

LANDSLIDES IN THE SUBCARPATHIANS BETWEEN IALOMIȚA AND DÂMBOVIȚA RIVERS AND THEIR IMPACT ON THE ENVIRONMENTAL FACTORS

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Résumé. Les glissements de terrain des Sous-Carpates d'entre les rivières Ialomița et Dâmbovița et leur impact sur les facteurs environnementaux. Caractéristique pour les glissements des Sous-Carpates est le fait qu'ils se distinguent par leur regroupement et développement dans le cadre des bassins géographiques. Les versants, pour la plupart déboisés, sont utilisés pour le pâturage et les cultures pomicoles. L'intervention anthropique, par ses aspects négatifs, influe sur le processus de préparation et de déclenchement des glissements de terrain (déboisement, pâturage excessif, sectionnement de talus, exploitations en carrières ou souterraines). Les particularités d'ordre géologique, hydrogéologique et géomorphologique sont mises en évidence comme défavorables pendant les années à précipitations abondantes, quand ont lieu des glissements de terrain déclenchés par l'érosion fluvio-torrentielle. Les quantités d'eau excessives données par les pluies abondantes et de longue durée des derniers ans, ainsi que la fonte rapide des neiges à cause des températures élevées, ont déterminé la modification de l'équilibre des versants sur lesquels se trouvent des localités, des établissements socio-économiques, des voies de communication, des cultures agricoles et pomicoles, des zones forestières. Les glissements de terrain, à côté des facteurs générateurs naturels, sont déterminés par des processus antropogènes (exploitations irrationnelles du fonds forestier, travaux d'exploitation des matériaux de construction situés sur les bords des eaux qui déterminent sur des longues portions la descente du talweg de quelques mètres), processus intenses d'érosion des rives, associés aux conditions géomorphologiques favorisant l'apparition des glissements de terrain.

General considerations

The unit of the Subcarpathians situated between Ialomița and Dâmbovița, located in the south-east of Romania and having a general orientation north-west to south-east/east, is a part of the Subcarpathians of Ialomița, which belong to the Curvature Subcarpathians, geographically located in the Sucarpathian hydrographic

basins of west Dâmbovița and east Ialomița. It is made up of a succession of anticlines, oriented east-west, which correspond to the summits, and anticlines, which correspond to narrow depressions oriented likewise. The Subcarpathians make up one of the geographic units where the dynamics of the riverbed and slope geomorphological processes is extremely active, determining extremely unfavorable effects on the economy and the human habitats.

The fragmentation of the Subcarpathians of Ialomița is related to their structure, lithology, climate and vegetation, and an important role in this sense is given by the erosion caused by the hydrographic network, which leads both to a horizontal and to a vertical splitting of the topographic surfaces. In the Subcarpathian area under analysis, the density of the fragmentation reaches higher levels, between 2-4 km/km², the slope of the longitudinal profile being of up to 25-50 m/km. On the hill slopes, especially on those hills with a high relief energy (over 100 m) and massive deforestations, in the context of a varied and friable lithology, one can notice a movement of the points where the valleys start towards the area of interfluves, which determines an increased horizontal fragmentation. On conglomerates, grit stones and calcareous stones, the slopes are abrupt, while on the structural surfaces, on the flanks of certain anticlines, along the large glacis es, their slopes are reduced. The slopes which contain different rock strata with different properties have a complex form; the grit stones and the ravines influence the accentuated incline, while the slight inclines are found on marls and clayey rocks, on sands and diluvia. There are also convex slopes, found on the flanks of diapire arcs.

A characteristic feature of the landslides of the Subcarpathians of Ialomița is the fact that they have a special arrangement and development in the hydrographic basins. The potential conditions and the forces that trigger landslides influence large areas in the Subcarpathians between Dâmbovița and Ialomița, as they are made up of Miocene and Pliocene formations with more or less cemented clays and sands, included in folded and fault structures, being affected by neotectonic uplifts. The slopes, most of them deforested, are used for intensive grazing and tree cultures. The anthropic intervention, with its negative aspects, influences the process of landslide preparation and triggering (deforestations, excessive grazing, sectioning of the slopes, exploitations in quarries or mines). The geological, hydrogeological and geomorphological characteristics favor the appearance of landslides, during rainy years (1970-1972, 1975, 1995-1996, 2001, 2005).

1. Areas undergoing the risk of landslides

In the upper basin of Ialomița River, there is an area of clayey schists, clayey and marly schists and dusts, characterized by a high frequency of the stratification layers that hold and store water, triggering landslides (Bezdead, Buciumeni,

Glodeni, Vârfuri, Vișinești, Vulcana Băi); in the hydrographic basin of Dâmbovița, the presence of Eocene formations in a 600-700 m thick *facies of sotrile*, with intercalations of fine and rough grit stones, sometimes friable, with clays and marls, constitutes well-defined stratification surfaces, on which, when there is humidity excess, landslides may occur (Bărbulețu, Malu cu Fori, Pucheni, Râul Alb, Văleni Dâmbovița). In the area of the localities Cobia, Dragodana, Hulubești, Lucieni, Valea Mare, there are deposits of gravels, sands and clays, low-cohesion strata where large water quantities can be stored. When riverbeds are eroded and descend, the drainage from these deposits to the watercourse accelerates, triggering landslides.

The events occurred and the observations made so far allow us to state that the periods of landslides in the Subcarpathians of Ialomița, occur during or after the melting of the snow layer (Vârfuri- February 1980, Râul Alb-March 2005, Răzvad-March 2005), and also during the periods with lengthy rains (Malu cu Flori - June 1979, Vișinești - June 2001, May-September 2005, Buciumeni, Bezdead, Pucheni, Răzvad, Văleni Dâmbovița -2005) - fig. 1.

Besides the natural generating factors, landslides are triggered as well by anthropic activities, like: excessive exploitation of the forest fund, begun at the end of the 19th century and continuing at present (Malu cu Flori, Pucheni, Văleni Dâmbovița, Vișinești, Vârfuri, etc.), exploitation works for construction materials on the watercourse, without feasibility studies and the approval of specialized institutions, determining a several meters lowering of the talweg on long sectors, intense riverside erosion processes, associated to landslides.

In the hydrographic basin of Ialomița, the geological substratum made up of clays, marls and grit stones, the morphometric and morphographic features of the slopes, the low degree of afforestation, associated to different forms of anthropic intervention - deforestations, inadequate agricultural exploitation of slopes (excessive grazing on the communal land; orientation of the arable land perpendicular on the level curve - for example, on the left slope, in Doicești area; inadequate exploitation of construction rocks - in Fieni, Pucioasa and Doicești), determined an intense degradation of the sloping lands. The most representative landslide occurred in Vârfuri on February 13, 1980 beginning with 10.00 a.m.; it occurred over a period of 6 hours and affected the center of the locality (the town hall was completely destroyed, as well as the new cultural center, local shops and school and 60 dwellings of the local population) and the fruit-growing trees plantations situated on the slopes affected by the landslide (between Valea Neagră and Valea Părușului). The landslide occurred on the direction S-SW, on a slope with a 10% incline, had a speed of 6-7 m/h, and concerned a 700-800 m long stripe, whose widths varied from 200 m to 600 m, while its depth ranged between 5 and 20 m, triggering crevasses and landslides (Fig. 1). Nearby this locality, other

areas have been affected by (new or reactivated) landslides in 2001, 2005, 2006: Buciumeni, Fieni, Moțăieni and Pietroșița, their local economy suffering losses.

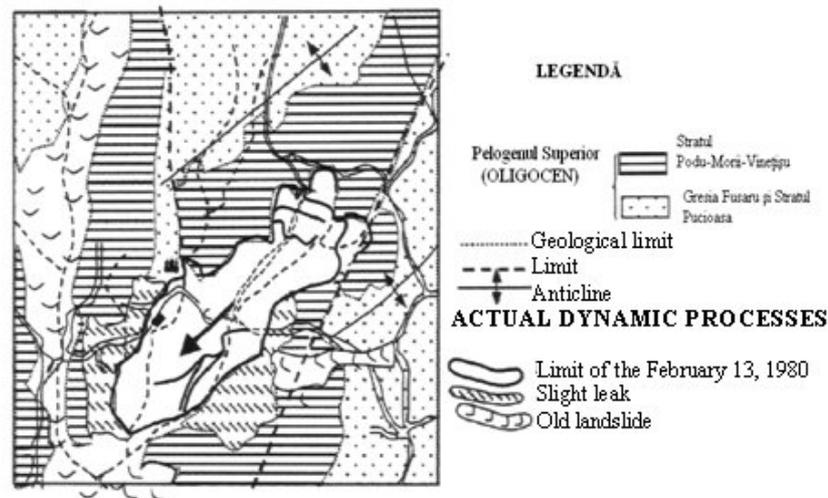


Fig. 1 - Geological and tectonic landslides (according to Istrate., 2005)

Near Vârfuri, in NE, there is Vișinești Commune, where landslides affected dwellings, ways of communication and fruit-growing plantations situated on the slopes (1980, 2001, 2005, 2006). In the area of the localities Răzvad, Ocnîța, Gura Ocnîței, landslides are present on the slopes under the form of canyons on the most abrupt slope line, which evolved in links of deep erosion. In the geographic area of Fieni, Runcu and Brebu, on Ialomicioarei Leaotei Valley, landslides associated to ravine erosions affect the slopes. Landslides are active as well in the localities: Vulcana Băi, Șotânga, Glodeni, Doicești and Aninoasa, triggering important material damage - they affected the ways of communication (departmental and communal roads - DJ, DC), dwellings, socioeconomic institutions, hydrotechnic and art works (bridges, riverside protection and consolidation). The actual geomorphological processes affecting Vulcana Hills are characterized by massive land displacements, associated here and there with ravines and erosion at the surface. The right slope of Ialomița River, as well as the left slope of Vulcana rivulet, are the typical image of a relief resulted from the association of several categories of massive land displacements, superposed in time and space.

In the hydrographic basin of Dâmbovița, landslides affected several localities, both in the past and at present. The relief of Dâmbovița basin in

the Subcarpathian area is characterized by slopes with a 10-40% incline and a 100-300 m relief energy, a low degree of afforestation (15%), which, in association with average yearly precipitations of 700-900 mm and a favorable geological structure (alternances of grit stones, marls and clays), triggers landslides, too.

In the locality Văleni Dâmbovița, on Muscel Valley, in 1979, the excess of soil humidity and the underground springs triggered landslides. In the area of the locality Malu cu Flori (the villages Micloșanii Mari and Micloșanii Mici), made up of strata with a general slope of 10^0 - 18^0 to the nord, while the structure in *facies de sotrile* is made up of yellowish-gray friabile grit stones, and intercalations of gray and purple clays and marls and in Pucheni, the slopes of Valea Largă have been and continue to be affected by landslides (1921, 1941-reactivated in 1955, 1970, 1979, 2001-2006) produced by springs and excessive precipitations, which created water accumulations that continually feed the underground strata made up of series of grit stones, clays and marls, creating the grounds for triggering such processes. The antropogenic factors (intense exploitation of the river rock for constructions) determined the deepening of the riverbed of Valea Largă Rivulet, intensifying its riverbed erosion and removing the earth at the foot of the slopes, favoring the appearance of landslides. In Malu cu Flori, landslides have seriously affected scores of dwellings, ways of communications (the national road DN Târgoviște-Câmpulung in 1979, 2001, 2005, 2006, the communal road DC in Micloșani), the left side of Dâmbovița River, more than 1600 ha fruit-growing tree plantations, and the course of Dâmbovița River risked to be blocked. Landslides are active in the localities Râu Alb, Bărbulețu, Voinești, being caused by the springs and the excessive precipitations that created water accumulations that feed the underground strata (grit stones, clays and marls) creating the grounds for triggering landslide processes and affecting dwellings, ways of access and plantations.

2. Landslide prevention and post-landslide management

Landslide prevention and post-landslide management requires a knowledge and analysis of the activities that need to be carried out in such situations, according to pre-established procedures. These activities take place at all levels, from a national level to a local level, in order to assure the realization and the application of the forecasting, prevention, protection and intervention measures, as well as the estimation of the effects and damages.

Civil protection measures and actions in case of disasters must be conceived for all the phases of such events: pre-disaster, during and after the disaster, as well as long term measures and actions. Preventive measures are conceived and applied in order to avoid or limit the consequences of disasters and are completed by

measures of preparation, which represent a set of actions and measures meant to assure a rapid intervention in order to minimize losses and distructions.

A major influence on slope stability goes to water, which maintains a supplementary humidity in the strata, triggers leaks on the slopes or concentrated flows under the form of torrents and rivulets, which requires the application of complex measures for diminishing their effects, like:

- reducing or annulling the erosion at the foot of the slopes, given by concentrated flows (torrents, rivers) by an adequate arrangement of the riverbed (riverside defense, bottom thresholds, dams for decreasing the slope in the riverbeds that have a torrential character);

- interception of the surface waters that flow on the slope and their fast evacuation by executing specific antierosional works (inclined canals, outlet), determining a reduction of the quantity of water that infiltrates in the slope;

- technical-economic programs to intensify the measures of slope afforestation in the case of landslide-prone slopes;

- control of the underground waters ascensional levels by executing drilling works to lower them; this action can have a major influence on the stability of the slopes that have been affected by older landslides;

- interception of the underground water flows with horizontal drainages achieved transversally or longitudinally on the slope; decrease of the underground water level, along with the determination of the humidity decrease in the land mass situated above the depression curve and the reduction of the influence of the hydrodynamic force of the underground current by modifying the flow direction and the hydrodynamic slope;

- eliminating the possibility of appearance of water accumulations in the large fissures of the slope by filing them with a low permeability degree soil, which will trigger the elimination of the hydrostatic forces in the fissure and will influence the energetic balance of the slope's stability;

- fighting against the phenomenon of electroosmosis present at the boundary between clay strata and marl strata, because of the activity of anaerobic bacteria, by creating some strata with iron rods penetrating in the strata and shortcircuiting them, which leads to the removal of the excess of humidity;

- protecting the coast springs in order to prevent their blocking (which can occur when certain slope arrangement works are carried out) in order to maintain the natural drainage of the slope;

- reducing the weight determined by the construction of heavy buildings on the upper third of the slopes, and avoiding the construction of transversal roads on the slopes;

- maintaining/ increasing the capacity of biodrainage given by the vegetation on the slope, which results in the rapid elimination of water excesses and a supplementary resistance thanks to tree roots.

Preventing, fighting against and stabilizing landslides and fighting against soil erosion, all these were carried out by means of complex works during the period 1975-1984, in the zones identified as presenting landslide hazards, on an area of over 9000 ha; the works amounted to around 90 million lei. For instance, in the localities Hulubești, Ludești and Valea Mare, in order to stabilize these processes, there were executed regularization works for the leaks on the slopes, consisting in coast channels connected to outlets constructed on the slope line, leveling works as well as works for filling out the holes produced by landslides in order to avoid the infiltration and the accumulation of the water coming from precipitations and from the melting of the snow, while in the upper area of the slopes, afforestations were carried out. In the area of Văleni Dâmbovița, Pucheni, Malu cu Flori (on Turnului Valley, Valea Preotesei and Valea Largă) the same kind of technical solutions was applied as in the zones of Hulubești, Ludești and Valea Mare. Moreover, depending on the local specific needs, other underground drainage networks and transversal works on the ravines were achieved. In the area of the localities Runcu, Bărbulețu, Pietrari, landslide stabilization works and soil erosion limitation works were achieved by regularizing the leaks on the slopes, in 1984-1985.

After 1990, given the lack of financial funds and the lack of interest on the part of the central and local authorities, no more landslide stabilization works and soil erosion limitation works were carried out, and no other investments for repairing and maintaining these watercourse arrangements were carried out. The dangerous hydrometeorological phenomena recorded especially after 2001, affected and even destroyed the works achieved previously, landslides being reactivated mostly in the same areas known from before 1990. One can state that, if the existing works are not rehabilitated, they will become dangerous, triggering landslides and having major repercussions on the social and economic life of the areas concerned.

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