A VERY BIG LANDSLIDE IN THE IALOMIȚA SUBCARPATHIANS
(AT MICLOȘANI, DÂMBOVIȚA COUNTY), REACTIVATED IN FEBRUARY 2010

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Abstract: In the last ten days of February 2010 a reactivated landslide of significant proportions took place surrounding Miclosani village (Malu cu Flori village, Dambovita County. The Subcarpathians internal to Dâmbovița river). The previous landslide occurred in the Summer of 1970. The authors of the article analyze this phenomenon according to the following aspects: morphology and morphodynamics, the impact on the environment, the economic effects and the solutions for the functional and economic stabilization and rehabilitation of the affected area.

Key words: reactivated landslide, Miclosani, Valea Larga, the Ialomita Subcarpathians,

1. General presentation

The landslide from Micloșani, a village within the rural locality Malu cu Flori (Dâmbovița county), is situated on the right valley side of the Valea Largă rivulet (a tributary of the Dâmbovița river), which is a morphohydrographical basin developed in the Ialomiței internal Subcarpathians (fig. 1).

Fig. 1. Landslide from Micloșani (Malu cu Flori, Valea Largă Basin, Ialomița Subcarpathians)
This is a deep and very big landslide (about 1 km²) formed on a deluvium valley side. So, this is an area liable to such big landslides, being disposed on a clayey-marly-sandstony geological background, as well as on a clayey-illuviating pedological background. At the same time, this area is placed in an unbalanced geomorphological profile.

The landslide from Micloșani is placed in the category of the contemporary landslides, periodically reactivated. It is registered on Romania's geological map (scale 1:200.000), Târgoviște sheet (L-35-XXVI), published in 1968. The area was reactivated relatively recently in the spring of 1970. Calamities were produced to the agricultural lands (orchards, hay-fields) disposed on the respective valley side, four households were destroyed and the county road Malu cu Flori – Pucheni became impassable on a distance of 550 m.

A period of 40 years of relative stability followed; this morphodynamic situation was gradually installed, when the technical works applied produced their effects. These works consist in: underground and surface drainages, land shaping the sliding body and planting it with fruit trees (apple-trees) in the system of state farms, planting pines and bushes in the area of the sliding cliff (situated, in its biggest part, on the interstream area line), correcting the bed of the Valea Largă rivulet with a series of thresholds and dams.

These regularization works of the longitudinal profile, as well as the consolidation works of the banks were destroyed, partly or totally, by the repeated high floods produced on the hydrographical artery and rehabilitation works have not been effectuated any more since 1990, because of the retrocession of the lands from the farm. The same thing happened to the main drainage channel applied on one of the landslide sides, which lost its hydrological function.

The area was last reactivated, suddenly, on 19th of February 2010 and the landslide continued to be significant on 20th and 21st of February, when an advancement of about 15 m. on a front of about 550 m. was produced. A reduction of the gravity process followed, so on the day of our examinations (23rd of February) the movement was slowly taking place generally, but varying from one place to another, on the different alignments and directions.

2. The causes of the primary landslide and of the landslide reactivated in February 2010

A series of potential favorable conditions in that area and certain reasons that initiated the gravity process in a temporal context, also favorable, caused the landslide from Micloșani.

The potential conditions make that valley side, on its whole profile, be liable to landslides. There is a total of factors that work together in the same sense: the geological substratum made up of Palaeogene clayey-marly-sandstony formations (flysch – Șotîrie, Strate de Plopu, the facies from Colți), disposed in a large folded structure (the area of the landslide lies on a flank of folded layers) – the above-mentioned formations supply the deluvium material (the slope material); the edaphic layer made up of clayey soils, which is another source of slope material; the deluvium feature of the valley side, causing instability and the risk to reactivate the older slide bodies; the micromorphology specific to the deluvium valley sides, meaning a high degree of cracking and many microdepressions with stagnant waters, which favours the infiltration and the feeding of the ground waters that are responsible for the reduction of the internal cohesion and for the appearance of the slide planes; the agricultural use of the lands (orchards and hay-fields) is a feature that emphasises the natural propensity to slides of this part of the valley side (whereas the lands on the slope in the neighbourhood, which are occupied with deciduous trees forests – evergreen oak, beech-tree - are relatively stable); the fact that these lands are continuously being used as a fruit trees plantation (apple-tree) in private propriety, on little plots, is an aggravating aspect.

The causes that release the landslide appear and act in circumstantial conditions. In
our case, the following causes had the releasing role:
- the intensification of the infiltration and of ground waters feeding because of the sudden melting of a very thick layer of snow (20 – 30 cm. in February) and of the hard rains from the second ten day's period of this month (the microdepressions and the cracks of the old slide body, especially in its superior part, favoured the infiltration of the waters from the rainfall, the increase of the volume and of the weight of the deluvium and inferior material involved, but also the decrease of the internal cohesion of this material);
- the gradual undermining of the deluvium valley side basis because of the erosion caused by the Valea Largă rivulet in the period that followed after the hydrotechnical works were destroyed by the summer high floods; the discharge of the deluvium body in gravity motion is produced on this undermined contact; the rest of the slide body was produced at the contact with the bed.

3. The morphology of the landslide

As we have already mentioned, the landslide from Micloșani is included in the category of the massif landslides that were reactivated on a deluvium valley side exposed to such mass movements.

This is a landslide with a complex morphology having the following features: a general setting in steps of the deluvium and a chaotic, but specific micromorphology, with furrows, terraces and depressions (fig. 2).

The massiveness and the complexity are the result of the genesis and dynamics conditions in which the valley side area accumulates.

Generally speaking, the landslide from Micloșani (Malu cu Flori) is made up of morphological elements that are specific to a landslide: separation cliff, slide body, slide forehead, slide bed (friction mirror).

A. The separation cliff

The separation cliff is mainly the same with the one of the landslide from 1970. It is situated on Valea Lungă – Dâmbovița interstream area line or beyond it. It is relatively stabilized, having three little and more active sectors.

It has a semicircular appearance, with more sections caused by the straight advancement of some drainage lines fed by the rainfall waters beyond the general alignment of the cornice; these waters also infiltrate in the deluvium mass of the valley side (clayey soils, clays, sandy clays, marls), then the gravitation causes their extremely complicated flowing towards the bed of the Valea Largă rivulet.

The separation cliff is generally fixed with vegetation – natural and planted: trees (pine), bushes (underbrush, hip rose), underbushes (blackberry), grassy plants (graminaceae).

B. The slide body

The slide body has big dimensions, of about 1 km². This body lies on the whole valley side profile, on a distance of about 1,5 km and a medium breadth of 0,6 km. It is a slide, deluvium valley side, as it is registered on the geological map (1:200.000) from 1968.
Fig. 2. Landslide from Micloșani. General shape and structure (Satellite image LANDSAT – 7):

1. Front of a landslide step with dense cracks; 2. Transversal cracks on the body landslide;
3. Landslide front; 4. County road and electric network affected by the landslide

The slide body is characterized by an extremely complex micromorphology, showing
a typology and a hierarchy of the forms: steps, terraces, furrows, separated by cracks, extremely varied as deepness, width and orientation.

a) **Slide steps, terraces and furrows.** Seven steps have been identified within the slide body, characterized by a remarkable relief energy (until 10 – 15 m).

The first step (numbered from the initial separation cliff) has a much more emphasized forehead, where the geological formations appear. A new separation cliff appeared here, when the area was reactivated on 19th, 20th and 21st of February 2010.

Some slide steps did a translation movement, others did a rotation or mixed movement (translation – rotation), which caused the formation of counter-slopes and microdepressions, that have already become places of water stagnation. These negative forms function as areas of water accumulation and infiltration and of maintaining the landslide phenomenon in the next years. The terraces of *leopard fur* type are specific for the lowest step.

We must also mention that terraces (slide terraces) and furrows (slide furrows) were formed in these major steps in which the body of this massive landslide is set out; all these terraces and furrows are affected by an extremely complex cracking, as dimensions and direction.

b) **The slide cracks**

Beside the cracks in the landslide body, we encounter the big marginal cracks, meaning the ones formed at the contact of the body with the firm coterminous land.

We can notice the following types of cracks in the landslide body:

- in transversal sense on the axle of the landslide (which is the main vector of the deluvium material movement); these cracks are characteristic of the forehead and the counterslopes of the landslide steps;

- in longitudinal sense, especially in the neighbourhood of the contact with the firm land;

- in diagonal sense, with orientations in different directions (a chaotic cracking).

The dimensions (0,25 – 0,5 – 1,25 m – depth; 0,1 – 0,2 – 0,5 m – width at the surface) and the orientations of the cracks certify the variations of the deluvium material movement on the slippery substratum (slide bed), which is not a continuous and uniform inclined plane, but a segmented plane relating to the slope angle. The movement vectors (the internal forces) are different as orientation and intensity depending on the direction and the inclination of the clay, marl and sandstone layers, and on the orientation and the dynamics of the ground waters (on their drainage).

The main vector of the slide body movement is orientated in the direction of the general slope of the valley side in that area.

The dense and deep cracking is a factor of maintaining the movement and the risk in the future, too. The stagnant waters in the microdepressions set out on the entire slide body work together in the same sense.

**C. The slide forehead**

The slide forehead, having the shape of a convex circle bow lying on about 640 m. arrived in the bed of the Valea Largă rivulet. The advancement of the deluvium body narrowed the bed very much and even obturated it temporarily in certain parts. Immediate interventions were necessary to avoid the formation of some risky accumulations.

The general dynamics of the landslide (direction and movement speed) can best be noticed at the level of the slide bed.
D. The slide bed

The slide bed is made up of marls and clays belonging to the different formations of the Palaeogene flysch (the facies from Șoțrile, Strate de Plopu, Colții). The depth where the slide bed is found is variable (3 – 5 – 8 m). It is not uniform as inclination and orientation, depending on the position and the orientation of the layer plane that allowed the landslide (the translation or the rotation).

The slide bed (as well as the hydrogeological conditions) must be well researched, as a condition to find the most effective measures to stabilize the deluvium body and to strengthen the valley side.

4. The results of the fact that the area was reactivated in February 2010

The fact that the area was reactivated in the period 19th - 21st of February 2010 produced the following effects in the territory:

- The destruction of the county road Malu cu Flori – Pucheni on a distance of about 0,5 km.; the works of provisional rehabilitation lasted for a week and meanwhile the connection of the rural locality Pucheni with the rural locality Malu cu Flori (situated on the national road Târgoviște – Câmpulung) was hardly realized on a detour;
- Damage at the electric power line and at the water pipe on that area;
- The destruction of the drainage works (the discharge channel) and of the afferent poplar plantation;
- Calamities produced to the afferent agricultural space (apple-tree orchards, hayfields, pasture lands);
- The narrowing of the Valea Largă rivulet bed and even its temporary blocking in a sector.

5. Solutions for the stabilization of the landslide and for the rehabilitation of the agricultural land and of the utilities

To stabilize the valley side and to realize the rehabilitation of the afferent agricultural space and of the utilities, a new technical project is necessary; this project must be based on an adequate speciality study and must be carried out by industrial units (societies) specialized in such works.

Among the engineering works that we consider necessary to be included in this project, we mention the following:

- surface and underground drainages;
- modeling the slide body after a period of stabilization by natural and artificial ways;
- the extension of the forest plantations (poplar, pine, acacia), on certain areas;
- keeping the apple-tree orchards only in the most stable areas;
- the regularization of the Valea Largă rivulet bed by means of longitudinal and transversal profile works on the section in contact with the valley side, but also upstream and downstream.