GEOMORPHOLOGICAL HAZARDS FROM THE REGHIN HILLS WITH RISK POTENTIAL

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Abstract: Geomorphological hazards from the Reghin Hills with risk potential. Current geomorphological processes have direct and indirect effects on both the environment and human activities. The exposed elements at risk are the population, settlements, infrastructure, economic activities and services that are in the area with potential manifestations of hazard. This study aims to identify the potentially hazardous geomorphological processes in Reghin Hills.

Key words: hazard, geomorphological process, geomorphological risk, Reghin Hills.

1. INTRODUCTION

Panizza et al. (1999) define geomorphological risk by "the probability that certain geomorphological processes take place in a time in a territory with a specific intensity, causing loss of life or property damages".

As the first element of risk, hazard is the source of an extreme event, with an energetic discharge at a certain time and in a magnitude difficult to predict, which causes imbalance on the development scale of systems towards a new equilibrium estate (Mac, Petrea, 2003). Geomorphological hazards interference with anthropogenic systems lead to risk appearance (Irimus, 2006). The frequency or hazard repeatability (vulnerability) condition risk appearance (geomorphic, hydrological, climatic, etc.).

2. DATA AND METHOD

The geomorphological hazards manifestation is conditioned by natural factors (lithology, morphometric parameters of relief, climatic conditions), as well as anthropogenic factors (misuse of agricultural land, uncontrolled exploitation of natural resources) (Irimus, 2008; Szilagyi, Irimus, 2013 2016). The main geomorphological processes with risk potential, which are present in the studied area can be grouped into: fluvial processes (depth erosion, lateral erosion,

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accumulation), mass movement processes (landslides, creep, soil compaction processes) and linear and areolar erosion processes. The results' analysis and spatial projection was done through field mapping and GIS analysis.

3. RESULTS AND DISCUTIONS

Fluvial geomorphological processes are highlighted by riverbed erosion, lateral and depth erosion, and through accumulation processes. They are most active in early spring, when snowmelt coincides with long spring rains, which generates significant increases in the river flow. The high water energy generates important changes in longitudinal and transverse profile of the river bed causing imbalances in the river system, embodied in the formation of alluvial rapids, islands, meandering or courses migration. Lateral erosion registers the highest intensity in the sectors of concave meanders, where through undermining river banks and slopes it causes subsidence and landslides.

Riverbank erosion is very active on the longitudinal profile of Mures River between the localities Vălenii de Mures and Brâncoveneşti, respectively Petelea and Gorneşti, where after the artificial water course modification, in order to operate the ballast in river bed, long segments of the bank were subject of lateral erosion and banks slip affecting road infrastructure, by undermining the embankment of DN 15 national road and electricity transmission system by destabilizing the supporting pillars of electricity transmission lines.

Landslides are the most widespread form of mass movements and represent a distinct mark in the landscape of Reghin Hills in a variety of shapes (Figure 1). Their development is favoured both by natural causes (pre-existing relief, lithological constitution of Sarmatian deposits predominantly sandy with clay interbeddings, rainfall regime, vegetation), and also anthropogenic causes (deforestation, which eliminated the role of fixer of the trees' root system to the upper part of the diluvia, overgrazing, changing of slopes grade, use of inappropriate agricultural technics etc.).

Unlike other denudation processes, occurring almost continuously, but carrying small amounts of material per unit of time, landslides are discontinuous modelling processes in space and time, but with visible effects on slopes' morphology (Surdeanu, 1998). They give destructive forms as complex as torrents, but their unpredictable nature is more powerful, "because the preparation process is done secretly, deep down, hindering the possibility of prevention and resulting in great damage" (Tufescu, 1966).

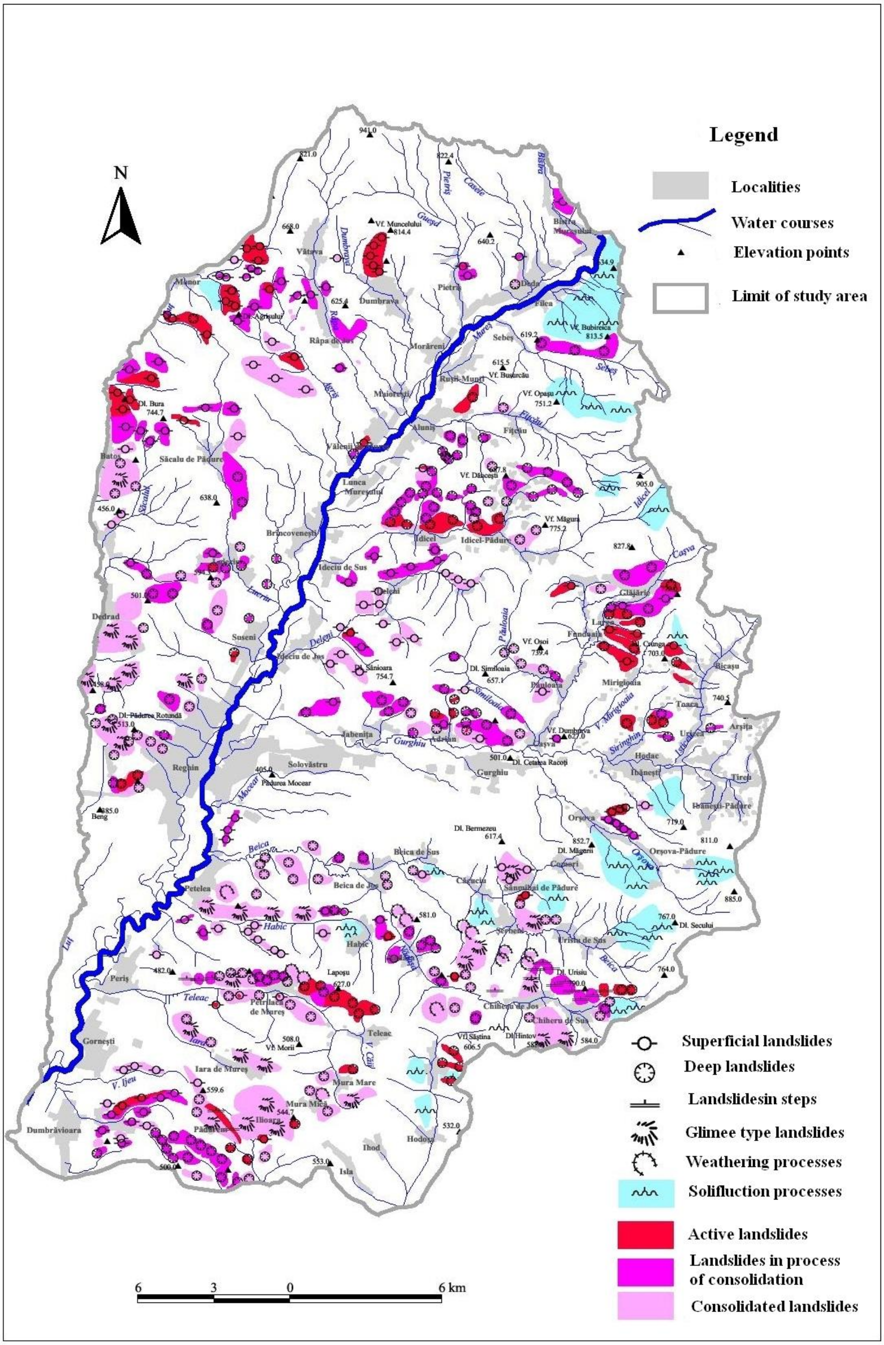

Figure 1. Reghin Hills. Landslides' inventory map.

Landslides in mounds or glimee, stabilized or stabilizing, are associated with the anticline flanks widespread in Teleac Hills, Batoș Hills and Monor Hills. The highest number of glimee appears in Teleac Hills, where the slopes flanking the valleys of the rivers Habic, Chiheru, Teleac and Căluşeri are carried into a withdrawal evolution under the action of sliding processes associated with ravination processes. The main scarps sometimes present heights up to 10 m, and behind the moving blocks lakes are forming especially in spring, due to accumulation of water from rainfall and snowmelt, representing a water supply for underground layers, thereby reactivating certain portions of old stabilizing landslides. On the scarps and the moving blocks of the landslides, strongly affected by denudation processes, the concentrated water flow determined the formation of ditches and trenches systems, active throughout the year (Foto 1).

Foto 1 Landslides - Teleac

Foto 2. Lenticular landslides - Ilioara

Lenticular landslides, generally caused by moisture excess, affect both topsoil and diluvium mass to a depth of 1-2 m. The main scarp is poorly highlighted, with heights between 0.5-1 m, and the moving blocks, which rarely exceed 100 m in length and 50 m in width, appear as small steps on the slopes caused by short, lenticular, chaotically superposed land waves. They are widely distributed across the entire studied area, including segments of front of the Mureș River 35-40 m terrace inside Vălenii de Mures Depression and Reghin Depression (**Foto** 2).

Shallow landslides generally characterize the upper half of the slopes with grades greater than 5-10°, and present the highest frequency in spring months, March-April – when the water from snowmelt overlaps the plentiful rainfall. Shallow landslides in combination with ravination causes the appearance of "bad lands" landscapes.

Landslides in furrows affect the upper soil part of less than 1 m deep, presented in relief as small, narrow, chaotically arranged furrows. Their presence facilitates the appearance of deeper landslides, due to water infiltrating areas without vegetation, and in freeze-thaw conditions the appearance of soil running.

Creep type movements are very slow movements caused by a slow but continuous rearrangement of the particles that form the slopes covering deposits. The phenomenon is intense on steep slopes, on foreheads of river terraces and at the contact between meadows and upper slopes. The effects are visible after a long period of time and materialize by creating slight curls under the vegetation cover, by tilting trees, and by cracking building’s walls.

The compaction is defined as a "slow vertically motion performed inside, loose or elastic rocks, taking the form of compression or tamping imposed by its own weight or other overload" (Grecu, 2009). The compaction through consolidation produced due to land overloading by construction, is the busiest on terrace bridges (Luieriu) and in areas immediately around the Mureș River, on lands obtained from the work of embankment, where the ground water level is very high and the sediments layer shows high thicknesses.

More common than compaction through consolidation is compaction by treading, also known as "*sheep paths*" that are largely developed on strongly inclined slopes covered with grass vegetation, subject to grazing. Results translate into relief forms of small, elongated or perpendicular on contour lines steps, with widths ranging from 10 to 20 cm.

Erosion through currents concentrated on slopes, through gullies, ravines and torrents, determines advanced slopes degradation with delicate problems of erosion control works.

Systems of gullies and ravines are widely grown on the slopes of the landslides’ bare main scarps and on the surfaces in with slopes covered with grass vegetation, especially those affected by overgrazing, where traces of animals creates favourable conditions for water accumulation from precipitation and its organization on concentrated flow. The largest areas affected by linear erosion can be met in Teleac Hills, on the slopes of the valleys Gurghiu, Habic, Chiher, Teleac and Călușer, where the lack of facilities for prevention and control associated with irrational land use favoured the acceleration of these processes (Foto 3).

Torrential bodies are the most advanced form of erosion created by currents concentrates on slopes that through the three actions they perform - erosion, transport, storage - form a system. Torrential bodies show a large development on steep slopes of the valleys Gurghiu, Luțului, Idicel, providing large amounts of alluvia for the main drainage systems. In some sectors, such dejection cones get into bed streams from the slopes (Idicel, Râpa), forcing the riverbed migration toward the opposite bank, where the intensification of lateral erosion creates bank collapses and migration of watercourse.

a

b

Foto 3.. Systems of trenches and ravines - Idicel (a) and Comori (b)

Areolar erosion is active on the surface of slopes with a gradient greater than 5°, bare or affected by overgrazing, during heavy rains and manifests itself through pluviodenudation and surface erosion (Figure 2).

Pluviodenudation or erosion through rain drops, through their actions of hit and splash, displaces a large amount of solid material from the surface of bare soils, which are subsequently taken over by surface runoff. The most exposed are arable lands situated on hillsides near settlements. Kinetic energy developed by raindrops hitting the bare ground during a rain shower is 1000 times greater than that developed by the same amount of water which flows on the slopes (Tufescu, V., 1966). The intensity of pluvoidenudation erosion is influenced by a number of factors, such as: the intensity and duration of precipitation, the size of raindrops, the degree of coverage with vegetation of the underlying surface, the degree of loosening soil, etc.

Surface erosion, known as *erosion through superficial currents* or *laminar erosion,* appears during raining periods, given the fact that water is not able to focus as currents, the runoff transforming in a sheet flow over the slope surface. The intensity of surface erosion manifests itself differently depending on the slope's length, gradient and shape, degree of vegetation cover, soil texture and land usage.

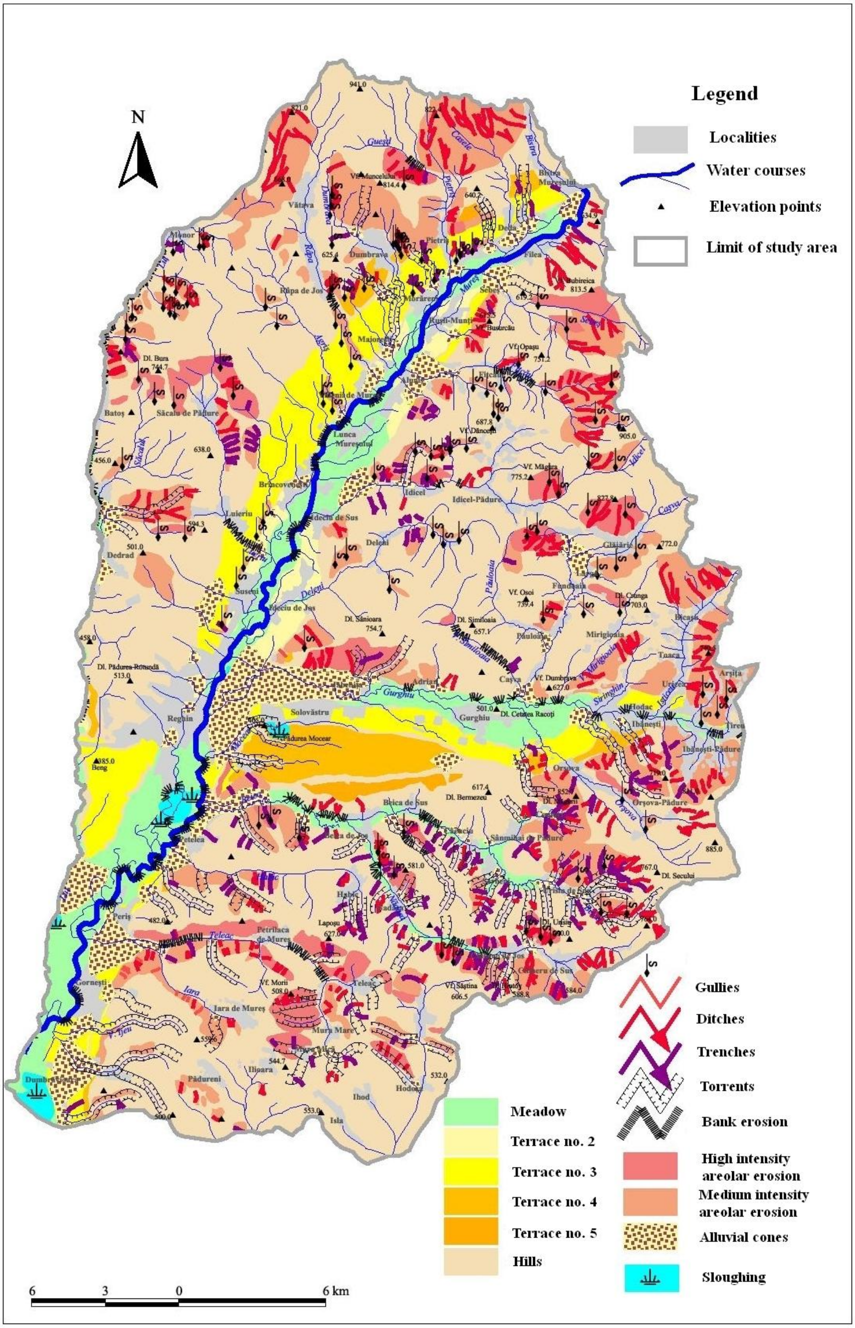

Fig. 2. Reghin Hills. Inventory map of linear and areolar erosion processes

Areolar erosion through pluviodenudation and superficial currents causes the washing of soil's top layer, the decrease of humus and nutrients in the soil, which results in land degradation and reduction of productive potential of agricultural land (Ionita, 2000).

From this analysis and assessment can be observed that the average value of effective soil erosion rate in the analysed area is 1.2 t/ha/year, the largest loss of soil (over 1 t/ha/year) being recorded on non-irrigated arable lands occupied by complex cultures mixed with natural vegetation and pastures where soil evacuation is developed through linear slope processes.

4. CONCLUSIONS

Current geomorphological processes have both direct and indirect effects on the environment and on human activities. The determination of land's susceptibility to geomorphological processes is of major importance in determining the impact they may have on population and for developing risk management plan.

REFERENCES

1. Grecu, Florina (2009), *Hazarde și Riscuri Naturale*. București University Publishing.
2. Ioniță, I. (2000), *Geomorfologie aplicată. Procese de degradare a regiunlor deluroase.* Iași: "Al. I. Cuza" University Publishing.
3. Irimuş, I. A, Vescan, I., Man, T. (2005), *Tehnici de cartografiere, monitoring si analiza GIS*.
4. Irimuș, I. A. (2006), *Hazarde şi riscuri asociate proceselor geomorfologice în aria cutelor diapire din Depresiunea Transilvaniei*. Cluj-Napoca: Casa Cărții de Stiintă.
5. Irimuş, I. A (2006), *Vulnerabilitate şi riscuri asociate proceselor geomorfologice în planningul teritoria.* In V. Sorocovschi (Editor), "Riscuri și catastrofe", Year III, No. 3, pp. 21-32. Cluj-Napoca: Casa Cărții de Știință.
6. Irimuş I. A., Petrea, D., Rus, I., Cocean, P. (2008), *Landscape vulnerability induced by meteorological, geomorphical and antropical processes in Transylvania Depression.* In "Studii şi Cercetări", s. Geology-Geography, No. 13, pp. 103 – 117, Bistrița.
7. Irimuş, I. A., Morărescu, G. R., Irimuş N. G, (2010), *Climatic and Hydrographic Variations in the Dinamics of Geographic Landscapes in North-West Depression of Transylvanian Plain,* Philobiblon: Journal of the "Lucian Blaga" Central University Library, Cluj University Press, 2009, Vol. 14, pp. 371-385, ISSN 1224-744.
8. Irimuș, I. A., Rus Mădălina-Ioana, Cioban, T. D., Bilașco, St. (2015), *Quantitative Estimation of Annual Average Rate of Soil Erosion in the Almas Hydrographical Basin, Using USLE and GIS*. 15th International Multidisciplinary Scientific GeoConference on Informatics, Geoinformatics and Remote Sensing, Conference Proceedings/ Vol. II, Geodesy&Mine Surveying, Cartography & GIS. pp.1071-1079.

Published by STEF92 Technology Ltd 51"Alexander Malinov", Sofia, Bulgaria, ISSN 1314-2704/ ISBN 978-619-7105-35-3/DOI :10.5593/sgem 2015B22.

9. Irimuș, I. A, Szilagyi, J. (2013), *Considerations on the thermal conditions in the Reghin Hills.* In V. Sorocovschi (Editor), "Riscuri și catastrofe", Year XII, Vol. 12, No. 1/2013, pp. 66-77, ISSN 1584-5273, Cluj-Napoca: Casa Cărții de Știință.
10. Mac, I., Petrea, D. (2003), *Polisemia evenimentelor geografice extreme*, In V. Sorocovschi (Editor), "Riscuri și catastrofe", No. 1 Cluj-Napoca: Casa Cărții de Știință.
11. Marian, Flavia-Luana, Irimuș, I. A, Zaharia, C. S., (2016), *Qualitative landslide risk estimation in the Baia Mare depression*, *Romania*. In "Carpathian Journal of Earth and Environmental Sciences", February, Vol. 11, No. 1, pp. 123-130. Accession Number: WOS: 000370208300011.
12. Măguț, Flavia, Zaharia, S., Glade, Th., Irimuș, I. A (2012), *Comparing performances of heuristic and logistic regression models for a spatial landslide susceptibility assessment in Maramures County, Northwestern Romania*. Vol. 14, EGU 2012-7633 Geophysical Research Abstracts.http://meetingorganizer. copernicus.org/on-line /EGU 2012, session/9260/ISI.
13. Moigrădean, O., Irimuş, I. A (2016) *The effects induced by the floods in Upper Crasna Basin*, In V. Sorocovschi (Editor), "Riscuri și catastrofe", Cluj-Napoca: Casa Cărții de Știință.
14. Panizza, M., Fabbri, A. G., Cavallin, A., Marchetti, M., Geneletti, D. Alkema, D., (1999), *Geomorphologic Assets in an Environmental Context*, Contribution to IAMG, Norway.
15. Szilagyi, J., Irimuş, I. A, Togănel, C., Szilagyi Emilia (2016), *Rainfall Aggressiveness Evaluation in Reghin Hills using Fournier Index.* In V. Sorocovschi (Editor), "Riscuri și catastrofe", Vol. 18, No. 1, pp. 83-89, ISSN 1584 -5273, Cluj-Napoca: Casa Cărții de Știință.
16. Szilagyi, J., Irimuş, I. A, Rus, Mădălina, Cioban, T. (2016), *Evaluation of Soil Erosion in Reghin Hills using the USLE Method.* In V. Sorocovschi (Editor), "Riscuri și catastrofe", Vol. 15, No. 18, pp. 91-99, ISSN 1584-5273, Cluj-Napoca: Casa Cărții de Știință.
17. Szilagyi, J., Irimuș, I.A, (2013), *The excess of Humidity and its associated Risks in the Reghin Hills.* In V. Sorocovschi (Editor), "Riscuri și catastrofe", Year XII, Vol. 12, No. 1/2013, pp. 89-99, ISSN 1584-5273, Cluj-Napoca: Casa Cărții de Știință.
18. Tufescu, V., (1966), *Modelarea naturală a reliefului şi eroziunea accelerată,* Edit. Academiei R.S.R., Bucureşti