

THE HÂRTIBACIU TABLELAND. GEOMORPHOLOGICAL RISKS

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The Hârtibaciu Tableland (4,000 sqkm, 80 km long and 50 km wide) is a distinct subunit of the Transylvanian Tableland. Sarmatian and Pannonian sedimentary formations represent an alternation of impermeable marly-claey strata and permeable strata of sands, loosely cemented sandstones and conglomerates with a monocline structure, locally disturbed by folds of a general E-W or N-S orientation. The grade of fragmentation in point of energy and density of slopes, geodeclivity, climate and edaphic conditions, as well as human intervention reflect in the diversity of present-day geomorphic processes. A hierarchy of geomorphic risk classes – high, moderate and low, has been established based on slope dynamics, as the outcome of a combination of main criteria (type of dominant process, volume of material dislodged by erosion, landslides and human activity). Transition from one class to another has rather a limited value for predicting process evolution.

The normal evolution of natural processes in agreement with slope balance at a certain moment, tends to stabilise the terrain. Whenever extreme natural phenomena cause imbalances on slope, bringing about changes of relief configuration and producing material damage or casualties, geomorphological hazards develop.

Key words: Hârtibaciu tableland, geomorphological risks.

Introduction

The Hârtibaciu Tableland (4,000 sqkm, about 80 km long and 50 km wide) lies in the south-east of the Transylvanian Tableland (*Fig. 1*), between the Târnava Mare Valley in the north, the Visa Valley and the lower course of the Cibin in Sibiu Depression in the west, the Olt Valley in the south and the Transylvanian Subcarpathians in the east. Structural-lithological, morpho-graphical-morphometrical and hydrographical particularities, as well as human activities join in individualising the tableland from a geomorphological viewpoint.

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Fig. 1. Location of Hârtibaciu Tableland

Its main characteristic is high slope dynamics. Denudation is an indicative of marked fragmentation, differentiating a relief underlain by Sarmatian rocks in the south of the tableland and by Pannonian ones in the northern part. The contact between these formations is visible not far north of the Hârtibaciu drainage net, running almost parallel to the tableland in the median and the lower course of the basin. Instability on slope is mirrored also by land-sliding associated with gulying. In terms of the expansion, frequency and intensity of present-day geomorphological processes, themselves tributary to the precipitation regime, type of slope and human intervention (deforestation, plantation of fruit-trees, and cultivation of crops), six types of geomorphological risk classes have been distinguished: high, moderate, and low.

Morphographical and Morphometrical Particularities

Hillsides – high of 550-600 m in the west and 700 m in the east are the main land forms. There are also two erosion surfaces: an upper surface (Proșteea Mare-David, 1945, or Amnaș-Posea, 1969) situated in the western part of the

tableland at ± 600 m alt.; and a lower surface (Hârtibaciu surface – Grecu, 1992) at ± 500 m alt. in the west and ± 625 m alt., in the east. Usually, the two surfaces are linked by wide saddles in the source area, built by sub-sequent modelling.

Looking at the distribution of registered values, it emerges that relief fragmentation is closely intertwined with lithology. Average fragmentation density runs between 2-3.5 km/sqkm, with a relief-energy of 90-300 mm/km. Declivity, which depends on the degree of fragmentation and lithological make-up, varies from 5° to 10° on structure-controlled surfaces, up to 55° on the well-developed cuesta scarps; on terraces and levelled surfaces slopes dip by 2° - 5° only. Ordinary values range between 15° and 25° . (Fig. 2)



Fig. 2. Slope map

Structure and Rock Particularities

Sarmatian sedimentary formations occur between the Olt and the Hârtibaciu Rivers, while Pannonian deposits underlie the area between the Hârtibaciu and the Târnava Mare (Vancea, 1960). They consist of an alternation of impermeable strata (marls and clays) and permeable strata (sands, loosely-cemented sandstones and conglomerates) with a locally disturbed monocline structure of E-W or N-S orientation, generally. The succession of anticlines and synclines is blurred by the low declivity slopes of the few landforms generated by a folded structure represented by the mildly dipping monocline folds (Grecu, 1992). A peculiar feature is the cuesta relief. Its high incidence is due to strata inclination, strong relief fragmentation caused by the density of the subsequent secondary network, and the recurring contacts among the intercalations of different horizons (marls, clays, sands, sandstones and less frequently conglomerates).

Present-Day Geomorphological Processes

Landslides, here and there gullying and sheet wash, have the highest incidence on the Hârtibaciu Tableland (*Fig. 2*). Present-day modelling depends on the regime of precipitation (600-700 mm/year), variety of rocks, types of slope and vegetation coverage. There are various types of landslide-triggered mechanisms, depth and size of discharged material, forms, age and degree of stabilisation in the area (Gârbacea, 1964; Gârbacea, Grecu, 1981; Grecu, 1982, 1983, 1992, 1997).

The massive glimee-type landslides (dislodging a material cover thick of 5-20 m and over) are particularly severe at Saeş (1,550 ha), Movile (900 ha), and Saschiz (615 ha) (Grecu, 1983, and Gârbacea, 1964, respectively) (*Fig.3a, Fig. 3b*). Smaller glimee-affected areas can be seen on either bank of the Hârtibaciu River, where they cover the whole of the usually deforested slope (eg. at Movile and Cornăţel), hang over it (Țeline), or affect the watershed (Apold) (Grecu, 1992). Deep slides, in their turn, cover wide areas everywhere on the Hârtibaciu Tableland, the material moved being 2-5 m thick. However, their incidence is higher in the southern part of the tableland where the substrate consists of clay-marly rocks (*Fig. 4*).



a



b

*Fig. 3. Glimee-type landslides: a – Movile landslides (2009),
b – interfluve Apold landslides (May 2012, F. Grecu)*



Fig. 4. Modelling of north – Făgăraș cuesta through gully erosion (2009)

Lanslides are associated with gullying. The latter occur mainly in the north of the Hârtibaciu River and in the NW of the homonymous tableland (at Șeica Mare, Axinte Sever, etc), where deep erosion is precipitated by the sandy-clay substrate (Făgăraș cuesta) (*Fig. 5*). Aggressive gully and ravine occurrences are recorded with a higher frequency in the upper drainage basins or in the case of torrential organisms developed on cuestas. Beginning from the Pleistocene to the present-day, landslides represent the major modelling processes. Deep erosion is rather a recent process, triggered by human activity (forest logging, farming, etc). The relief modelling process is particularly severe in March, May, June and July (Grecu, 1992).

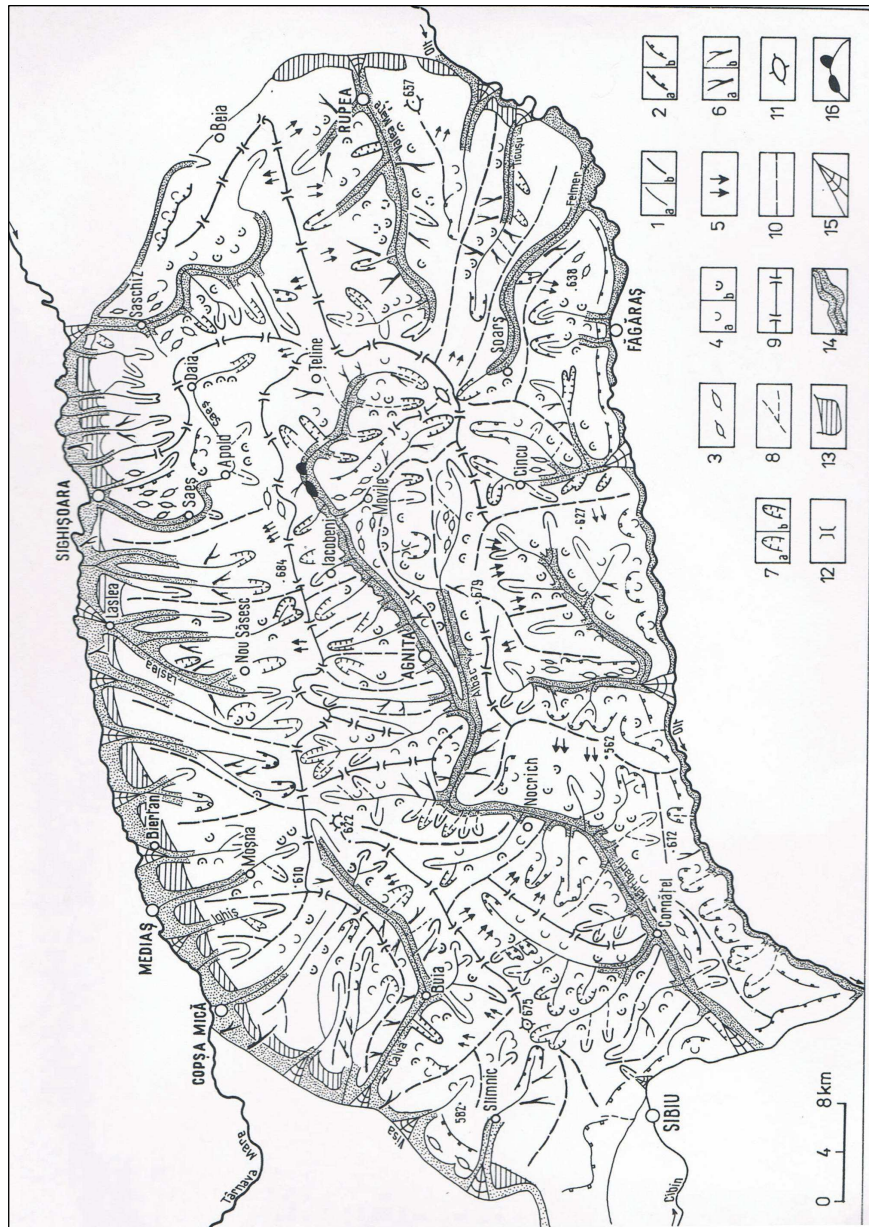


Fig. 5. Present-day modelling processes in the Hârtibaciu Tableland: 1 – scar up to 10 m: a) active; b) fixed; 2 – scar between 10 and 25 m: a) active; b) fixed; 3 – monticles (glimee)(5-20 m-thick dislodged material); 4 – deep landslide (2-5 m-thick dislodged material): a) active; b) fixed; 5 – sheet-wash; 6 – gullies (2-5 m): a) active; b) fixed; 7 – ravines (over 5 m deep): a) active; b) fixed; 8 – small-fixed valley (torrential organisms); 9 – summits with hillocks and saddles; 10 – flat summits; 11 – erosion outlier; 12 – saddle; 13 – terrace; 14 – floodplain; 15 – alluvial fan; 16 – reservoirs

Categories of Geomorphological Risk

Geomorphological risk is defined as a probability for the occurrence of some phenomena liable to changing the dynamic balance of slopes hence visible effects on the environment. Like changes can be influenced or unleashed by climatic and anthropic factors. The impact of their action is distinctively different in terms of rock and structure, types of slope, edaphic, hydrogeological conditions and degree of vegetation cover (Coteț, 1978; Burton *et al.*, 1978; Torry, 1979; Chowdhury, 1980; Alexander, 1991; Mac, Irimuş, 1991; Bălteanu *et al.*, 1996; Grecu, 1997; Sandu, 1994, 1998 etc.).

The Map of geomorphological risk (grounded on present-day geomorphic processes) has a complex character. It makes a synthesis, based on repeated investigations, of a set of geomorphic factors, highlighting the dynamics of the Hârtibaciu Tableland relief. The maps used to make it as close to reality as possible were: map of morphostructure and morpholithology; map of land use; map of slopes; map of soils, and map of slope exposition.

This Map of geomorphological risk is an important achievement, because 1) it foreshadows risk-prone areas; 2) it can be used to inventory natural areas and resources with a view to their adequate use; 3) it shows the degradation of unstable or fragile environments; 4) it facilitates the zonation of areas fit for construction works; 5) it defines and assesses the constraints or limitations posed by natural landform.

The elaboration of geomorphological risk maps for the southern part of the Transylvanian Tableland is an old-standing preoccupation, particularly with authors who have long been engaged in the study of slope dynamics (Sandu, 1994; Grecu, 1997).

The categories of geomorphological risk (*Fig. 6*) in the Hârtibaciu Tableland are grouped by degree of stability and dynamics of moving material, intensity and frequency of landslides associated with gullying and impact of human activity. The six categories of geomorphological risk have been listed under three risk classes: high, moderate and low (large-scale mapping 1:25,000, 1:50,000 depicts risk classes). The scale used for the particular case of the Hârtibaciu Tableland (1:4,000,000) allowed for generalisations without belittling the scientific substance.

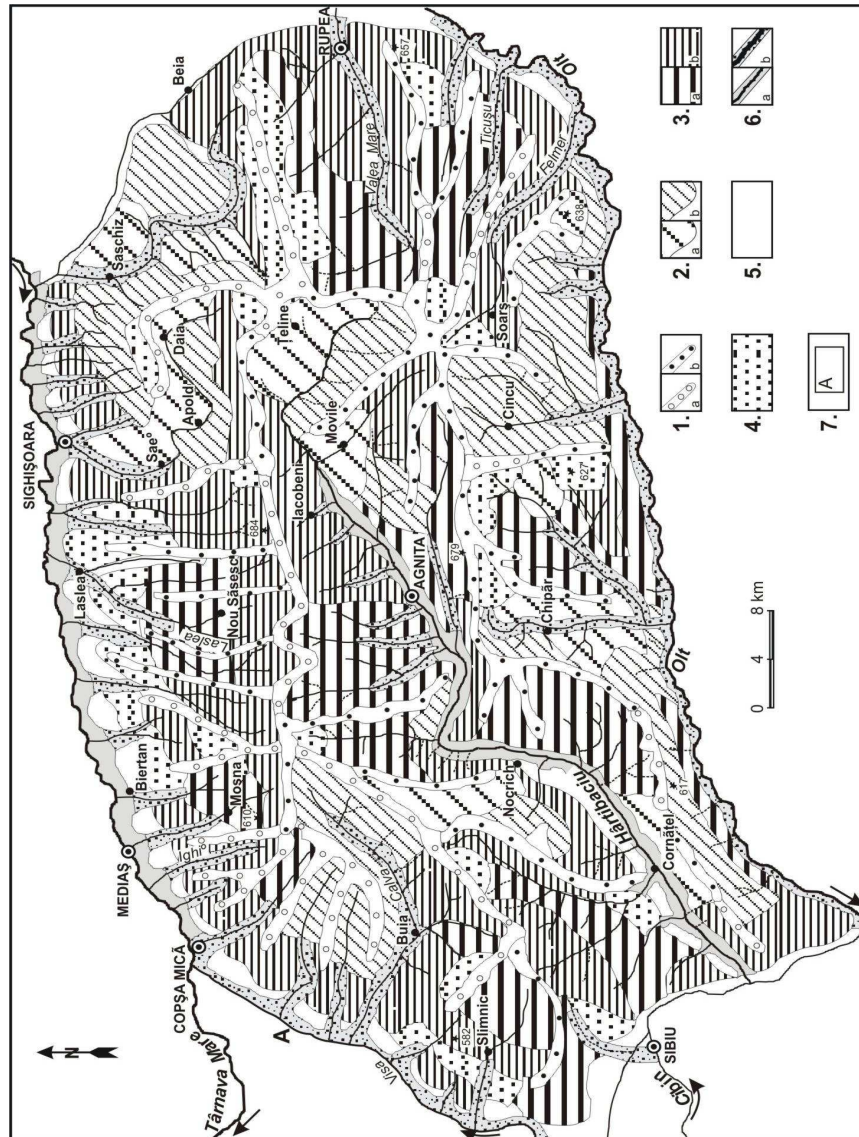


Fig. 6. Map of geomorphological risk in the Hârtibaciu Tableland: 1 – risk-free afforested summits (a); b) low-risk deforested summits narrowed by the extension of headward ravines and landsliding; 2 – slopes at high risk from: a) monticle-like (glimee) landslides thick of 5-20 m, sometime over 20 m; b) deep landslides thick of 2-5 m, frequently associated with gullyng; 3) slopes at moderate risk from: a) annual reactivation of deep slides and of gully source areas; b) gullyng associated with rock-and-soil falls; 4 – slopes at low risk from periodic reactivation of sliding and reduced sheet wash; 5 – risk-free slopes; 6 – major channels at high risk from periodic flooding (a); at moderate risk (every two years) (b); 7 – Localitation in Fig. 1.

High Geomorphological Risk involves two situations:

– *slopes at high risk from glimee-type massive landslides (5-20 m-thick dislodged material)*. With a lithological substrate consisting of sandy marls, clays, loamy clays, a 200-250 m relief energy, 3-3.5 km/sq km relief fragmentation and declivity of 25°-20° up to 55°, slopes have a high morphodynamic potential. As a rule, these slopes, currently found at Saeş, Movile, Saschiz, Țeline, Cornăţel, Nocrich, Chirpăr and Cincu, are deforested, with unproductive lands;

– *slopes at high risk from deep slides (2-5 m-thick dislodged material) are frequently associated with gullyng*. In this case, the slope substrate contains sandy clays, relief energy ranges from 100 m to 150 m, density of fragmentation varies between 2.5-3 km/sq km, and declivity registers 15°-45°. Representative areas stretch out east and south-west of Saschiz, west of Țeline, west of Movile, south of Soarş, south of Cornăţel, in the upper basins of the Calva, the Slimnic, etc.

At high risk from periodic floods stay also the major channels of the Târnava Mare and the Hârtibaciu rivers (*Fig. 7*). In the case of the Olt River (outside the Hârtibaciu Tableland) the erection of dams and the formation of reservoirs after 1987, have depleted periodic flood-induced risk, now at moderate levels.

Moderate Geomorphological Risk

This category of slope have the same rock substrate as above, relief energy of 80-120 m, density of fragmentation 2-2.5 km/sq km and declivity of 15°-35°, even 45° in some places.

Moderate geomorphological risk involves two situations:

– *slopes at moderate risk from the annual reactivation of deep landslides and of the source area of ravines which occupy the middle portion of slopes*. Like slopes (south of Nou Săsesc, east of Țeline, north and south of Agnita, south of Nocrich, etc.) have been deforested and are used as orchards and pastures;

– *slopes at moderate risk from gullyng, associated with frequent rock-and-soil falls*, are found between Saeş and Nou Săsesc, on the righthandside of the Hârtibaciu between Agnita and Brădeni, on the righthandside of the Ticuş, the Felmer, etc.

The Târnava Mare and the Hârtibaciu river channels on the Hârtibaciu Tableland also fall into this category of risk.



Fig. 7. The Hârtibaciu riverbed (May 2012, F. Grecu)

Low Geomorphological Risk

This category comprises the main summits and in part their deforested secondary extensions. Risk is due to the headward advance of ravine sources and the reactivation of old scarps. Also at low risk from periodic reactivation of old slides and weak sheet wash stand segments from the median third and the upper part of slopes. These slopes have usually the lowest morphodynamic potential (5° - 15° , here and there 20° - 25°). Field investigations have shown that periodic reactivation of landslides can be stabilised over a relatively short time-span (2-3 years) if grasses are planted

Conclusions

Delimiting classes of geomorphological risk is fairly relative, because transition from one class to the other depends on the evolution of slope processes.

The Map of geomorphological risk forecasts the emergence of two distinct categories of processes: 1) processes conformable with the natural, normal evolution of the relief in terms of its state of equilibrium at a given moment, and 2) extreme processes, that bring about visible changes in its state of dynamic equilibrium (often relating to heavy precipitation, the undercutting of a slope foot, etc).

Under normal circumstances, geomorphological processes evolve in keeping with the state of slope equilibrium at a given moment, tending to stabilise the terrain. When extreme phenomena disrupt this equilibrium, altering the relief

pattern by destroying existing forms and engendering new ones, causing material damage and casualties, we are faced with geomorphological hazard situation. Therefore, maps of geomorphological risk, apart from their scientific value, may become a practical tool for the interdisciplinary commissions entrusted the licencing of territorial planning projects; at the same time, the private sector should have a say in the assessment of hazard-prone situations.

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