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Geomorphological researches in Ózd–Pétervására Hills

Summary and Theses of PhD dissertation

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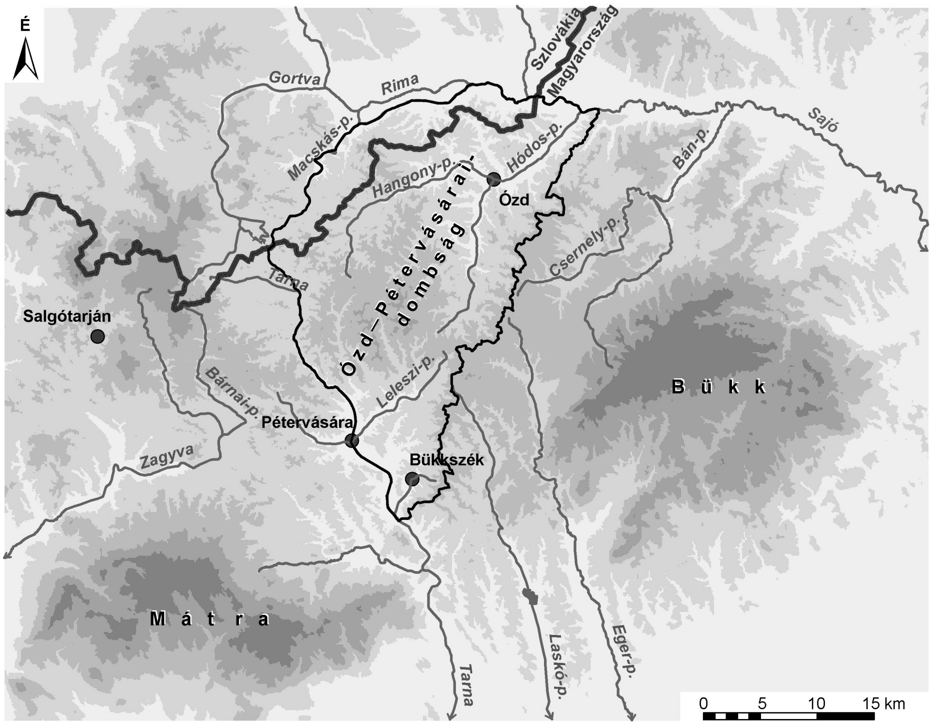
Introduction and aim of the study

The geomorphology of the „sandstone hills", situated in NE Hungary (Heves, Borsod-Abauj-Zemplén and Nográd county) and SE Slovakia, is rather unknown. There are few (and mainly older) researches and publications about the landforms of this area. Even the name and the border of this microregion is uncertain. Various names were used in literatures and maps (Vajdavár Mountains, Gömör–Hevesi Hills, Heves–Borsodi Hills, Ózd–Pétervásárai Hills etc.).

The primary aim of this dissertation was to collect the most relevant geomorphological informations of the area and to complete these with the results of new researches and observations in order to achive a consensus on the geomorphology and the name of this land.

In the geomorphological examination traditional and modern methods were applied. I analysed digital terrain and elevation models with different methods in order to complete the field works and observations (traditional methos) with more objective results. I tested some modern methods as well by validating and modifying them to achive better results.



Location of researched area

Research method

The geomorphological researches were based on field works and observations. I did not want to map each individual entities of the landforms, but I strived to recognize and describe the typical forms and the rules of their situation, distribution and evolution in the landscape.

Digital terrain and elevation models were also used in this work. The ~91 m resolution SRTM (Shuttle Radar Topography Mission) digital terrain model was applied in landscape regionalization and orographic typification. Using 20 m resolution digital elevation model I calculated the relative relief (range), slope, potential draniage network, relative elevation above local base level of erosion, and applied these models to analyse draniage networks and to prepare the geomorphological sketch map of the microregion. I prepared and analysed the digital models with Arc GIS 9.2 software and its extensions.

I examined some selected properties of erosion and derasion valleys with statistical methods. The influence of the geologic and geomorphologic patterns on the stream and draniage networks was analysed by direction statistics (EGYED L. 1957, NAGY E.–NAGY I. 1965, GÁBRIS GY. 1986). The relationship between the shape of derasion valleys and their location was analysed by chi-square methods.

Summary of scientific results

The study area is mentioned with a lot of different names and spatial extent in the geographic publications. In order to take a stand on this question I prepared and considered the publicated results of former researches complemented with field works and observations and digital terrain analysis. As a summary **an orographical unit can be found among the Tarna river, Macskás stream, Rima river, Sajó river, Hódos stream and Leleszi stream (1. thesis)**. The central part of the microregion is connected to the Bükk region with a wide saddle. Hence it can be considered as part of the Bükk region, but there are wide basins (Pétervására–Leleszi and Ózdi basin) between them. (The mentioned rivers and streams are not the exact borders of the microregion. The acurate regionalization was not the aim of the dissertation.)

Compiling the geomorphological map of the area with traditional methods (using topographic maps and making field observations) some problems were identified. Accurately mapping of the main landforms, such as valley floors, interfluves, terraces, and other geomorphological levels is very difficult, because recognizing these forms depends on individual professional experiences and skills. So the traditional mapping method is too subjective. Therefore, I used GIS and digital elevation modelling to try to edit a more objective geomorphplogical map. Using the digital elevation model of the microregion I prepared the new derivative showing the *relative elevation above the local base level of erosion*. **Analysing the histogram of this new terrain variable the valley floors and five geomorphological levels were identified (2. thesis)**. Three of these levels are corresponding with the results of former researches and field observations. This new method has not accomplished yet. It is not suited to mapping the main forms in itself, but it provides useful informations for the geomorphologists.

I applied two different techniques to determine the draniage network of the research area. The blue line methods identify the streams and rivers from topographic maps (GÁBRIS GY. 1987). The potential drainage network comes from the digital elevation model (TARBOTON, D. G. et al. 1991). I estimated the potential drainage network using different parameters to generate different draniage densities. Comparing the draniage networks – determinated different ways and parameters – of the catchment areas of the main streams provides the following result: **In the Tarna river catchment area there are more streams and valleys with small watershed (0,25–1 km2) than in the Sajó catchment (3. thesis).**

The bifurcation ratio (HORTON, R. E. 1945) of the stream channel networks of most catchment areas in the microregion higher than the average. This could indicate a sort of geological, geomorphological factors wich determinate (determinated) the evolution of the draniage system. After the detailed statistical analysis of the streams and stream segments directions I have concluded that **the directions of the permanent streams are influenced jointly by geologic structure and the average aspect of the surface. The streams and**

stream segments with higher order are more determinated than the ones with lower orders (4. thesis).

The slope gradient of the digital model of the relative elevation above the local erosion base level is above the average in the middle parts of the Hosszú-völgyi and Nagy-völgyi stream valleys. Considering the high rates of the relativ relief (range) and the convex longitudinal profile of the mentioned streams in that area, I have concluded that **the middle parts of the Hosszú-völgyi and Nagy-völgyi stream valleys are antecedent (5. thesis).** It is corresponding with the reuslts of my field works in these valleys and the observations of SZÉKELY A. (1958) in Tarna valley.

The stream valleys that originates in the highest central region of the Ózd–Pétervására Hills and have a mouth in the surrounding lower (mainly basin) areas have two different morphologic parts. In the highest region the valleys are narrow and deep with „V" shape. In the lower surfaces the valleys widen, the valley floors flare and the valley sides become gentle. In these interfluve sides and slopes the most common landforms are the derasion forms like derasion valleys with different shapes and sizes, derasion saddles, derasion buttes. The interfluves are generally asymmetrical. They have sides with different steepness and length where the shapes and density of derasion forms are also dissimilar. This unequal distribution of derasion forms in the two sides of interfluves is not always obvious. I analysed the relationship between the locations and morphologic properties of derasion valleys with nonparametric statistic (chi-square test) in two interfluves (as sample area) situated in the Pétervására–Leleszi basin. I found that **there are no significant relation between the shape of derasion valleys and their location, but the derasion valley networks in longer and gentle slopes are more complex than in the shorter and steeper ones (6. thesis).** According to my field observation this result is valid not only for the sample area, but for other similar parts of the Ózd–Pétervására Hills.

There are a lot of active slides in the landscape. Most of them are mantle or block slippage and slides with flow. They usually affect small areas and move slight mass. Except the natural causes (for example the slope erosion) the most common (indirect) causes of the slides are the dirt roads in the researched area. **The dirt roads and road cuts in the foot slope incrase the average steepness of the slope; in the mid- and crest slope they reduce speed of the runoff waters and incrase the infiltration causing the slides (7. thesis).** Several greater landslides also connected with human activity. The slides near Arló are caused by mining (LEÉL-ŐSSY S. 1950, 1973, PEJA GY. 1955, 1956a).

There are a lot of different size hollows and some caves in the sandstone cliffs. Most of them formed by selective denudation or lateral erosion of ephemeral streams and they are mainly developed by condensed water and biological weathering. The greater and longer caves were usually digged by human to use them as cellars, quarters, stockyard, hiding-places or fresh water source. **Some natural and anthropogenetic caves and hollows are developed by solution. It is proved by the high amount of lime in the sandstone and by little dripstones and thin cruststone in that caves (8. thesis).**

The weathering rind is the typical formation of the surfaces of sandstone rocks and cliffs in the landscape. In some places it is more than a centimeter thick crust, but in other surface it makes a thin coat or it is absent. Formation and evolution of the weathering crust and its influence on rocks denudation is researched by the experts working in monuments protect as well (HORVÁTH Z. A.–TÓTH M. 1999). Reuslts of their researches of buildings and statues can be compared to the rock surfaces in the nature. The hard weathering rind protects the surface against denudation. Under the crust the stone is transformed and slacked by physical-chemichal processes. Finally the crust exfoliates and the fast denudation of the unprotected rock begins. The surface of the sandstone rocks and cliffs becomes patched. **On the rocks**

witch are situated in shady, windless places or in narrow, hazy valleys, where the air steam is common, thick weathering crusts are formed and developed (9. thesis).

Two different morphological parts of the microregion can be recognized based on the field work I did. The central part, with its higher average elevation and relative relief (range), deep and narrow erosion valleys, steep slopes and high gradient streams, is looking like a mountain. The surrounding lower surfaces have wide valleys with spacious, moderate gradient floors and gentle slopes with a lot of various derasion and erosion-derasion landforms on them – like a hill. This observation was proved by the result of the modified Hammond landform classification (HAMMOND, E. H. 1964a,b, DIKAU, R. et al. 1991) adapted for the digital terrain model. The central region is classified as „low mountains” and the surrounding basins classified as „open hills”. **The microregion can be typified as a low mountains with dissected piedmont (10. thesis).**

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