SPECIAL ISSUES RELATED TO THE LANDSLIDES OF ROMANIA

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On Romanian territory, landslides are encountered in all relief units; the existing differences being related to several factors, among which important roles are played by rock, slope, relief fragmentation density, clearings, moisture degree of deposits. The importance of landslides within present-day processes is very different from one region to another. Landslides play a determinant role in the slopes' modeling of the Carpathians, the Subcarpathians, the Moldavian Tableland or the Transylvanian Tableland.

1. Landslides' Causes

The potential factors of landslides are: rock (physico-mechanical properties), structure (way of association of strata), slope, type of vegetation.

Clays, coloid-rich marls, with a high degree of plasticity frecquently favour landslides. Clay and marl intercalations between less plastic strata lead to big landslides that affect valleys' slopes entirely. The high slope to which the lack of vegetation is added favours the producing of landslides; their type and width depend upon the rock.

Tree vegetation prevents landslides to occur through its role in the circulation of precipitation and water in soil, assuring a uniformization of the slope deposits' moistening.

The most important *triggering factors* for landslides are variations of volume and moisture content of rock masses, torrential precipitation, cutting at the slope basis, anthropic cutting of relatively stable slopes, other anthropic activities, and earthquakes. Most landslides take place after intense humid periods (spring, autumn), after torrential rainfalls following a long drought period on a highly fragmented terrain.

2. Regional Aspects of Landslides

On the Romanian territory, one can distinguish among regions with different landslides in terms of frecquency and morphology.

2.1. Regions with a high frequency of landslides – include various relief units, with a great petrographic and structural diversity, generally specific to **hills** but also to the **sedimentary (flysh) mountain unit**. Slope conditions, high fragmentation, weight and volume variations of rocks on the slope and of the alteration cover lead to the appearance of landslides and mudflows that usually affect over 50% of the slopes area.

In **the Moldavian Tableland** landslides are unevenly disitributed on the units. They have at the same time different degrees of intensity. In the Suceava Tableland and the Moldavian Plain various types of landslides, with high frequency, are to be found; in the Central Moldavian Tableland landslides have a reduced weight in comparison to other types of movement; to the south of the tableland there are rocks favouring landslides to occur although their high friability does not allow the maintainance of big landslides, only of shallow ones. So, there can be distinguished: *outliers of big landslides* of Pleistocene age; *step-like landslides (pseudoterraces)* that took place under periglaciar conditions; *mound shaped landslides*, occurring on deforested slopes, are the present day type moving most of the material; *nest-like landslides* representing the most frequent type in the actual slope evolution; *landslides in clods* affecting the deluviums of the valleys slopes; *landslides of landslip type* which are developped in torrential catchments.

The Transylvanian Tableland shows a great variety and density of landslides, due to the extended areas occupied by sarmatian rocks. F Grecu (1985) differenciates:

– *Massive landslides (glimee),* deep or very deep, which are stabilized. They have their maximum frequency in the Transsylvanian Plain and the biggest size in the Hârtibaciu Hills.

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– The main characteristics of the glimee-type landslides in the Transylvanian Depression have been approached by Tiberiu Morariu, Virgil Gârbacea, who also introduced the term of *glimee* at the XIth International Geography Congress in 1964. This type of landslides affect both the regolith and the geologic substratum on big depths. The mean area of glimee-affected terrains is 50-150 ha (among the most extended being the ones at Saeş – 1550 ha, Movile – 900 ha, Saschiz – 615 ha) (*fig.1*). Generally the most extended areas with glimee are at the limit between Pliocene and Miocene (e.g. at Movile, Agnita, Dealul Frumos, Merghindeal, Cornăţel), but they can also appear only in Pliocene or Miocene (Saeş) simple deposits. The spor-pollen analyses in different parts of the slope affected by landslides permitted to establish their *age*. The first stage in the glimee's evolution took place in Würm, the second in Postglaciar and the third in the Early Holocene. The areas affected by glimee are generally deforested with the scarp line in the proximity of the forest limit. The terrains are used for pasture, vineyards, cereals cultivation and orchards (*photo 1, 2, 3*).

Photo 1. The landslide of Movile – the asymmetric character

Photo 2. The present day modeling process of slope – Hârtibaciu Tableland

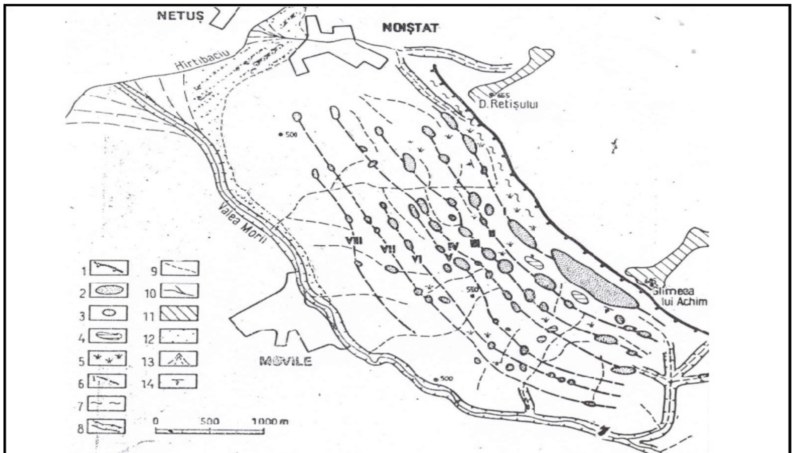
– *Step-like landslides (pseudo-terraces)* have been described for Târnava Mică Hills, Hârtibaciu Hills and Apold-Sibiu Depression having the form of small steps or terraces.

– *Wave-like landslides,* which have the form of small waves with lakes between them, are shallow reaching 3-5m.

– *Landslides of tongue shape* have a high frequency and contribute to the present-day modeling of slopes.

– *Mudflows* which occur in the presence of impermeable rocks.

– *Shallow landslides* occupy extended areas especially in the central part of the Transylvanian Tableland and affect the grass cover after long rainfalls.



Geomorphological map of landslides at Movile
1.Sear, 2. Elongated, well individualized tumuli; 3. Rounded tumuli; 4. Lakes; 5. Excees of humidity; 6. Landsliding; 7. Sheet sliding; 8. Gully erosion; step banks; 9. Temporary network; 10. Erosion level; 11. Floodplain; 12. Alluvial fan; 13. direction and declivity of strates

Fig. 1. Geomorphological map of landslides at Movile (Grecu, 1992)

Photo 3. The landslide glacis profil

The Paleogene flysh Mountains and the Subcarpathians show a lithological variety of folded strata. There are differences in the occurrence of landslides between the carpathian and subcarpathian region due to differences in rock type and in the deforestation rhythm. One may distinguish among:

– *Linear landslides (tongue shaped)* which sometimes in the Subcarpathians reach the character of a debris torrent.

– *Landslides in clods* differentiated after the volume of the mass moved and the nature of the slip plane

– *Nest-like landslides* which are frequent in the Subcarpathians

– *Haltered landslides* specific to the deforested mountain slopes.

In this region the highest frequency and intensity of landslides is met in the Buzău Basin. They belong to the following types: 25% massive, deep landslides; 35% landslides of small depth; 40% shallow landslides. Their occurrence and triggering is related to the presence of Neogene flysh, the alternance of thick strata of clay, sandstones, marls but also due to other factors such as: the clearing of forests and the intense wood exploitation, the long duration of drought followed by long rainy periods (1942, 1969, 1975), snow melting and long rainy periods (springs of 1939, 1970, 1973), seismic manifestations (1940, 1977, 1986, 1990), undercutting at the slope base through fluvial erosion (1969, 1970, 1975).

2.2. Regions with medium frequency of landslides include units with moderate conditions for the occurrence of these phenomena due to some intercalations of plastic rocks.

In the Getic Plateau landslides occur in sand and gravel deposits which contain frequent clay lens. The process is accelerated by deforestations and secondary hydrographical network. Landslides are more frequent in the northern part, where the declivity and fragmentation are higher, while in the southern part the piping-plastic processes predominate. The following types of landslides are specific: wave-like landslides, complex landslides in torrential reception basins, piping-plastic movements.

The Western Hills with landslides related to sands, gravels and clays. Between this region (north from the Mureş river) and the one of piedmonts in the south of the country, there are similarities concerning rock type, fragmentation, deforestation, and the main type of landslides. Specific are: wave-like landslides, complex landslides in torrential reception basins, piping-plastic movements

2.3. Regions with low frequency of landslides correspond to the Mezozoic cristalin and the Cretacic flysh mountain area, the volcanic zone and the Mehedinţi Tableland where the landslide potential is reduced. The process affects predominantly the slope deposits and sometimes even the rock.

The landslides on these mountain units concentrated in the alpine and sub-alpine sector, as well as in the forest sector and the intra-mountain depressions.

For the alpine and subalpine sector there can be distinguished processes such as: *solifluxions, landslide in clods, gliding blocks, landslides-rollings, rollings-landslides.*

In the forest domain there could be remarked: *wave-like landslides that affect the soil, wave-like landslides that affect the alteration cover, wave-like landslides that affect Tertiary plastic rocks.*

The Mehedinţi Tableland is characterized by *wave-like landslides* produced on the slopes where clays and marls are frequent.

2.4. Regions with very low frequency of landslides or without landslides refer to the Dobrogea Plateau, the Romanian Plain, the Western Plain. The process occurs sporadically and only under certain conditions, imposed by the action of triggering forces. In the Dobrogea Plateau big landslides produce on the shores of the lakes Babadag and Măcin, on the dobrogean side and along the cliff South to Constanţa.

In the plains in the South and West of the country frequent are: *piping-plastic movements,* and on small areas *wave-like landslides*.

The piping-plastic landslides of the Covurlui Plain are found on its Eastern slope, along the Prut Valley, with periodical reactivations from 1929 until present, related to rainy years, to constructions and vibrations. Specific is the interference of more processes: piping, compaction, rock-falls, landslides, rain wash, sheet-wash, gully erosion also due to the presence of some loess horizons separated by fossil soils which lie on clay-sandy formations of Upper Pleistocene age (*fig. 2*).

They show a step-like morphology:

– *the upper landslide step* is bordering the depression to its exterior;

- the landslide takes place on a clay slip bed, most of it being covered by arbust vegetation;

– *the medium depression* – lies between the two main landslide steps, containing water accumulations, lakes, sectors of moisture excess;

– *the lower step* contains the oldest deluviums that also suffered most of the movements;

– *the base glacis* appears like a discontinuous strip, as a result of its wash from the exterior landslide step.

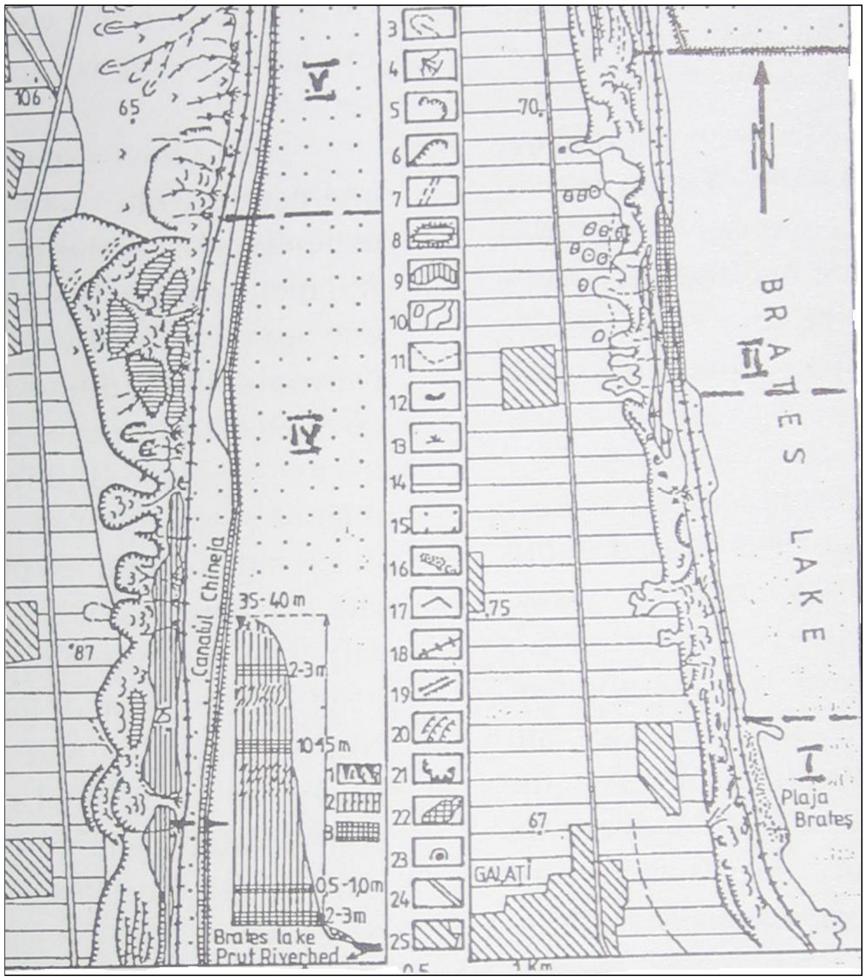


Fig. 2. Geomorphological map of Galaţi-Tuluceşti area (1. ravines, torrents, 2. sheet erosion; 3. active torrential basins; 4. alluvial fan; 5. scars partially stable; 6. active scars; 7. deep craks; 8. old slide steps partially activated; 9. stable slide steps; 10. underground cavities, piping tunnels; 11. old chanels; 12. lakes; 13. overmoist area; 14. field; 15. floodplain; 16. managed beach; 17. canal; 18. railway embankement; 19. dam; 20. leveled steps; 21. quarry; 22. embankment dam; 23. garbage – filled pipping cavities; 24. material highway; 25. settlement. *Geological section* (P. Cotet, 1976) – 1. soil; 2. alternative loess strata with fossil soils; 3. thick fossil soil strata. *Management problem sectors*: I. Non managed active slide area with moderate impact infrastructure; underground water pollution; II. Partially managed active slide area severe effects on rail and road; III. Areas of low morphodynamic activity with anthropic uses; IV. Active slide area, partially stabilized by afforestations; V. Plant-orchard stabilised area (Ielenicz, Mihai, Comănescu, 2008)

This has *unfavorable effects* upon the agricultural lands and the Galaţi-Bârlad railway (Ielenicz, Bogdan, Comănescu, 1998).

PROBLEME SPECIALE PRIVIND ALUNECĂRILE DE TEREN DIN ROMÂNIA

Rezumat

Pe teritoriul României sunt prezente o gamă variată de alunecări cu morfologie, vârstă şi grad diferit de activitate, localizate în Carpaţi dar mai ales în unităţile deluroase şi de podiş. Factorii care contribuie la declanşarea şi activarea alunecărilor de teren sunt: rocile (în special cele argiloase), anumite categorii de pante, condiţiile climatice (variaţia umezelii, precipitaţiile torenţiale), defrişările şi activităţile antropice. În prezenta lucrare sunt prezentate caracteristicile alunecărilor pentru fiecare regiune în parte în funcţie de frecvanţa acestora (regiuni cu frecvenţă mare – Podişul Moldovei, Podişul Transilvaniei, Munţii Flisului şi Subcarpaţii; regiuni cu frecvenţă medie – Podişul Getic, Dealurile de Vest; regiuni cu frecvenţă redusă – şi regiuni cu frecvenţă foarte redusă a alunecărilor – Podişul Dobrogei, Câmpia Română, Câmpia de Vest).

Cuvinte cheie: alunecări de teren, cauze, aspecte regionale, România

PROBLÈMES SPÉCIAUX CONCERNANT LES GLISSEMENTS DE TERRAIN DE ROUMANIE

Resumé

Le territoire de la Roumanie est affecté par de nombreux glissements de terrain avec différente morphologie, âge et degré d'activité, situés dans les Carpates, mais surtout dans les collines souscarpatiques et les plateaux. Les facteurs qui contribuent au déclanchement des glissements de terrain sont: les roches (particulièrement les roches argileuses), certaines intervalles de pentes, la condition climatique (la variation de l'humidité, précipitations torrentielles), la coupée des forêts et d'autres activités anthropiques. Dans cette étude on a choisi de présenter les particularités des glissements pour chaque région, en fonction de leurs fréquences (les régions à haute fréquence: le Plateau de la Moldavie, le Plateau de Transylvanie, les monts du flysch, les Souscarpates; les régions à fréquence moyenne: le Plateau Gétique, Les Collines de Ouest et les régions à fréquence réduite et nulle: le Plateau de Dobroudja, la Plaine Roumaine, la Plaine de l'Ouest).

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