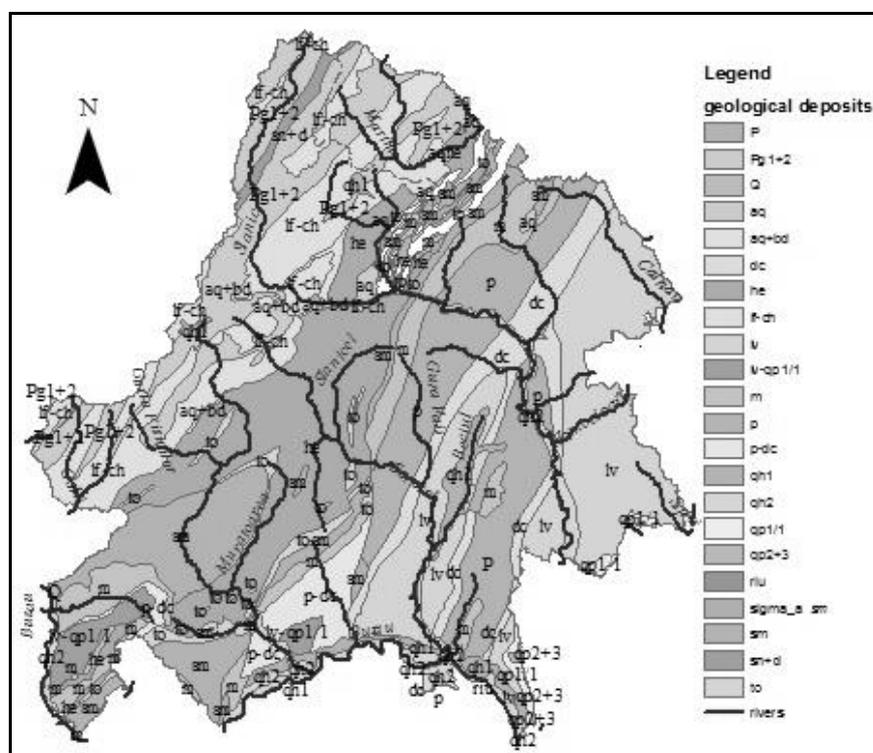




secondary faults, perpendicularly or obliquely oriented on the original ones. The Buzău Valley is outlined on the newest system of faults reflected by the particularly sinuous aspect of the main bed. The relief within the sub-Carpathian area, between the Călnău and the Buzău Rivers, is characterized by a great variety of relief the outcome of the tectonic processes that have affected the regional and local geological formations.

As a result, the hydrographic network created depressions on syncline and narrowings on the anticline, causing high values of relief energy. Also, there is a varied dynamic in both the slopes, the creation of a terraced relief, and in the low rivers, through the creation of large meadows and accelerated bed processes.

The relief developed on the marlstone and clays is perhaps the largest spread, the weight of these litofacies being important in the petrographic mosaic existing in the Subcarpathians. The clays are plastic rocks with a very high porosity and absorption degree, impermeable due to the material made up of fine granules, called pellets, with a diameter of less than 0.039 mm, which causes their cementation or consolidation (Ene, 2005). Depending on the dominant material, we can encounter sandy clays, clay and charcoal. Marlstones are characterized by increased hardness compared to clays, being rocks of transition between clays and limestones; may be marl itself, marl-lime, sandy marl (Fig. 2).



**Fig. 2** Lithological map of the study area – Subcarpathian area between the Buzău and Călnău Rivers (data processing in ArcGis software)  
Ages: *Quaternary* (qp1, qp2+3, qh1, qh2), *Pliocene* (m, p, p-dc, dc, lv), *Miocene* (to), *Upper and Lower Paleogene* (Oligocene – lf-ch, aq, bd, he), *Cretaceous* (sn+d, sm)

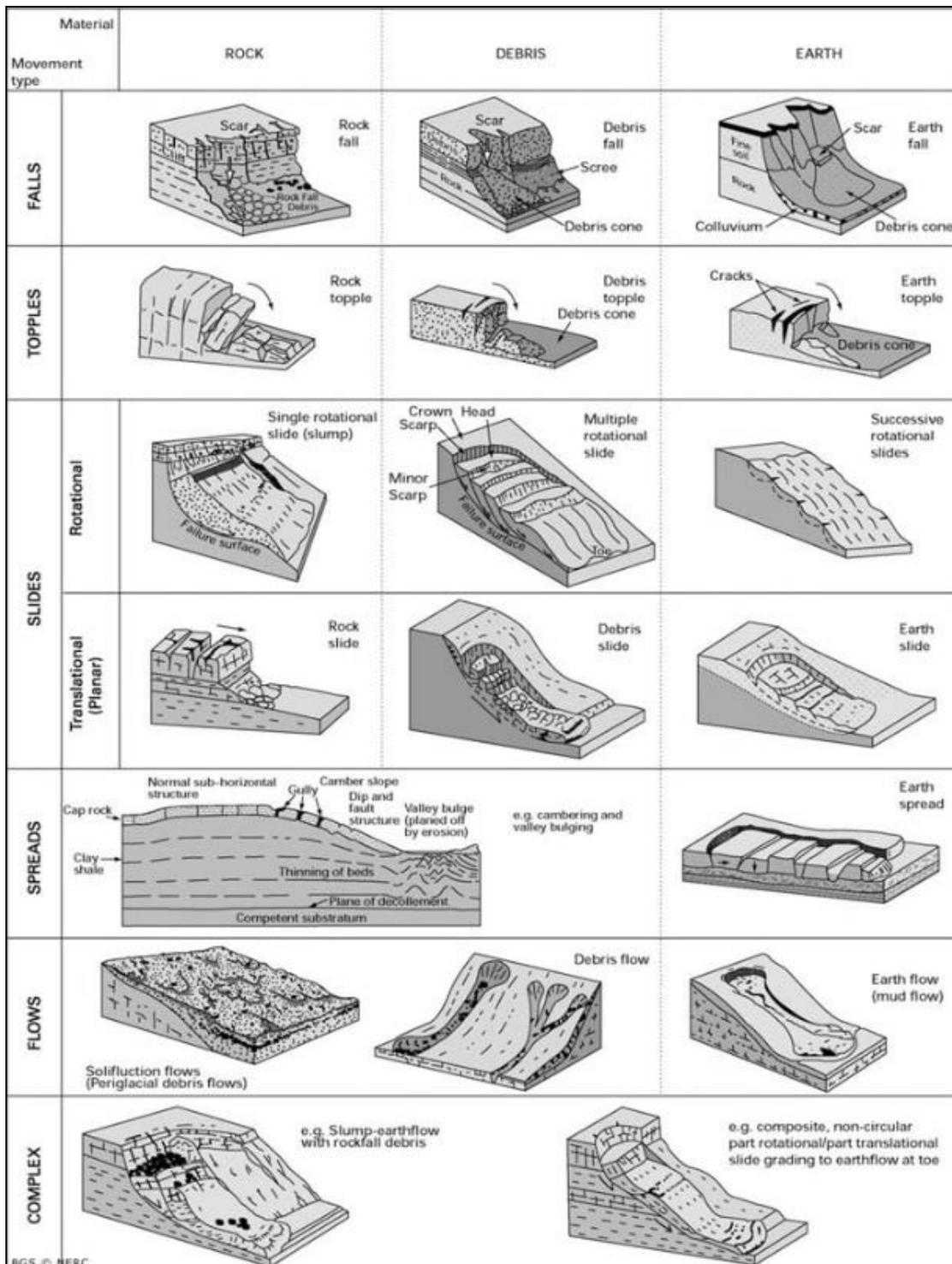
**2. Materials:** The analysis of the land movements in the Buzău Subcarpathians area, between the Buzău and the Călnău Rivers, was based on two types of activities:

- in the office, including the extraction of information from topographic maps at 1: 25,000 scale, topographic blueprints, aerial images or from certain software like Google Earth, and
- in the field, including the observation, recording and monitoring (limited by the financial and material support).

Subsequently, the information was centralized in the form of thematic maps designed by the ArcGis software package.

**3. Methods and results:** The methods of study were varied, conditioned by the physico-geographic features of the analyzed space, and by the logistic support available. For example, the Varnes classification system (Fig. 3) has been used, which divides the movements into 6 categories: falls,

topples, slides, spreads, flows and complexes, and which, depending on the mass of the collapsed or slid, is the displacement developed in rock (hard rock), debris (rock fragments) and earth (earthen type). The current paper approaches a brief classification, considering that the field displacements occur under the impulse of gravity, at different speeds. Depending on the speed of travel, we encounter sudden gravitational processes in the Buzău Subcarpathians: collapses, landslides, slope flows and slow gravitational processes (dry drift, freeze-thaw).



**Fig. 3** The classification of landslides (scheme based on Varnes – 1978, source [http://www.bgs.ac.uk/landslides/how\\_does\\_bgs\\_classify\\_landslides.html](http://www.bgs.ac.uk/landslides/how_does_bgs_classify_landslides.html)).

The physical and chemical characteristics of rocks, modeling agents and new-tectonic influence are just some of the determining factors in the development of geo-morphological processes and the formation of relief units. This paper deals with some forms of movement, but with a wide spread in the analyzed space, and they are as follows:

**3.1 Bad-lands** are generated by the processes of drainage and sedimentation affecting the clay and marl-stone, with sandy and sandstone interlaces. They accompany the slopes of the tributaries on the left side of the Buzău, but also appear at the base of the internal hills, such as Bisoca Hill, whose slopes are scattered with ravens, drainage ditches to give the specific ruinous appearance, and the landslides further accentuate the dramatic character. The main factors contributing to forming these reliefs are: the tilting of the slopes, the deforestation of the slopes, the torrential precipitations in summer and late spring.

A particular aspect is also determined by the occurrence of salt pits requiring a pseudocarst specific to bad-land areas: horizontal and vertical ballasts, drainage ditches, dissolution alveoli. All these forms are the outcome of the advanced degradation of the land without the protection of the vegetal carpet. Falls occur where the marl strata stand almost upright and are in succession with other harder strata (sandstones, conglomerates), and underlying erosion of the strata occur, or, as the case may be, mechanical disintegration. As a result, in the absence of a support, the layers above collapse under the impulse of gravity (Ielenicz et al., 2013).

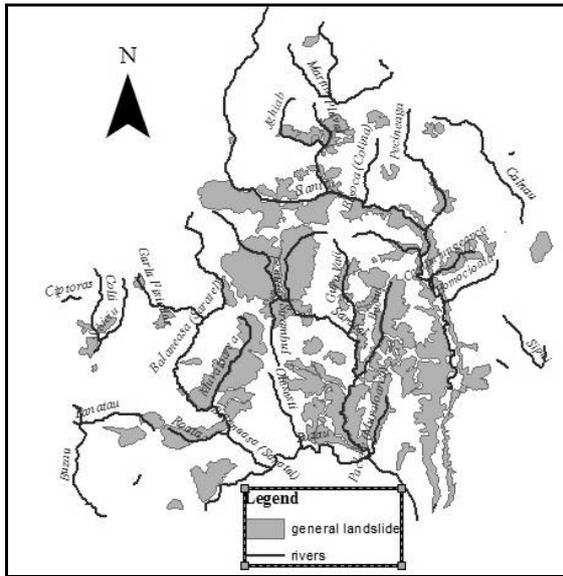
Slow movements of land are differentiated according to speed of displacement, so we meet:

**3.2. Solifluctions** occur on most of the slopes of average tilting, used for grazing. These processes are conditioned by the daily freeze-thaw cycle and affect the soil cover. These gravitational movements are invisible to the human eye but affect the field farmland and change the physiognomy of the slopes with a wavy appearance (Greco, 2018, Florea, 2003). Solifluction terraces represent a more advanced form of land degradation by solifluction and are spread over slopes with tilts larger than 10-12 degrees, with lengths of several tens of meters and widths of 1-2 m.

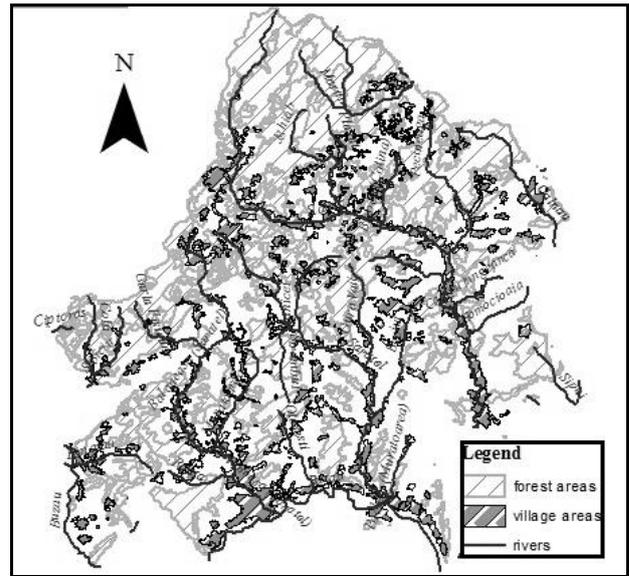
**3.3. Landslides** are the most widespread Geo-morphological processes in the sub-Carpathian area due to the large expansion of marls and clays. Their complexity gives them the quality of relief forms (Ene, 2005). For example, in the monocline area, genuine landslide valleys are formed, consisting of a spring (the feeding area), the sliding mass (the main course) with variable dimensions and shapes similar to those formed in the mountain glacier space, the sliding cone, formed in the lower part of the slope, and, depending on the consistency and speed of the material, it can take various forms, from the funnel, to the cloths of landslide diluvium.

**3.4. The mud flow (muddy torrent)** show a high degree of spreading and affect important areas of agricultural land. These are a consequence of the water overflow of marls or clays, which exceeds the upper limit of plasticity. The flow rate of the torrents varies depending on the viscosity of the moving material from a few meters per week to a few meters per day. The spreading cone flows to the downstream side and has a sharp 1-2 m. The most representative forms of flow are formed in the external part of the Subcarpathians of the Buzău, in the monocline area. For example, in the Călnău Basin, in the Valea Largă-Sărulești Valley - Salcie Valley, on the right slope to the valley of the Călnău; the flows were formed on the gentle slope of a cuesta, parallel layout, over a distance of about 2 km (The mud flow in Valea Largă-Sărulești-Valea Salciei area). Most of the times, they cross the access roads, temporarily damming the Călnău river bed; upstream lakes are formed. On the left slope, represented by the forehead of a cuesta, there are deep, topless and rotational slides (Complex landslide with mud flow in Valea Largă-Sărulești-Valea Salciei area).

**4. Discussion:** A rather controversial topic of discussion is given by the age of landslides. For example, the oldest landslides appear to be contemporary to the main relief units, but due to the fact that they no longer function, being basically incorporated into the current relief forms, it is questionable whether they can still be classified as landslides (Fig. 4). One thing is certain, namely, the current slides are grafted on the older landslides, now monitoring their reactivation, amid extreme triggering conditions: intense precipitation, earthquakes, the formation of accentuated slopes, excessive grazing, extreme deforestation (Fig. 5).



**Fig. 4.** General landslide map of the study - Subcarpathian area between the Buzău and Călnău Rivers (data processing between 2014-2016).

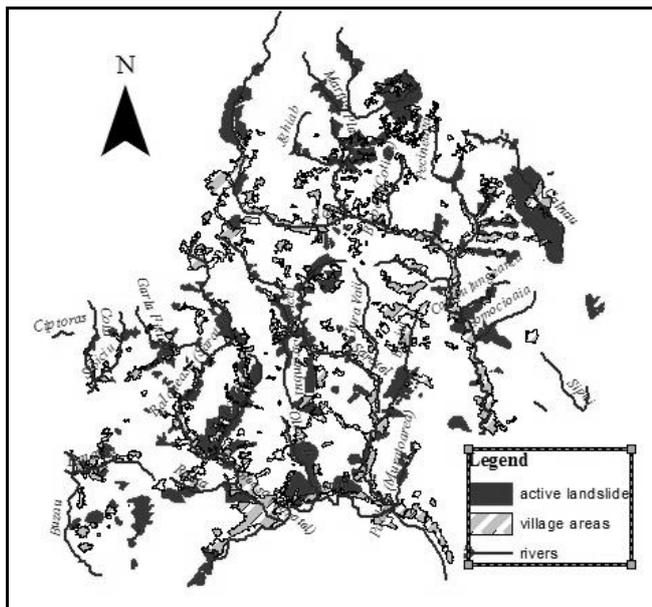


**Fig. 5.** The forest map of the study area - Subcarpathian area between the Buzău and Călnău Rivers (Land Cover -2007).

Another subject of discussion refers to the zonal tectonic activity. It plays an important role in the development and orientation of landslides, an example of such being the landsliding in the area of Rătești Monastery (October 2014, Fig. 6). It developed in the area of a tectonic-erosive depression, located between the Soimului Coast to the west and north, the Coast of Rătești, to the east and the Buzău Valley, to the south. The depression developed on an inverted fault system, to the north-south and the fall to the west; later, to the south, a series of normal secondary faults appeared, perpendicular to the main fault system, which are set up in steps towards the Buzău Valley. Anyway, the Buzău Valley, especially on the left side, is affected by sliding systems developed on the background of particularly active tectonic activities (Fig. 7).



**Fig. 6.** Landslide in Rătești – October 2014.



**Fig. 7.** Active landslide map of the study – Subcarpathian area between the Buzău and Călnău Rivers (data processing between 2014-2016).

**5. Conclusions:** The study of the dynamics of land movements is of great importance because these processes and forms of relief affect both human habitats and agricultural land, often having an irreversible character. At present, the lithological factor plays an important role in differentiating the land movements and slope withdrawal mechanisms, but the regionalization of these phenomena is a complex process conditioned by a series of physical and climatic factors. Their monitoring is therefore seasonal in nature, with the aim of monitoring the reactivating movements, especially if they affect the human habitat, including its support (infrastructure and agricultural land).

From a geomorphological point of view, the general evolution of the slopes shows their parallel withdrawal, together with the gradual decrease of the slope. The slopes affected by mud, ravenous and torrential floods are classified as severely degraded and therefore require afforestation and other measures to prevent materials from moving on the slopes.

**6. Acknowledgements:** This work was partially supported both project, by EEA Financial Mecanism 2009-2014, project number 22 SEE/2014 and the 29 PCCDI/2018 “GEORES” project financed by UEFISCDI, ROMANIA.

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