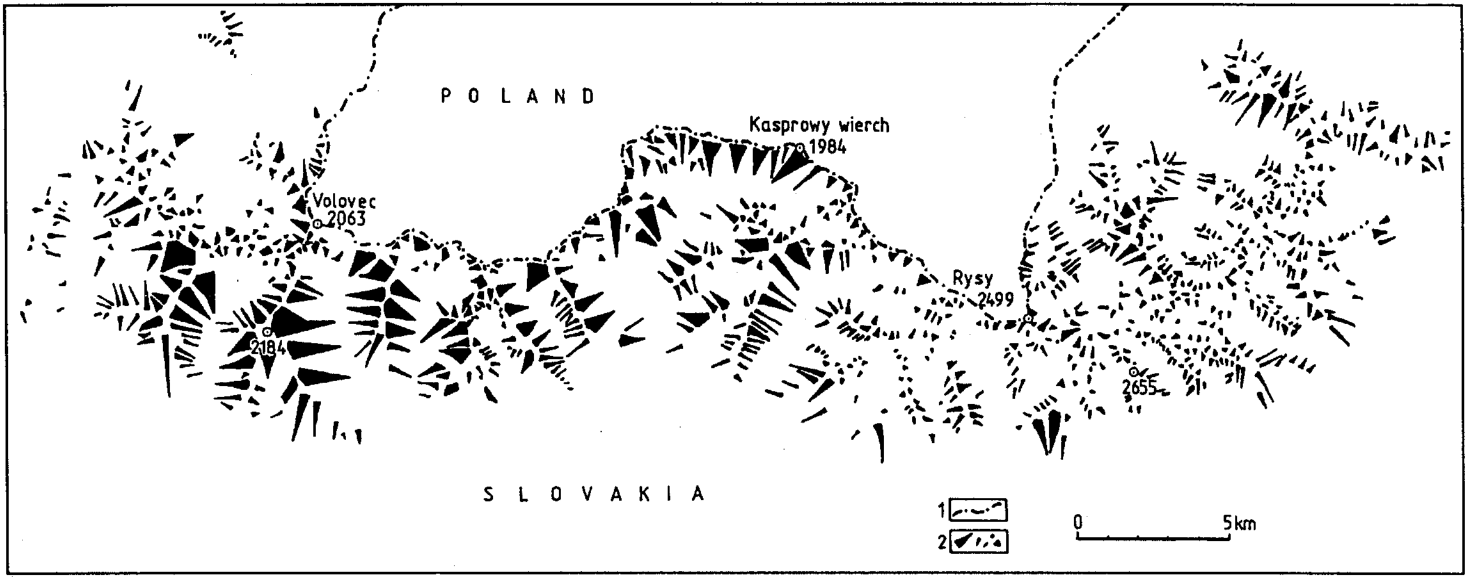


Fig. 6. Snow avalanche tracks in the Slovak part of the Tatra Mts (according to Knazovický): 1 — state boundary, 2 — size and direction of downfall

Ryc. 6. Szlaki lawin śnieżnych w słowackiej części Tatr (według Knazovickiego): 1 — granica państwa, 2 — wielkość i kierunek szlaku lawinowego

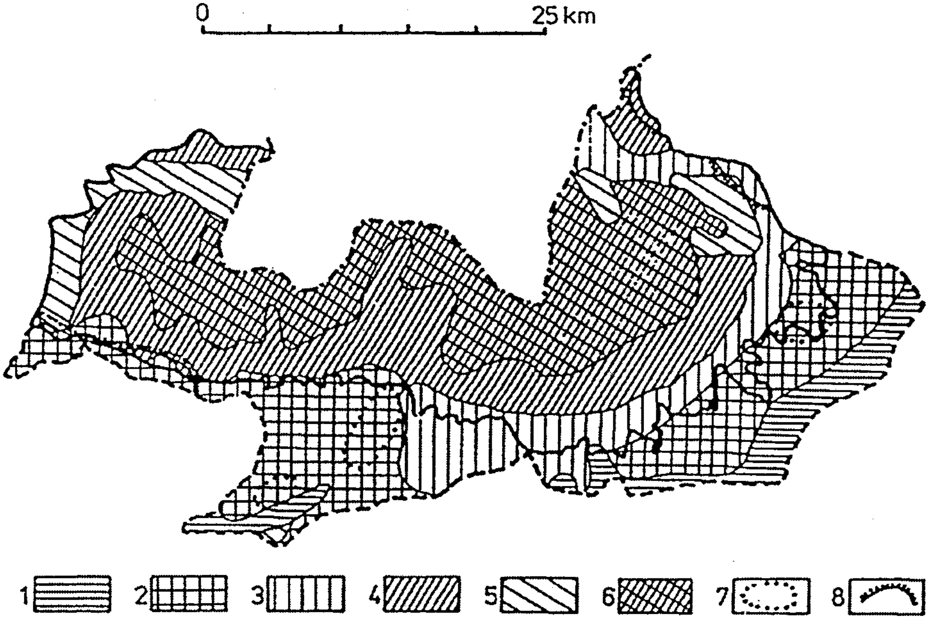


Fig. 7. Map of contemporaneous geomorphic processes on the territory of the Tatra National Park in Slovakia (according to Jakál, slightly modified by Midriak): 1 — fluvial accumulation-erosion process, 2 — slight fluvial erosion with weak slope movements, 3 — medium fluvial erosion with medium slope movements, 4 — strong fluvial erosion with strong vertical erosion, medium to strong slope movements, 5 — fluvio-karstic process, 6 — cryogenic processes above the upper timber line, 7 — colision of intensive gullies and landslides, 8 — area affected by rillerosion and landsliding

Ryc. 7. Mapa współczesnych procesów morfogenetycznych na obszarze Tatrzańskiego Parku Narodowego TANAP (według Jakála, nieco zmodyfikowane przez Midriaka): 1 — proces akumulacji i erozji fluwialnej, 2 — nieznaczne procesy fluwialne ze słabymi ruchami masowymi, 3 — erozja fluwialna i ruchy masowe o średniej aktywności, 4 — silna erozja fluwialna połączona z pogłębianiem koryt, średnie lub silne ruchy masowe, 5 — procesy fluwialne w obszarach krasowych, 6 — procesy kriogeniczne ponad górną granicą lasu, 7 — intensywne osuwanie, 8 — obszar intensywnie przekształcony przez systemy żłobinowe i osuwiska

to the creep 0.36 mm/year, due to the movement of grassland cover 1.8–28 mm/year),

— low to medium rate of the eolian processes (due to deflation 0.00003–0.5, in average 0.18 mm/year),

— low to medium rate of nival processes (due to the scraping of the surface by snow avalanches from some tenths of mm to 350 mm during one event, due to the retreat of the margins of nivation depressions 0.2–160 mm/year, due to denudation of the bare surface of nivation depressions 2.5 mm/year in average),

— negligible to medium rate of the cryogenic processes (retreat of rocky wall by gelivation 0.003–0.019 mm/year, lowering the bare surface by gelisaltation, i.e. by needle ice displacement 0.5–3.64 mm during one full regelation cycle).

In the cryonival morphogenetic system of the Slovak high mountains there are approximately 900 tracks of debris flows with the frequency once in 3–10 years and 1,754 tracks of snow avalanches, out of them 54% with frequent to very frequent occurrence (Fig. 7).

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STRESZCZENIE

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WSPÓŁCZESNE PROCESY MORFOGENETYCZNE W SŁOWACKICH KARPATACH (PRZEGLĄD BADAŃ)

Autorzy przedstawiają aktualny stan badań nad procesami morfogenetycznymi w słowackich Karpatach opierając się na publikacjach, które ukazały się w okresie ostatnich 15 lat, a zamieszczonych w spisie literatury. W części pierwszej omówiono procesy zachodzące w dziedzinie umiarkowanej leśnej, a w drugiej procesy działające powyżej górnej granicy lasu, tj. w dziedzinie krionowalnej. Zastosowano klasyfikację egzogenicznych procesów morfogenetycznych, opracowaną przez Stankovianskiego (1983) dla całego terytorium słowackich Karpat. Oprócz ogólnego omównienia roli poszczególnych procesów, zamieszczono ilościowe wskaźniki degradacji gleb wyznaczone na podstawie wieloletnich badań prowadzonych na obszarach testowych w ramach geomorfologicznego eksperymentu terenowego.