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CURRENT GEOMORPHOLOGICAL PROCESSES IN THE SOUTH OF GUTÂI MOUNTAINS

D. ANDRON[1], I.A. IRIMUŞ[1]

ABSTRACT. – Current Geomorphological Processes in the South of Gutâi Mountains. The current geomorphological processes that are highly aggressive in the south of Gutâi Mountains have been identified during onsite visits carried out between 2014 and 2017. The analysis on the landscape impact has been carried out by using GIS methodology. The pluvio-denudation mainly occurrs within the areas unraveled by the topsoil of the piedmont. The linear erosion is located within areas with a suitable slope for such processes and with a lithology that would allow their development (clay and sandy clay). Taking into account the elevated aspect of volcanic morphostructures, they resulted in the concurrence of the gravity processes as follows: collapsing and rolling, together with a pseudo-soil-flowing area located within the upper section of Șatra Massif. An original aspect of this is the identification of suffosion processes, as represented by a series of five suffosion cones placed on one alignment, and joined through a suffosion channel.

Keywords: *Șatra, current processes, suffosion, linear erosion*.

1. INTRODUCTION

The area is located south of Gutâi Mountains, at the contact between Maramureș Carpathians and Bukovina (north side) and Lăpuș Depression (south side). A series of volcanic structures like: Șatra, Măgura and Măgurița single themselves out within this area. Around Șatra volcanic neck, a piedmont has developed and bears its name, i.e. Șatra Piedmont. In order to have a big picture of this entire area, a map has been drawn to locate the site against the neighboring morphological units (Fig. 1) (G. Posea, 1957, 1962, 2005).

[1] *"Babeş-Bolyai" University, Faculty of Geography, 5-7 Clinicilor Street, Cluj-Napoca, Romania, e-mails: danutandron93@gmail.com, irimus@geografie.ubbcluj.ro*

The current geomorphological processes receive a scientific value within the territorial development and the capitalization of farming lands. The high dynamics of such processes may result in the occurrence of geomorphological hazards. Some farming lands have been identified as being impacted by linear erosion, as well as by some landslides. The occurrence of such processes, i.e. the landslides, has resulted in an impact on the strength structure of some of the houses in Ciocotiș village, located west of Șatra Piedmont.

The results secured after this research have been sent to local authorities in this area, so as to make them aware of the geomorphological hazards existing in this area, as well as to allow them to find the appropriate measures to stop such processes, and to develop the impacted areas.

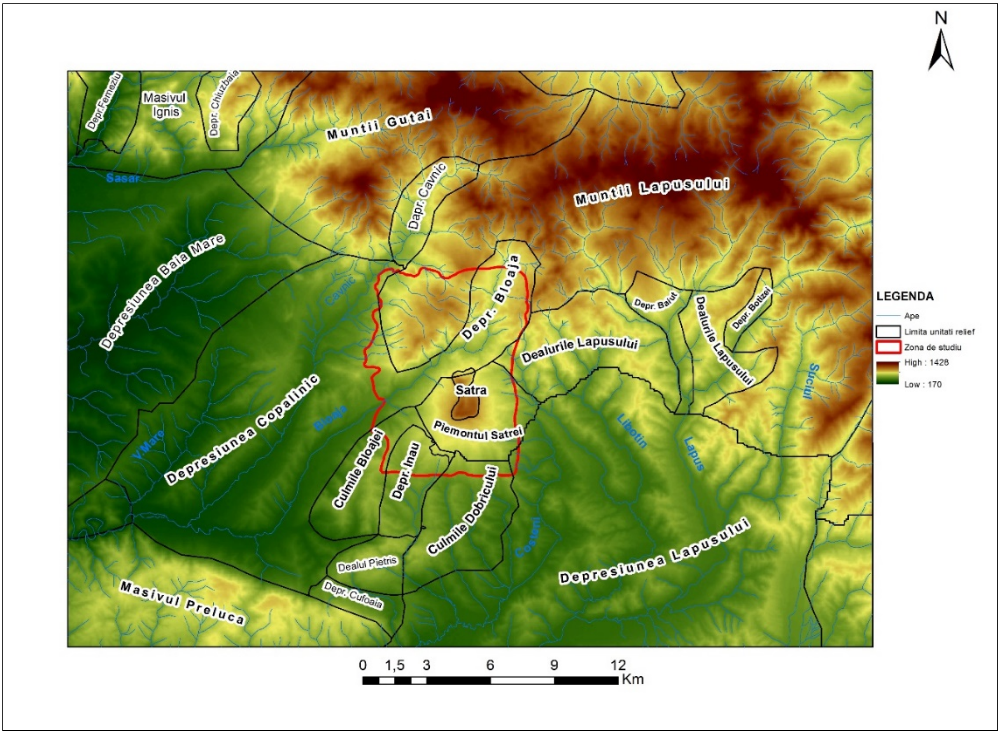

Fig.1. Location map

2. MATERIALS AND METHODS

The used methods consisted of identifying the areas with geomorphological processes and mapping such areas on survey maps (in the field) and on ortho-photo plans (in laboratory). We have prepared the preliminary databases based on the mapping information, GPS measurements and geomorphometric maps. The latter ones have been inferred from the DEM created from the contour lines vectorized on the 1:25000 survey map. All these operations conducted to draw the geomorphometric maps have been based on the use of Arc Map 10.2.2. by applying the methods described by Ioan Aurel Irimuş et al. in different specific papers (I. A. Irimuș, 1997; I. A. Irimuş et al, 2005).

Data validation has been carried out by following the evolution of each geomorphological parameter occurring on the geomorphometric maps. The final results have been summarized on a geomorphological map where all morphodynamic processes of Șatra Massif are presented, together with the accompanying piedmont.

3. RESULTS AND DISCUSSION

3.1. Pluviodenudation

The areas where pluviodenudation occurs through the hit and splash process are mainly overlapping areas impacted by linear erosion, where the land has no topsoil. The process is almost completely stopped in areas where grass is present. The areas impacted by the pluviodenudation are south, east and west of Șatra Piedmont, which represents a major area with farming lands for the neighbouring villages. A large quantity of solid material ran off land surfaces that are exposed after removing topsoils, subsequently taken by the surface landslide (I. A. Irimuş & J. Szilagyi, 2017). The forest roads are also impacted due to the fact that they are improperly developed. The road material consists of dirt, clay and sandy clay that are prone to be impacted by pluvio-denudation actions (V. Tufescu, 1966). Excessive grazing of livestock from neighbouring villages results in a drastic reduction of the vegetal topsoil within many areas, and that is supporting the erosion by rainfall.

3.2. Linear erosion processes

In some areas, the runoffs are concentrated in small flash floods that result in the occurrence of linear erosion processes. The factors leading to the occurrence and development of such linear erosion are: lithology, slope aspect, slope inclination and man-made factors (Maria Rădoane et al, 1999; M. Vanmaercke et al, 2016; I. Ioniţă, 2011; Petronela Chelaru & I. Ioniţă, 2013).

The values of these factors are within the limits established by the specific literature, as set forth above. Following on site investigation conducted between October 2015 and May 2016, several areas with channels and ravines have been identified. These are located on the slopes of Șatra Piedmont oriented from north to east and south to west. The lithology consists of clay and sandy clay (M. Borcoş et al, 1980). The inclination of these slopes is comprised between 10^0-25^0. The man-made actions are added to such factors. They consist of: removal of grass, land clearing, plain and forest road constructions, use of non-compliant farming methods. In the case of several farming lands, the ploughing has been performed perpendicularly on the contour lines.

All areas with channels and ravines have been located with the help of GPS device, measured with the measurement tape (length, depth, width), mapped, and drawn on the field notebook. Figure 2a presents a ravine identified south-west of the piedmont. This ravine has 35 m in length, 1.65 m in depth (on average) and is 2.5-3 m wide.

Fig. 2a. Ravine in southwest piedmont

Fig. 2b. Linear erosion processes on forest roads

Another activity observed during field visits consists of dragging logs from wooded areas with the help of forestry tractors. Such practice creates large channels on the land and therefore supports the development of linear erosion (Fig. 2b).

3.3. Gravitational processes

3.3.1. Collapses and rolling

Such processes have been located on the western, south-western, and north-western slopes of Șatra Massif, as well as within Măgura and Măgurița Massifs. The factors that allow such processes are the weather related events (freeze-thaw), earthquakes of low intensity and gravity (J. S. Moquet, 2014; G. Posea, 2005; Maria Rădoane et al, 2001).

I. A. Irimuş (1993) established that disaggregation processes occur in most of volcanic necks (as it is the case of Șatra) or of the structural buttes, and rock debris trails are formed. Figures 3a and 3b present the rolled disaggregated material at different sizes.

The steep slope, the presence of exposed volcanic rocks (basalt andesites and hyalodacites), as well as the presence of disaggregation processes, like freeze-thaw within Șatra Massif and within Măgura and Măgurița Massifs, resulted in the occurrence of collapses and rollings (Maria Jurje et al, 2013; M. Kovacs & Alexandrina Fulop, 2003; T. Minghiraş et al, 2015). Due to the presence of such processes, we have identified a trail of rock debris, with loose rock blocks, at the base of the slope on the south-western side of Șatra. Walking in this area was difficult due to the fact that boulders and rocks were rolling upon the smallest movement.

Fig 3a. Small dacit fragments from the scree

Fig 3b. Scree

3.3.2. Suffosion

This process has been identified on the south-western side of Șatra Massif, within the piedmont. It consists of five suffosion cones of different sizes, connected to one another through a suffosion channel.

Mostly, this process occurs and develops within loess rocks. Numeorus current papers proved that this process can also occur within other rocks, as for instance sandy clay like the ones in Șatra Piedmont (M. Maknoon & T. F. Mahdi, 2010; D. Marot et al, 2014; D. Marot, Y. Sail & L. Sibille, 2012). The slope is between 5^0 and 25^0, the suffosion acting on lands with an inclination lower than 30^0 (Maria Rădoane et al, 2001).

At the end of October 2015, we have identified five suffosion cones of different sizes connected to one another through a suffosion channel extending from cone no. 5 to cone no. 1. These are present on a clearly established alignment on a length of about 40 m. We have recorded several GPS locations with a Garmin GPS device so as to establish their geographical position. The next step was to map all these and to perform length, width and depth measurements, which have been summarized in table 1 and figure 4.

Table 1. Measurements of suffosion cones

	Cone 1	Cone 2	Cone 3	Cone 4	Cone 5
Length	7 m	7 m	4 m	4 m	1.5 m
Width	4 m	3 m	2 m	2.5 m	1 m
Depth	0.7 m	1.3 m	0.5 m	0.5 m	0.2 m
Altitude	722.74 m	723.32 m	724.04 m	726.05 m	728.85 m

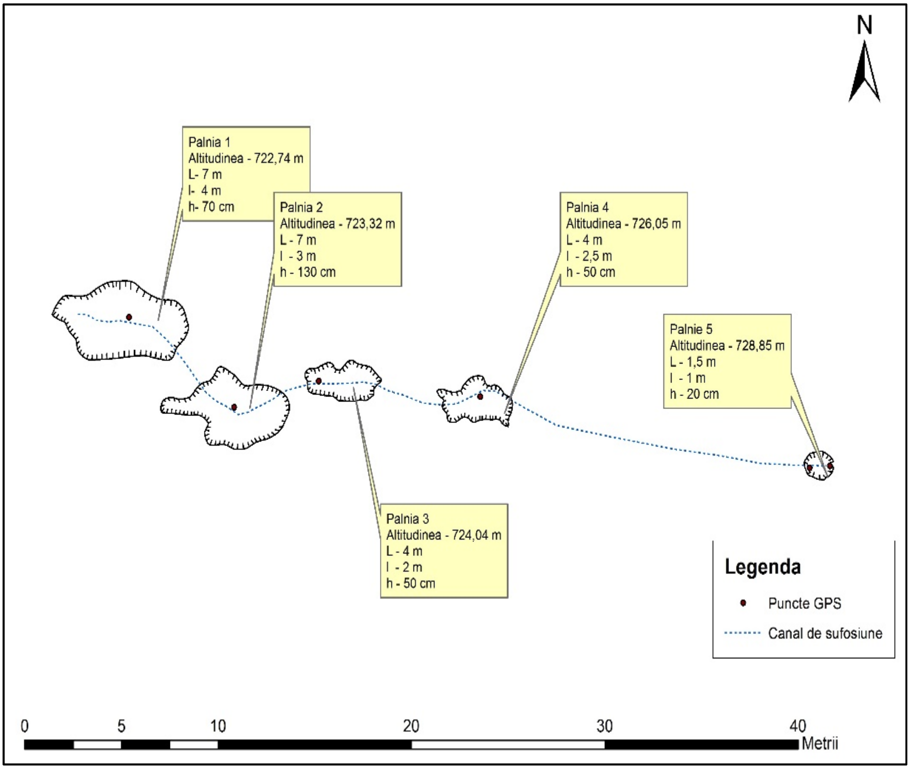

Fig. 4. Sketch of suffosion cones

Fig. 5. Incipient cone

The presence of the hole of the suffosion channel has been identified with all 5 suffosion cones. A new cone has been identified between cones no. 4 and no. 5, but it is in its initial formation stage, being the size of a boot (fig. 5). The suffosion channel presents variable dimensions, larger within the cavity of the suffosion cone. The route has been drawn intuitively based on a line that connects the centers of the cones. We should mention the fact that three out of five cones present vegetation associated with hazelnut trees.

3.3.3. Pseudosolifluction

Another form has been identified following the field visit and is included in the gravity processes and cryonival processes, i.e. pseudosolifluction. The presence of such process on the south-western side of Șatra is strengthen by the previous investigations (A. L. Washburn, 1973; H. French, 2003; G. Murătoreanu & I. Ipingău, 2007; J. G. Anderson, 1906; Maria Rădoane et al, 2001).

The first parameter, required for such process to occur, is thawed soil. The soil must be loose enough and the clay must be specific. After analyzing the geological map, it results that the area with psudo-solifluction overlaps a layer of sands, pebbles and red clay (M. Borcoş et al, 1980).

Another factor supporting the pseudo-solifluction is the freeze - thaw interchange, which is intensified within this area especially during the transition season, i.e. spring. A less important impact is presented by the sudden thermal alternations between night and day.

A conclusive clue associated with the presence of pseudosolifluctions are the formicaries covered with grass (Fig. 6 a, b), which have been identified in a small clearing without trees. These are known in the Romanian specific literature as "marghile" (quagmire - a boggy area). They can be formed provided that the inclination is poor. They have been identified within areas where the slope has an inclination comprised between 3.5^0 and 10^0. In order to present their actual size, the pictures were taken with two different reference points: a mobile phone (fig .7) and an individual (Fig. 6).

Fig. 6. Formicaries (photo: Andron Dănuţ)

Fig. 7. Dimension of the formicaries (photo: Andron Dănuţ)

3.4. Man-made processes

Șatra Massif presents several works related to the development of land so as to become a farming land. These have been identified mainly within the eastern side of the Massif, within Ciocotiș village area (Fig. 8a). The logging activity developed on the wooded areas of the slopes, due to log dragging (skidding) along the slopes, has resulted in the production of small channels in the land, which on their turn support the occurrence and development of linear erosion events (I. Mac, 2003).

Another landform resulted due to the man-made actions is the presence of an artificial lake, located 50 m away from Șatra Monastery (Fig. 8b). This was probably created for supplying this monastic settlement with water.

Fig 8a. Agricultural terraces **Fig 8b.** Artificial lake

4. CONCLUSIONS

Șatra Massif and its adjacent volcanic peaks present an elevated dynamics of the geomorphological processes. Following field visits, the resulting forms have been located, mapped and described. The linear and suffosion processes have been identified on the sunny and semi-sunny slopes of the Șatra Piedmont. On the shadow and semi-shadow slopes of the Piedmont, and following physical disaggregation, debris rock trails have been formed, with loose boulders and rocks, and a pseudo-solifluction area has been identified within the upper side of Șatra.

The results have been disseminated to local authorities so as to make them aware of the geomorphological hazards associated with their farming lands and houses, as well as to allow them to enforce mitigation and measures for stopping such geomorphological processes.

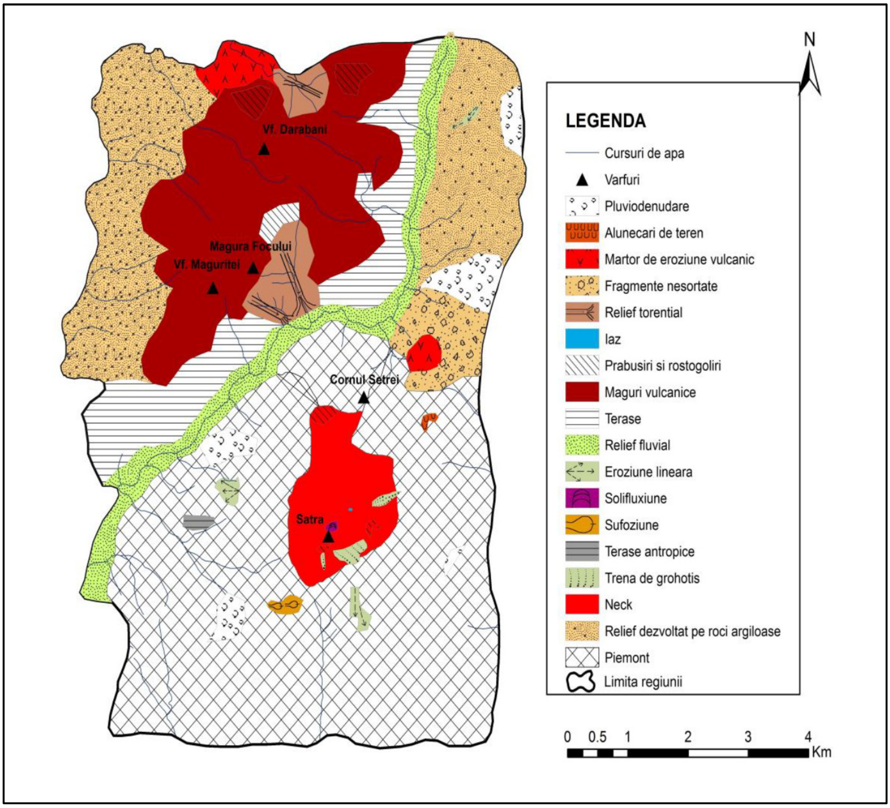

Fig. 9. Geomorphological map

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