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# RESEARCH UPON LANDSLIDES AT MOSOROASA, VALCEA COUNTY

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***Abstract:***
*Landslides are a major degradation form of the natural environment with significant economic and social problems that affect all areas of earth slopes. In Romania, these processes are more intense in the Curvature Sub-Carpathians from Vrancea County to Vâlcea County. This paper presents the causes and forms of mass movements on slopes and customizes these problems for a slide area at the Olanesti river basin.*

***Keywords**: land degradation, shifting land masses, geological deposits, climatic indicators, digital terrain model highlighting*

## INTRODUCTION

More than 80% of the Romanian territory has medium to high risk of landslide, the highest risk area being the Carpathian Mountains curvature, which also includes Valcea County.
From the viewpoint of deep erosion, Vâlcea County occupies the fourth place in Romania, and from the viewpoint of landslides, it ranks first. At present, the total ground area affected by these active phenomena in Vâlcea is 38.720 hectares. Out of this, 13.200 hectares are affected by surface erosion, 3.700 hectares by landslides and 21.820 hectares by deep erosion.
The research area is placed on the South-western side of the Mosoroasa Hill at Olanesti, with a 15-18% North East – South West slope; a 385 m long landslide occurred on the slope, 90 m far from the drainage divide, to the thalweg of the Mosoroasa Valley. The landslide front is 91.5 m in its maximum width (Rosulescu S.D., 2011).

## MATERIALS AND METHODS

From the geomorphological point of view, the area is placed on the South-West side of the Mosoroasa Hill, close to the summit. The Hill is part of the morphostructural unit known in literature as ―Getic Depression", which extends to the Southern part of the Southern Carpathians, reaching Bals-Slatina.

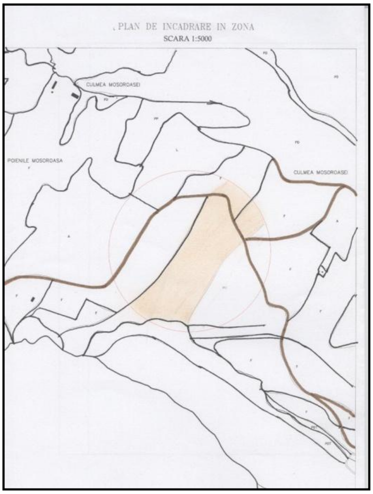


Figure 1 Study area position

The landslide has affected the slope from the hill summit to the Mosoroasa stream which runs from East to West and is a left tributary of the Olănesti River. Landslides are also present on the Southern part of the stream, where the ground area has a South-East to North-West direction. The main factor triggering the landslide is the high precipitations level, which has resulted in reducing the resistance parameters of the layers that form the slope covering (Rosulescu S.D., 2011).
From the geological point of view, the deposits that are currently forming belong exclusively to the Eocene (set out in monocline) and the Quaternary Period. These formations, whose total depth reaches 2000 m, are formed of two conglomerate horizons separated by a loamy

one: on the upper side, the quaternary covering of variable depths (2-15 m0, formed by the degradation of the main rock; the fixed consolidated rock deposits represented by Eocene formations consisting in two conglomerate horizons separated by a sandy, grey and rough clay package, figure 2.

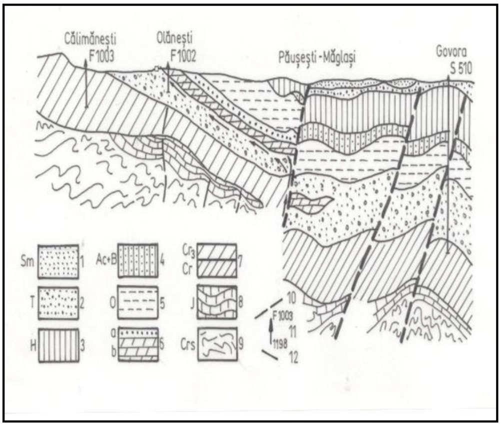


Figure 2 Transversal geotechnical profile through the study area

The geological profile on the NE-SW direction shows the presence of eight layers, as follows:

(1) Vegetal soil;
(2) Yellowish, plastic, running dust;
(3) Sandy, yellowish, plastic, running dust;
(4) Clayish, grey-blackish dust up to -1.60 m, grey-yellowish in the rest, plastic, running;
(5) Blackish, running mud;
(6) Clayish, light and yellowish sand, with grey films;
(7) Clayish, grey, plastic, consistent dust;
(8) Dust with $CaCO_3$, grey, plastic, rough, with yellowish slate films;

**The climate** of the Mosoroasa region is temperate continental of the transition continental climate subtype, with the following parameters: the annual average temperature is 10.2$^oC$, the absolute low temperature is -31$^oC$, the absolute high temperature is 40.6$^oC$, the annual average precipitations are 750-800 mm/year.

The climatic indexes determined according to the climatic classification made by ICPA (National Research and Development Institute for Soil Science, Agro-Chemistry and Environment) allow a more complete assessment of the climate effect on the environment;

- Balance index (Bi);

Bi = P – ETp = 707.3 – 680.0 = 27.3 mm.

- Hydro-climatic index (Ih) :

$$Ih = \frac{P}{ETp} \cdot 100 = \frac{707.3}{680} \cdot 100 = 104\%$$

- Aridity index (Ia):

$$Ia = \frac{P}{T+10} = \frac{707.3}{10.2+10} = 35 \cdot$$

These climatic indexes show that the Mosoroasa landslide belongs to the low excess climatic class of the excess area. Thus, there is mainly a more humid climate in the area, which favours slope ground degradation processes by erosion and landsliding.

From the **hydrological** point of view, the following parameters of slope running were calculated for the Mosoroasa area:

**-** the annual average volume of flowing water (V):

$V = b \cdot H \cdot S$ ($m^3$)

where:
b – average flowing coefficient
H – annual average precipitations, m
S – water collecting surface, $m^2$

$V = 0.88 \cdot 0.7 \cdot 35.000 = 21.560$ $m^3$/year

The result of the above calculations shows that a flowing volume of 21.560 $m^3$/ year or 0.6 $m^3$/ $m^2$/ year is reached on the landslide surface of Mosoroasa throughout a year.

- The slope flowing debit (Q):

The precipitations registered on the 8$^{th}$ of March 2010 were considered, characterised by an intensity of i=0.02 mm/min.

$Q = 167\ i \cdot Ks \cdot S$ (l/s)

Where:
i – Rain intensity, mm/min
Ks – Flowing coefficient
S – Water collecting surface, ha

$Q = 167 \cdot 0.02 \cdot 0.6 \cdot 3{,}5 = 7.0$ [l/s]

The debit flowing on the landslide surface in the case of moderately intense precipitations (0.02 mm/min) is 7.0 [l/s].

These data indicate that precipitations are the main factor which maintains the landslide process development.

The Mosoroasa landslide monitoring took place from 2009 to 2011, when topographic measurements were performed, geomorphology was analysed in progress, while intervening

with a soil mass modelling in order to render the sliding-proposed changes visible.
The monitoring of the sliding progress by topographic measurements started by identifying/planting benchmarks in the fixed areas, as well as on the slide mass surface. Collecting data by topographic elevation helped obtaining the ground quotas and allowed the comparison with the previous measurements in order to indicate the ground mass time and space movement (Manea S., 2009).
Topographic measurements were performed using a 3D laser scanner in the research area, in a region traditionally mentioned and characterised from the topographic point of view. At present, the 3D laser scanning technology represents a specific method of determining the scanned objects‘ positions and correlating the photographic information with topographic information. This technology allows the user not only to determine surfaces, volumes, quotas or other topographic information, but also to correlate this information with the ground aspect, the vegetation covering, etc. Using the scanner processing software, the interest items are highlighted by the user who can design the digital pattern of the ground and then highlight the upper or lower slopes, as well as other interest items, figure 3.

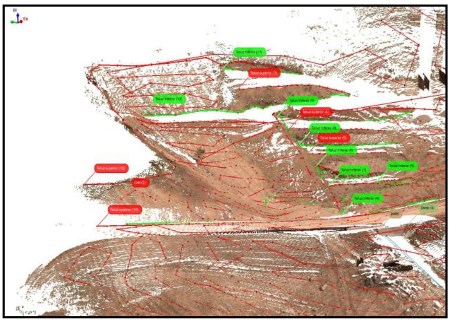

Figure 3 Digital pattern of the ground by highlighting the upper and lower slope with the help of 3D scanning

## RESULTS AND DISCUSSIONS

The study concerning the Mosoroasa landslide progress was based on the topographic elevation of the ground mass from one year to another. For this purpose, topographic points were placed on the satellite image of the study area (figure 2), both on the sliding surface and benchmark positions on the determined ground. The image allowed us to determine precisely the current use categories of the ground which are different from the area cadastral plan. One can notice that the sliding area was used as pasture and was laterally bordered by two afforested areas eroded by the low tree density.
The landslide progress map, edited at a 1:500 scale (figure 3), indicated the position of the points topographically elevated, the corresponding quotas, as well as several infrastructure elements: the Păusesti–Măglasi–Mosoroasa communal road and the overhead power line, both items being degraded by landslide.
The digital processing of the topographic elevations resulted in the progress plan with level curves of 0.25 m in equidistance (figure 4). This offered the possibility to elaborate longitudinal and transversal profiles through the ground, in order to determine the ground volume moved during the landslide between two successive measurements.


Figure 4 Situation plan with level curves

We hereby present an example (figure 5), i.e. a longitudinal profile through the landslide axle that has a slight thalweg form.

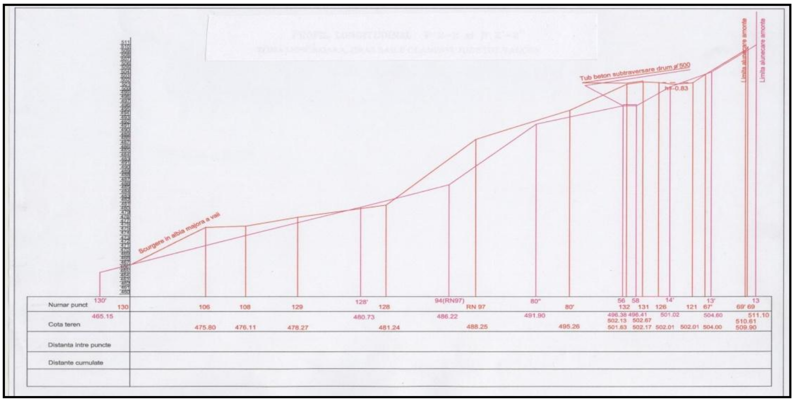


Figure 5 Longitudinal profile sliding

By processing and interpreting the profile data, we can conclude that the ground volume moved during a year was approximately 0.69 $m^3$/ year on the thalweg line of the ground mass sliding.

In parallel with the classic ground elevation, a modern method was used for more detailed research related to the landslide evolution, i.e. the 3D scanning of the research area. The final image of the sliding ground is presented in fig. 6, which provides the possibility to visualize and analyze the micro relief forms of the sliding mass, which favours the establishment of several punctual improvement techniques.

## CONCLUSIONS

The landslides of the Olănesti hydrographic basin, the Mosoroasa region, affect the two slopes of the stream with the same name, following the intense erosion produced on the valleys of the region, which has destabilised the slope basis.

The triggering factor of the mass movement processes are the precipitations falling during the cold period of the year. The degradations produced by the slope slide result in a direct negative impact on the road and electric infrastructure, as well as the constant use of the lands.

The evaluation basis of the improvement techniques is represented by the slide progress dynamic research by using the periodic topographic monitoring.

Preliminary research shows that, from 2010 to 2012, the landslides at Mosoroasa moved an average ground volume of 0.63 $m^3$/ year.

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