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GEOMORPHOLOGICAL EVENTS OF MEDIUM SCALE (Case Study)

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The subject of this contribution is a hilly region in Slovakia - Myjavská pahorkatina. This hilly land was settled and agriculturally exploited since the 14th century. A typical phenomenon in this landscape are intensive present geomorphological processes on slopes, flood plains, river beds. There is certain traditional hypothesis trying to explain these events. It is the assumption that these processes were caused by changes in land use during 20th century. But the spatial analysis of geomorphological events cast doubt over this hypothesis. The results of spatial analysis anticipate an other hypothesis. It can be hypothesis of metastability. It can be formulated as follows: If we investigate the relief within small time-space dimensions, then it appears unstable, as "full" of local topical events. It we investigate the relief within large time-space dimensions, then it appears unstable, as "full" of regional longlasting irreversible trends. There are some medium scale geomorphological processes and forms "between". This medium scale level behaves like a buffer muffling both forms of unstability.

Key words: geomorphological events, middle scale, land use, Verschachtelung, Traditionelle Weiterentwicklung, metastability

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INTRODUCTION

The Institute of Geography of the Slovak Academy of Sciences participates in the joint Israeli-Slovak-Czech project "The Response of Fluvial Systems to Large Scale Land Use Changes". The Slovak part of international project team is researching the mentioned topic in the catchment of the Jablonka river.

This study concentrates upon one particular aspect of the problem: geomorphological events of medium scale.

SUBJECT AND PROBLEMS

Upper part of the Jablonka catchment lies in the White Carpathians. The main ridge of afforested mountain range reaches the sea level altitude of 900 m. The foothill is in about 400 m above the sea level. The medium and the largest part of the catchment is situated at the foreland of the White Carpathians. The least part is in Little Carpathians. The Jablonka river cuts the narrow and afforested ridge of rather low mountain range (400-500 m a.s.l.) and mouths to the Danube Lowland. Its mean discharge at this point is 1 m^3/sec.

We have concentrated our attention to the most extensive part of the catchment, the Myjava hilly land. This area is characterised by broad, plain parallel ridges indicating extensive plateaus at 300-500 m above the sea level. The slopes of the valleys are 40-80 m high. The bottoms of the main valleys are wide and flat. The general geomorphological situation is characterised by monotony. Three basic large forms alternate here: ridge, slope and bottom of valley. Rock variance is scarce. Flysch-like rocks (flysch with dominant marls, sandstones and sands with conglomerates, calcareous sandstones and shales) predominate. Their resistance is medium to low. Fine textured deluvium coming from weathered parent substratum is thick, reaching in places 10-15 m. Almost all erosional forms are cut into this mantle. The parent rocks seldom occur on the surface. Mean annual precipitations in Myjavská hilly land are 650-700 mm.

The present land use is the result of long development. Some villages here had originated in 14th century. The strong wave of agricultural colonization took place in the 2nd half of the 16th century. The colonization culminated at the beginning of the 19th century. In that period substantial part of area was deforested and transformed into pastures, meadows and fields. Numerous villages and rural settlement was dispersed (kopanitse) and communicated by a thick road network.

Land use pattern was that of a minute mosaics. It has reflected not only the natural setting but also the property relations and agricultural technology. This land use has been essentially preserved until mid-20th century. Radical change came in the period of collectivisation in the years 1949-1975. Collectivisation meant a principal, politically motivated alteration of property relations (the state became the owner of the land), work organisation (central planning) and technology (heavy mechanisms, use of chemical substances).

Collectivisation has erased the original mosaic type of pattern. Small lots were joint into large cooperative fields. Step-like character of many slopes has vanished. Small though numerous terraced plots were leveled. Many shallow rills and dell-like depressions as well. However, many parts, namely the badlands, landslides etc. rema-

ined intact as the too dissected relief could not be leveled with heavy mechanisms. The area of forests grew during the period of collectivisation. Hence there were two sides to the collectivisation. Some areas were untouched, some have been entirely changed.

After heavy rains or rapid snow melting intensive geomorphological processes occur on valley sides. The main rivers responsed as well. Growing discharge causes floods.

These facts evoke following problems:

- Is occurrence of mentioned slope processes due to land use change made by collectivisation?

- Have these processes character of a fluctuation?

- Does this fluctuation concern only individual localities, or the whole catchment area?

EXISTING KNOWLEDGE AND THE NEW HYPOTHESIS

There exist two hypotheses we can lean on while solving the mentioned problems. Both are partially well grounded and partially unsatisfactory.

The older hypothesis is based on climatic geomorphology. It supposes that the plateau induced by flat ridges originated in the Plio-Pleistocene period in the form of pediment. Pediment of that period occurs in whole Western Carpathians. It is denoted by the term "river level". During the Pleistocene this pediment was disected by rivers. The system of parallel valleys originated. The main valleys, bottoms of the valleys, slopes with valley-like and dell-like depressions, widespread smoothness of surface, thick deluvium are regarded - according this hypothesis - as forms of the Pleistocene origin. It is supposed that the determination of geomorphological events by global and long-lasting climatic changes can be extrapolated to small spatiotemporal events. The autonomy of local and ephemeral events is neglected. This hypothesis stresses the large spatiotemporal context at the cost of "now and here" events.

The second hypothesis is based on the dynamic geomorphology and experience with actual processes in some localities. After heavy rainfalls the intense runoff processes occur on many slopes. The term "runoff processes" comprises a group of the processes like sheet wash, rill erosions, interril erosion They occur on slopes where the land use pattern was changed by collectivization. The causal relation is evident in many such localities. The climatic events combined with the change of the land use caused the runoff. But this causal relation is usually connected with silent and broadly accepted supposition that the certain generalisation can be made. It is supposed that the experience with local and ephemeral processes can be simply extrapolated to large spatiotemporal context. It is silently supposed that the observed local events represent the whole catchment, that the observed ephemeral events represent the most important part of the whole history of catchment.

There are some important differences between the two hypotheses. The first of them stresses large spatiotemporal events and neglects the ephemeral events. The second hypothesis stresses the little spatiotemporal events and neglects events with large spatiotemporal dimensions.

These hypotheses can be regarded as two poles. Then it is reasonable to suppose the middle scale geomorphological events are situated between them. The hypothetical middle scale events are balancing between the two poles. They are showing - according their position - ambivalent character. They are breaking long lasting periods in shorter or middle spans of time. The dominance of geomorphological heritage is slackened by them. On the other side the hypothetical middle scale events are embracing ephemeral events into longer middle periods. The dominance of actuality is slackened by them. The hypothetical middle scale events present themselves in spatial structure too. The continuity of large forms is broken into smaller middle forms showing certain degree of autonomy. Simultaneously the spatial discontinuity of small point-like forms are joint into the organization of middle forms. Now we shall try to interpret the studied area and solve the mentioned problems in terms of middle scale events.

MIDDLE SCALE EVENTS

There is an important difference between time an spatial structure of middle scale events. The time structure is not directly observable. It can be deduced of directly observable spatial forms of geomorphological forms. The function and position of middle scale forms is - according to adopted hypothesis - ambivalent. They are breaking larger forms and simultaneously unifying the smaller forms. The studied area is visually differentiated on the forested and non-forested areas. This physiognomic difference corresponds to relevant geomorphologic difference (Fig. 1). In the forested areas the small forms are usually unified according to the composition principle of "Verschachtelung" (Bremer, H. 1989, Urbánek, J. 1995). In the non-forested areas the small forms are unified according to the composition principle of "bedding" or "layering" (Bremer, H. 1989, Urbánek, J. 1995).

The relief of non-forested areas is smooth. The widespread smoothness tends to mask complicated structure of form. For instance, above the commune of Stará Turá

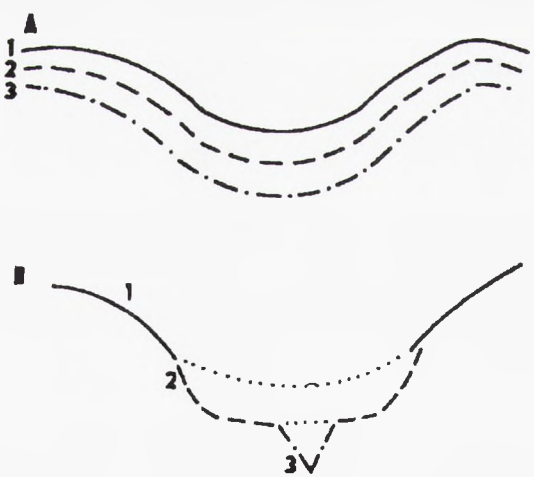

Fig. 1. Time-spatial relations between generations of the forms.
A. Traditionelle Weiterbildung, B. Werschachtelung. 1, 2, 3 - generations of forms.

there is a typical dell-like depression - Lazový jarok. Geomorphology would interpret this depression as periglacial dell. But it is not a dead relic. After heavy rains the muddy water flows from the depression towards the commune. This has probably repeatedly occurred before collectivisation and also after it. We are dealing with the phenomenon that might be denoted by a German term "traditionale Weiterbildung". Ambivalent significance of the word perfectly illustrates the situation. Something durable is persisting in the background of the new, topical events. Something new is happening despite of long lasting tendency. Duration is represented by persisting smoothness. The topical changeable aspect is represented by the sequence of different processes (periglacial processes, processes before and after collectivisation). This dell-like depression can serve as a model of the layering process while three generations of various geomorphological events merge together to one little differentiated smooth forms. Such layering or stratification, eventually "traditionale Weiterbildung" characterizes extensive smooth areas. However, the single layers are distinguishable. Basic links can be likewise outlined. These relations are illustrated in a partially idealised form in Fig. 2. Natural slopes inherited probably of the Pleistocene can be well identified. Traditional and modern land use pattern is represented by the form systems. However, they are all small forms. They represent a background on which basic large forms can be identified, on which both land use patterns were put on. They are smooth slopes between flat ridges and bottoms of valleys. These basic forms are differentiated. Important is the differentiation to concave and non-concave forms (regarding the course of the contour lines).

Traditional land use pattern is depicted by aerial photographs and older topographic maps. Rests of it are found until the present time in many places (terraces, balks, roads). On this foundation an overall picture can be outlined. Traditional land use pattern has a form of variegated mosaics consisting of small fields (forests, pastures, meadows, fields). A dense network of the borders between the fields of mosaics was represented by the balks, roads and terrain degrees between the terraced lots. This land use pattern reflects the property relations, organisation of work and technology of the period in question. It distinctly influences also the movement of the water on the slope. Water is organizing itself along by man re-disposed and fixed lines. It flows along the balks, on the roads, along the terraced plots and creates a network of grooves in a form of typical tree-like network. Well organized network is distinctly differentiated to erosional and accumulational areas. Erosional area lies on the slope, accumulational areas lies at the bottom of the main valley, as a rule reaching the bed of the main stream.

To the traditional land use an entire system of anthropogenic forms and shapes created by the flowing, prevailingly linearly organised water belongs. Underneath this system of forms in majority of the area an original smooth slope can be identified. In the areas where the traditional land use pattern does not interfere with the original smoothness of the slope we cannot talk about fluctuation. Land use pattern is superimposed and stratified over the older form without destroying or "breaking" it in any way. This though is not general. There exist areas, where precisely the traditional land use means fluctuation, that has "broken" the inherited natural smoothness of the slope and created various forms of bad land (see below).

Consequences of collectivisation can be immediately observed on extensive areas. They are described in detail in the works of M. Stankoviansky (1996, 1997). We shall briefly summarize them. Collectivisation removed the old land use pattern.

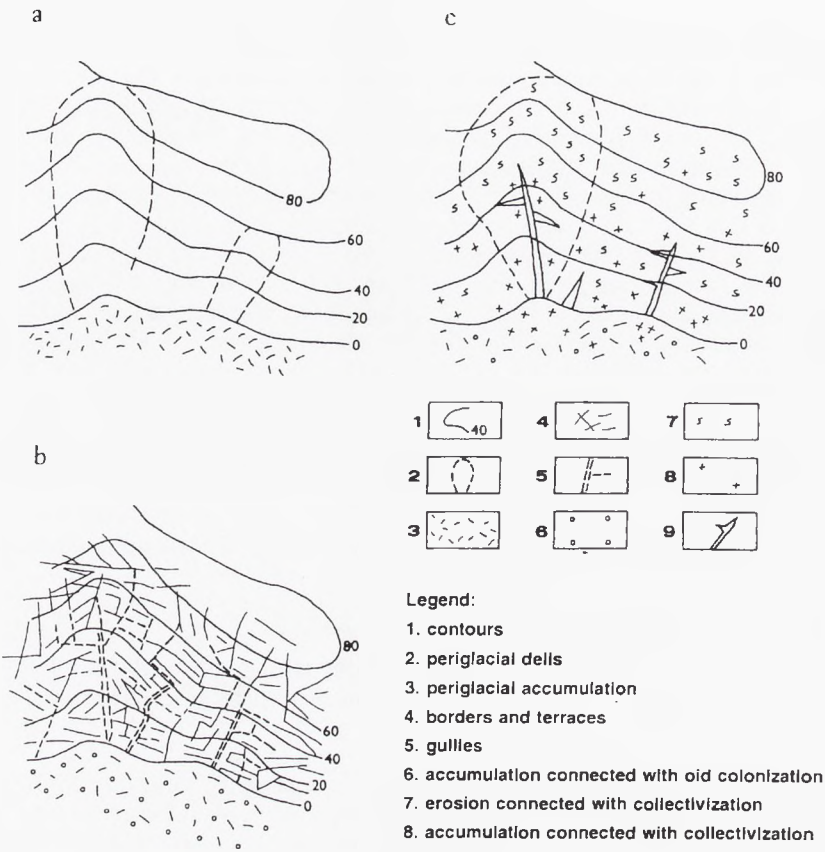

Fig. 2. Development of slopes.

Balks, roads, terraced lots, small gullies or dell-like depressions were leveled up by mechanisms. The original smoothness of slope was restored. On a unified, smooth slope large fields tilled by heavy mechanisms were founded. In general very good conditions were thus created for runoff processes. First of all at the places where the terraces agree with the contours were removed. However the runoff processes are poorly spatially organised. They are not re-disposed to any lines like the roads, balks and terraces used to be. All the contrary. If these processes start to organized to lines and networks in natural way then they are erased in the next year through tillage. The overall effect of runoff processes is therefore areal. No distinct forms originate, areas of erosion or accumulations are difficult to discern. Poorly organized processes as a rule do not transport material up to the main stream. The material stays on the slope or next to its foot.

It seems that the contact of the slope with the main stream is weaker than before the collectivisation.

On non-forested slopes the generations of form accommodate one on another, they stratify. As the original smoothness of the slopes has been preserved at this process of stratification we can talk about the "traditionale Weiterbildung" in a time span from the Pleistocene up to the present. But on the background of this long-term development we can talk also about certain fluctuation caused by collectivisation. This has several aspects. It means a qualitative change. A well-organized linear runoff linked to the traditional land use pattern changed to prevailingly sheet and purely organised type. Fluctuation means also a qualitative change. More material is transported on slopes. Thes changes are evident especially on concave slopes. Fluctuation means also a change in spatial organisation of the catchment as a whole. Material is transported to shorter distance, contact of the slopes to the main streams is weaker. However, the described fluctuation concerns only the non-forested smooth slopes. In the forested areas the original smoothness of slopes was broken.

Smoothness is widespread but not omnipresent feature. Some areas are forested. Forest usually cover the middle forms with different composition. This composition might be called "Vershachtelung". Compositional principle is the relation of inclusion. Younger form is included in older one. The limits between the forms acquire the form of a distinct terrain edge. No "Traditionelen Weiterbildung" just the opposite - a break of the traditional development, distinct fluctuation. The "Verschachtelung" composition shows some local variants.

Fig. 3 depicts the particular area that can be moreover considered a type. Similar situation often repeats. Flat ridges indicate extensive plateaus (A) with cut-in valley-like depression and two-storey compositions. Milder slopes (B) descend to the centre of the depressions where there are traces of preserved bottom (C). In the bottom of this older flatter depression is a system of profound gullies cut in. A long main gully cut into the base in its lower part is distinctly dominating. Numerous lateral gullies mouth in it. The slopes of the gullies are extremely steep, they reach the profundity of 10 or more meters. The slopes are active, they bear numerous traces of sheet wash, till erosion, gully erosion, and landslides. Bottoms are dry, very narrow. The lateral gullies mouth to the main gully in a hanging-over manner. Also the longitudinal profile of the gullies is distinctly step-like, uneven. Degree is the main component. Any distinct accumulation forms are missing. Only at the mouth of the valley-like depression into the main valley there is an cone (D) reaching as far as the main stream. The gully system is active in details and in the whole as well. The steep lateral slopes of the gullies, as well as the degrees in longitudinal profile bear distinct traces of processes.

The processes of linear water erosion created by the present gully system was triggered by man and old land use pattern. The networks of the present gullies are often linked to the anthropogenic forms, old terraces, roads and balks. The ground plan of the gullies copies the ground land of the land use pattern. This relation is only suggested in the area depicted in Fig. 3. However, it is quite evident in the contiguous areas (Stankoviansky, in press). After turning the old valley-like depression into a useless badland the area was abandoned by the peasants and forested. The activity of the processes declined. But that does not mean that the system of the gullies has completely disappeared. The system was triggered by man, though after a period of rapid growth it became a self-regulated one. It is still active event in spite of afforestation. After rains muddy water flows out of the system. It flows along the cone and reaches the main river. The stream is strong and it passes also such barrier as the

Fig. 3. Valley with system of gullies.

asphalt road. It leaves mud on the cone. It is an experience of the people living at the mouth of the valley-like depression.

The fluctuation is evident here. It is represented by the system of gullies incised into the bottom. This fluctuation is younger than the more shallow and smooth depression indicated by the rests of the bottom. This, only partially preserved older depression is perhaps a periglacial dell or the Holocene valley of the period before the first wave of colonization. The fluctuation represented by gullies is older than collectivisation. Collectivisation has not touched the area.

Topographic maps made before collectivisation depict the valley-like depression in present form.

Fig. 4 depicts the particular territory that also might be considered a type. Flat ridges indicate plateaus (A) in cut-in valley-like depression with a two-storey composition. The slopes of the depression (B) descend to well-marked bottom (C). There is a branched incision cut-in the bottom of this older depression. Its composition is similar to catene. The incision consists of five chained parts. In upper part its form is the one of dell-like depression (D). Lower this depression passes over a distinct terrain degree to an incisions (in time of rains it is a small waterfall) (E). The slopes are steep 3-4 m high. There are numerous traces of slope processes. The bottom is about 6-7 m wide, filled with debris. There is a distinct through deepened by a periodic stream. Lower again a very distinct, 3-4 m high tread (waterfall) follows, under which is a permanent water spring. Below the spring the valley (F) has a transversal V-profile. The slopes are 10 or more meters high. They are very active

Fig. 4. Valley with permanent stream.

(sheet wash, till erosion, gully erosion, landslides). In spite of it in a narrow bottom not accumulated material was found. Material brought in from the slopes is evidently carried away by the permanent stream. In the part "G" the slopes do not alter though the bottom is widening. But there is still no distinct accumulation. Not even at the mouth of the very steep furrow from the slopes of the valley is any accumulated material. Further up the slopes gradually decrease, the valley ends and mouths to the main valley. The cone lies here (H) stretching up to the main stream. In time of rains muddy water flows from valley to the cone.

Fluctuation is represented by a narrow "V" valley cut into a well distinguishable bottom of older depression. Also in this case the fluctuation is younger that this probably periglacial depression. At the same time it is older fluctuation than collectivisation. Topographic maps made before collectivisation depict the present situation. Erosion that has created younger incision was probably also in this case triggered by old land use pattern. After certain period of growth and distinct catena-like differentiation the young valley became a self-regulating one. It is still active despite of the fact that a major part of this catchment is forested.

Fig. 5 brings two typical valley-like depressions, with a common cone at the bottom of the main valley. Composition of both depressions is similar to catene. In both cases it is a combination of landslides with fluvial form. In the first depression fluvial forms dominated and in the second prevail the landslides. From the plains indicating plateau (A) milder slopes (B) drop into the first depression. Depression starts by a landslide (C). An undulated landslide is drained by the system of episodically watered furrows. Only the principal one has a permanent stream. It proceeds by a waterfall (3 m high) into the next section of depression (D). The form of this part is that of a deep incision. The slopes are about 10 m high, steep and active (sheet wash, rill erosion, gully erosion, landslides) The bottom is several meters wide, flat. The stream is cut in it by 1-2 m. The longitudinal profile is uneven, the stream intensively eroded. In the next part (E) the stream accumulates. The slopes gradually lower, the bottom widens, the bed becomes shallow, water spills over the whole bottom covered by fresh material, loam. At the mouth of the main valley is a cone (F). The streams gets completely lost here, its seeps into the material. There is no contact with the stream in the main valley. Between the first and second valley-like depression is a smooth slope (G).

In the neighbouring valley-like depression landslides dominate. Under a distinct scarp (H) is a slid material. The upper part is cut by a system of occasionally watered furrows (I). Lower the slide is cut by a system of deep furrows with permanent stream (J). The slopes of the furrows are about 10 m high, steep, live. Bottoms are uneven, streams are intensively eroding. A considerable part of the slid material is carried away by water. Lower is another turning point. The stream flows in a wide dell-like depression, a bottom of which is only slightly cut by it (K). The drop of erosion is abrupt and distinct. Further on the mentioned cone it seeps in and gets lost (F).

Similar to the preceding examples also this double valley-like depression distinctly breaks the surrounding smooth surface. It is older than collectivisation that has touched this area only marginally. The traces of the traditional land use patter are occurring here. But it is difficult to state whether the traditional land use pattern triggered off the described processes. Interaction of the landslides and fluvial processes can create a self-regulating systems also without any contribution of man. Such

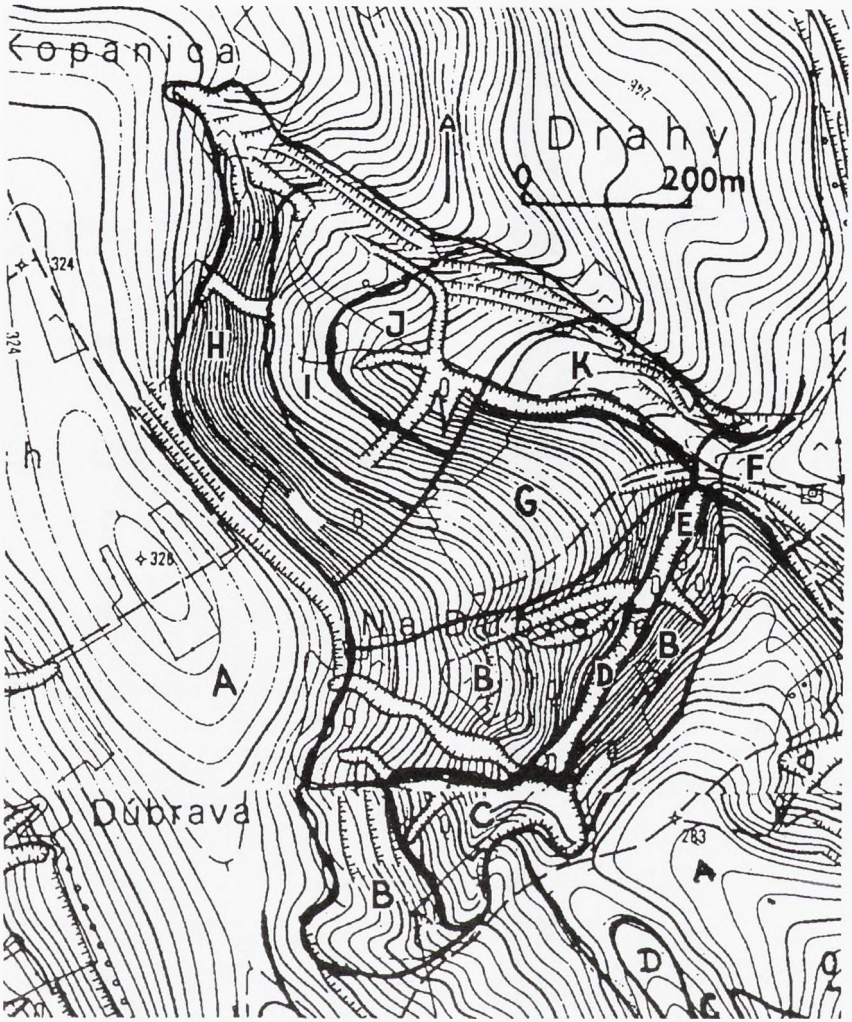

Fig. 5. Valley with landslides.

systems were described in the neighbouring region. (Urbánek 1986). Hence, it is possible that the fluctuation that has broken the original smoothness of slopes occurred before the arrival of man, at the turn of the Pleistocene-Holocene era.

CONCLUSION

The spatial differentiation of middle scale form is older than collectivisation. The human impact represented by the collectivisation was strongly influenced by this geomorphic heritage. Mosaics of middle scale form functions as a bumper. It reduces and disperses the effects of collectivisation, channelling them into certain localities.

This is the reason why the fluctuation provoked by collectivisation was not projected into the level of the large forms and did not affect their basic differentiation. This is the result of fluctuation linked to the traditional land use pattern.

Acknowledgement

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GEOMORFOLOGICKÉ JAVY STREDNEJ VEĽKOSTI (príkladová štúdia)

V Myjavskej pahorkatine sa rytmicky striedajú tri základné formy - ploché chrbty, ich svahy a dná hlavných dolín. Chrbty indikujú plošinu vo výške okolo 400 m n.m. Svahy sú vysoké 40-80 m. Dná dolín sú ploché a široké. Územie budujú vcelku nie veľmi odolné horniny paleogénu a neogénu. Delúvium je miestami až 10 m mocné. Podložie vychádza na povrch iba zriedka. Po silných dažďoch či prudkom odmäku sa hojne vyskytujú na svahoch i dnách dolín intenzívne procesy.

Pahorkatina je silne ovplyvnená človekom. Intenzívna kolonizácia začala v 16. storočí a vrcholila v 19. storočí. Vytvorila charakteristickú poľnohospodársku krajinu s množstvom drobných políčok, lúk, lesíkov a sídiel. V polovici 20. storočia v procese kolektivizácie sa obraz zmenil. Namiesto drobných políčok vznikli veľké monotónne parcely.

Tieto fakty evokujú systém problémov:

- Sú súčasné procesy zapríčinené zmenou vo využívaní zeme počas kolektivizácie?
- Majú tieto procesy charakter radikálnej zmeny, fluktuácie?

- Vzťahuje sa táto fluktuácia iba na jednotlivé lokality, alebo na povodie ako celok?

Pri riešení týchto problémov sa môžeme oprieť o dve hypotézy. Prvá spočíva na ideách dynamickej geomorfológie a skúsenosti so súčasnými procesmi. Po prudkých dažďoch sa na svahoch zmenených kolektivizáciou objavujú intenzívne procesy. Je to nesporný fakt.

Tento evidentný príčinný vzťah sa však spája s tichým predpokladom, že tieto lokálne javy môžu byť extrapolované na povodie ako celok. Druhá hypotéza spočíva na ideách klimatickej morfológie. Predpokladá, že plošina zreteľne indikovaná plochými chrbtami bola v pleistocéne rozrezávaná dolinami. Základné tvary, chrbty, svahy, dná dolín, mocné deluvium sú podľa tejto hypotézy výsledkom modelácie v periglaciálnej klíme. Počas holocénu bol tento základný obraz iba nepatrne premodelovaný.

Prvá hypotéza zdôrazňuje súčasné procesy na úkor dlhodobých vývojových trendov a veľkých foriem nimi vytvorených. Druhá hypotéza zvýrazňuje veľké formy a im zodpovedajúce dlhodobé trendy na úkor aktuálnych procesov a malých, nimi vytvorených foriem. Medzi oboma hypotézami je zreteľná medzera. Táto môže byť vyplnená hypotézou, ktorá predpokladá existenciu foriem strednej veľkosti. Tieto formy majú ambivalentnú pozíciu. Porušujú kontinuitu veľkých foriem, pričom vytvárajú na ich pozadí diskontinuálnu mozaiku. Súčasne zjednocujú malé formy do celkov podobných geomorfologickým katénam. Sú to autonómne, samoregulujúce sa formy.

Myjavská pahorkatina je vizuálne diferencovaná na mozaiku zalesnených a odlesnených území. Táto vizuálna mozaika korešponduje do značnej miery s geomorfologicky dôležitou priestorovou diferenciáciou. Je to diferenciácia na dva základné typy foriem strednej veľkosti - katén. V zalesnených oblastiach sú malé formy spravidla zjednocované na princípe, ktorý je dobre vyjadrený nemeckým termínom "Verschachtelung". Mladšia, menšia forma, je zahĺbená do staršej, väčšej. V nezalesnených oblastiach sú malé formy zjednocované na princípe vyjadrenom nemeckým termínom "Traditionelle Weiterbildung".

Mladšia forma leží na staršej bez toho, že by ju zásadným spôsobom premodelovala. Dôležité je, že riešenie vyššie spomínaných problémov sa mení v súlade s načrtnutou priestorovou diferenciáciou.

Na zalesnených svahoch je do starého periglaciálneho dna zarezaný asi 10 m hlboký zárez - výmol alebo dolinka. Je starší ako kolektivizácia. Je zapríčinený starým, klasickým spôsobom využívania zeme. Pozdĺž medzí, terás a ciest dochádzalo k intenzívnej koncentrácii povrchového odtoku. Koncentrovaná voda na predisponovaných miestach vytvorila systémy eróznych zárezov "badlandy". Tieto sú napriek zalesneniu dodnes aktívne. Mnohé z nich komunikujú s hlavným tokom. Na dnes zalesnených svahoch treba fluktuáciu pripísať starému spôsobu využívania zeme, kolonizácii pred kolektivizáciou. Navyše je to fluktuácia, ktorá sa netýkala iba svahov, ale povodia ako celku.

Reliéf na odlesnených svahoch je typicky hladko modelovaný. Na prvý pohľad to vyzerá tak, akoby tu boli zachované periglaciálne formy. Z periglaciálu zdedená hladkosť je vskutku rezistentnou črtou. Mozaika drobných políčok ju porušila iba v detailoch, v malých formách, terasách, medziach, cestách. Vcelku však hladkosť reliéfu ostala zachovaná. (Iba na predisponovaných dnes zalesnených častiach svahov vznikli systémy eróznych zárezov, ktoré znamenajú radikálnu zmenu, fluktuáciu pôvodnej, hladkej tvárnosti). Kolektivizácia odstránením medzí a terás pôvodnú hladkosť svahov zvýraznila. Výsledkom bola fluktuácia. Táto znamenala kvalitatívnu zmenu. Prevažne lineárne, priestorovo dobre organizované procesy boli nahradené plošne pôsobiacimi, slabo priestorovo organizovanými procesmi. Došlo i ku kvantitatívnej zmene - po svahoch sa pohybuje viac materiálu.

Fluktuácia má ešte jeden aspekt. Pôvodný kontakt svahov s hlavným tokom bol prerušený. Materiál, ktorý sa dnes pohybuje dolu svahmi, ostáva stáť na nich, alebo na ich úpätí. Táto fluktuácia sa nedotýka povodia ako celku.

Teraz zmeníme naše hľadisko. Pozornosť sústredíme na povodie ako celok, na mozaiku zalesnených a nezalesnených plôch, resp. mozaiku dvoch druhov katén (foriem strednej veľkosti). Vývoj povrchových tvarov na dnes zalesnených a dnes odlesnených častiach svahov neprebieha simultánne. Fluktuáciou prešli katény zjednotené na princípe "Verschachtelung" práve tak, ako katény zjednotené na princípe "Traditionelle Weiterbildung". Rozdiel je však v charaktere a veku týchto

fluktuácií. Jednotlivé časti povodia sú teda nestabilné, prechádzajú fluktuáciou. Povodie ako celok, ako mozaika katén, sa však javí ako pomerne stabilný útvar práve preto, že fluktuácie jeho častí sú rôzne a nesimultánne. Tento druh stability možno nazvať metastabilitou.

Obr. 1. Časovo-priestorové vzťahy medzi generáciami foriem.
A - tradičný vývoj, nakladanie foriem, B - vkladanie foriem, 1, 2, 3 - generácie foriem

Obr. 2. Vývoj svahov.
1 - vrstevnice, 2 - periglaciálne úvaliny, 3 - periglaciálna akumulácia, 4 - antropogénne terasy a hrany, 5 - výmole, 6 - akumulácia spojená so starou kolonizáciou, 7 - erózia spojená s kolektivizáciou, 8 - akumulácia spojená s kolektivizáciou

Obr. 3. Dolina so systémom výmoľov.
A - ploché chrbty, B - mierny svah, C - staré dno depresie, D - kužeľ

Obr. 4. Dolina so stálym tokom.
A - ploché chrbty, B - mierny svah, C - staré dno, D - úvalinová depresia, E - plytký zárez, F - hlboká dolina s priečnym profilom v tvare písmena "V", G - hlboká dolina so širokým dnom, H - kužeľ

Obr. 5. Dolina so zosunmi.
A - ploché chrbty, B - mierny svah, C - zosuny, D - hlboká dolina s priečnym profilom v tvare písmena "V", E - hlboká dolina so širokým dnom, F - kužeľ, H - odlučná stena zosunu, I - zosun nerozrezaný výmoľmi, J - zosun rozrezaný výmoľmi