Landslides in Olpret Valley Basin

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Abstract. Olpret Valley basin is an integral part of higher order relief unit of Cluj and Dej Hills, located in their north-east. Lithological substrate composed of friable deposits, belonging to the Low Miocene (clay, marl, sandstone, poorly cemented conglomerate). The presence in this region of Bobâlna Hill, 693 m high, which is a part of the old structural Badenian surfaces, made of riodacitice tuffs (Dej tuff) induces a relatively high relief energy, due to the torrential rainfall character in summer and the relatively high slopes, and explains the frequency of modeling processes of relief through landslides. 10 delapsive landslides were discovered. Most of them are old slides, glimee type. To these there are added some other slides, which appeared due to other reasons than the periglacial modeling from the late Pleistocene and early Holocene. The formation of these landslides are due to exceptional amounts of rainfall from 1942, 1970, 1975, 1985.

Keywords: landslides, glimee, mounds, holoambe, acăstăi, Băbdiu stone

1. Introduction

Olpret Valley basin is an integral part of higher order relief unit Cluj and Dej Hills, located in the north-east of these hills. The limit of the basin is creeping on the turn and river system of Olpret Vad valley towards northwest, Şimişna valley on the west Codor valley on the southeast (Pop, 1967) and Luna, Lujerdului and Mărului valleys on the south (Fig. 1). Although the pool area is small, (138 square kilometers), the current and contemporary geomorphological processes are highlighted. By means of nowadays processes regarding the evolution of the system development, the reference is made on the late glacier period, the end of Pleistocene and early Holocen, while contemporary processes shaping the landscape scale are analyzed on human life scale.

Olpret Valley is one of the tributaries on the left of the Somes River, the confluence with the collector river being Dej town. It is a consistent valley type, its tributaries being subsequent valleys. The studied perimeter is characterized by the existence of a relief which is consistent to the monoclinal and tabulated structure (Pop, 2012).

2. Research methodology

The following steps have been taken:

a. Choosing the research theme.

b. Documentation Stage – this stage has been held in the library and consisted in reading the bibliography, and the necessary information from the Internet.

c. Field Research Stage – it consisted in supplementing information related to the landslides through direct observations, measurements and pictures landslides. A questionnaire was applied to a sample of people to assess their perception of the hazard they are exposed (based on the model provided by Surdeanu and Gotiu (2007).

d. Information Processing Stage – the legitimate manifestation of landslides has been analysed and interpreted by means of the data obtained from bibliographic sources, observations and measurements. Cartographic materials of Olpret Valley area have been elaborated.

Lithological substrate consists of loose deposits belonging to the Lower Miocene (clay, marl, sandstone, poorly cemented conglomerate). The presence in this area of a segment of the old structural Badenian surfaces (Bobâlna Hill, 693 m), consisting of riodacitice tuffs (Dej tuff, Ciupagea *et al.*, 1970) induces a relatively high relief energy (Fig. 2), taking into consideration the 240 m altitude at the confluence of Olpret Valley with Somes river, downstream of Dej. Gârbacea (1997) believes that the existence of volcanic tuff in western Transylvania Depression plays an important role in shaping of glimee slides, because "causes lasting stability of the slopes, before the trial slip, causing in this way an accumulation of tension in mass slope". The torrential rainfall in summer, the slopes of 10-15° which occupy about half of the studied area explain the frequency of slope modeling processes through landslides (Pop, 2007).

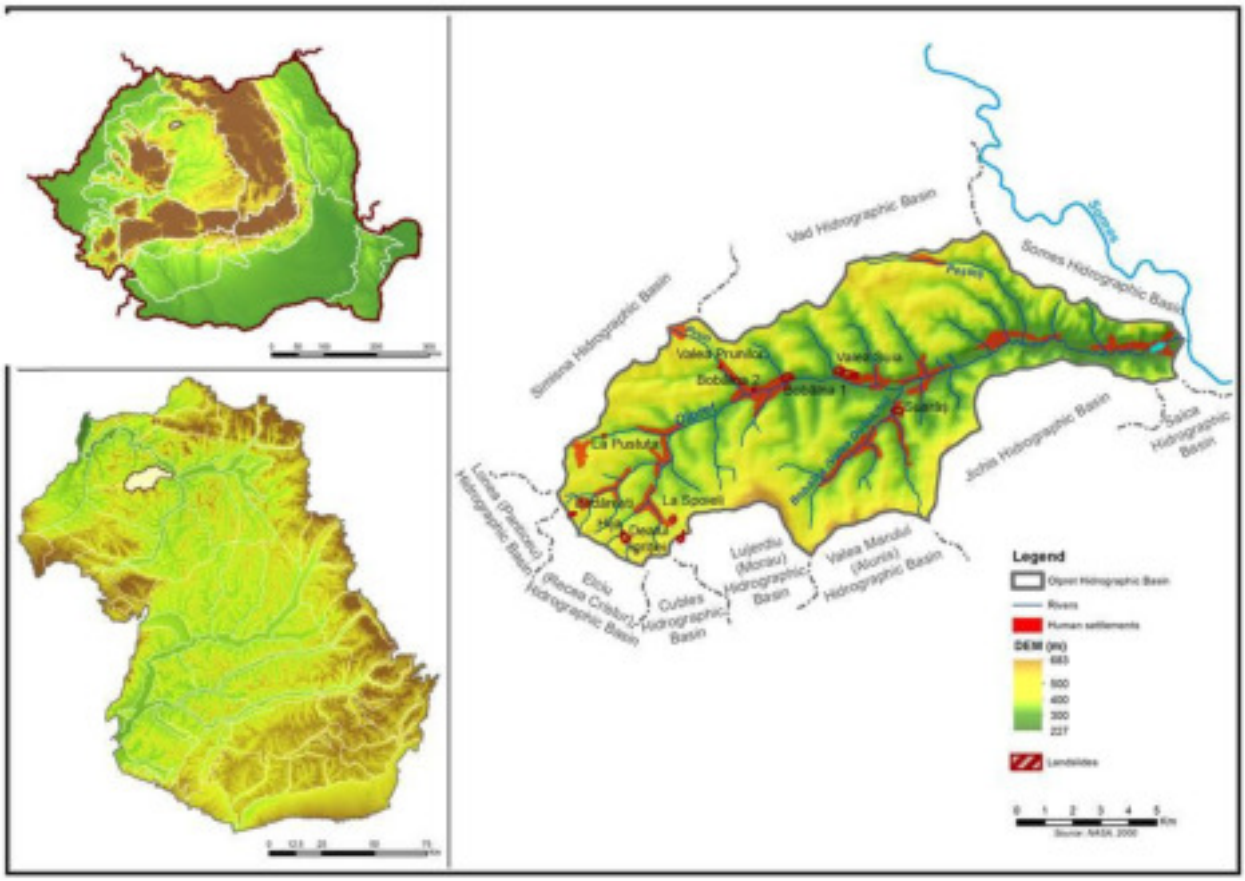

Fig.1. **Framing of the territorial Olpret morphohydrographic basin**

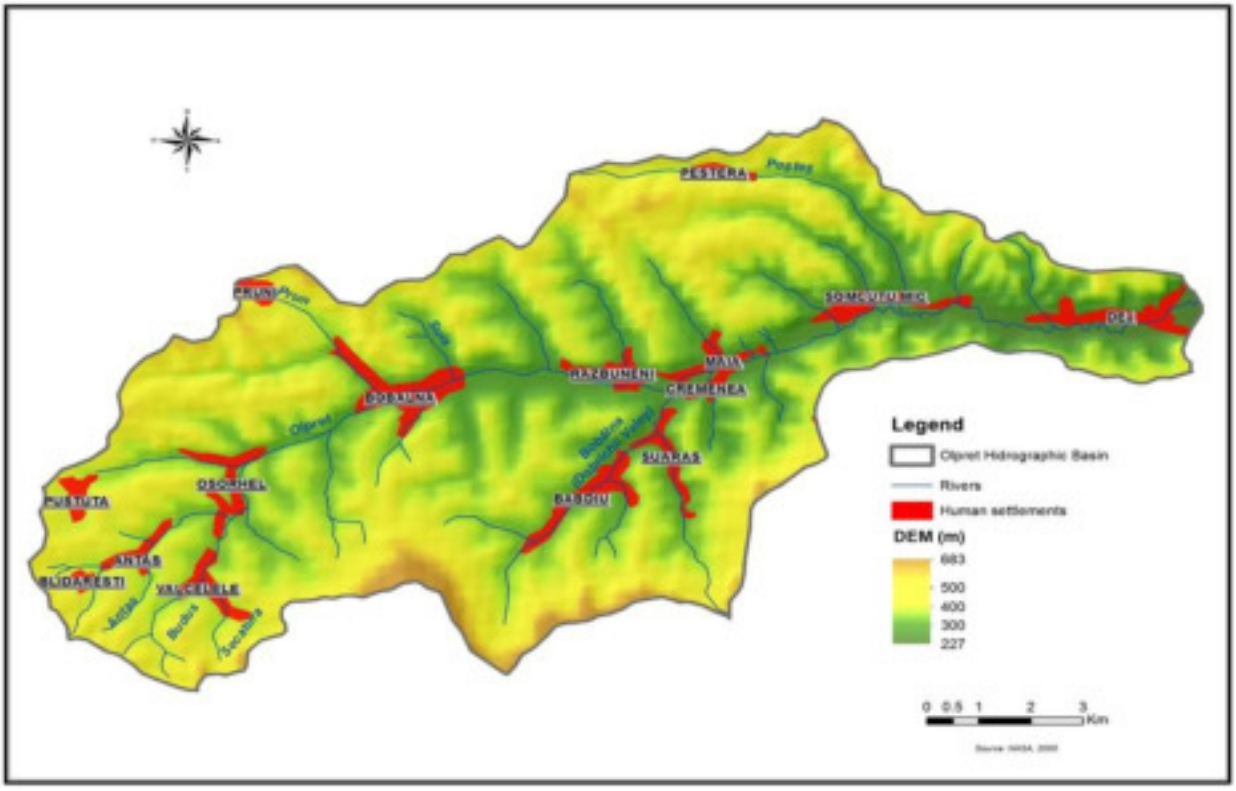

Fig.2. **Hypsometric map of the Olpret morphohydrographic basin**

Mac (1976-1980) classified the landslides into three categories, meaning slipped mass movement: the detrusor, delapsive and mixed. Of these types, the Olpret Valley meets delapsive and mixed slides. Gârbacea (2013), quoting Tufescu classifies landslides into four categories: 1. shallow landslides ; 2. lenticular slides ; 3. slides in mounds; 4. slides in pseudoterrace. Olpret basin`s most common are the old glimee type, locally known under the names of "holoambe" or "acăstăi". Some contemporary landslides are added to the above mentioned ones, which came into being due to other reasons different from the ones characteristic to late Pleistocene Slides and early Holocene. The initiation or reactivation of these landslides are due to large amounts of rainfall, the ones in 1942, 1970, 1975, 1985, similar to lenticular slips from Suarăş, on the right side of Băbdiului valley, the valley that is at the source of Antăş, as well as Pustuta landslide or the sliding slope from the source of Buduş valley (Fig. 3).

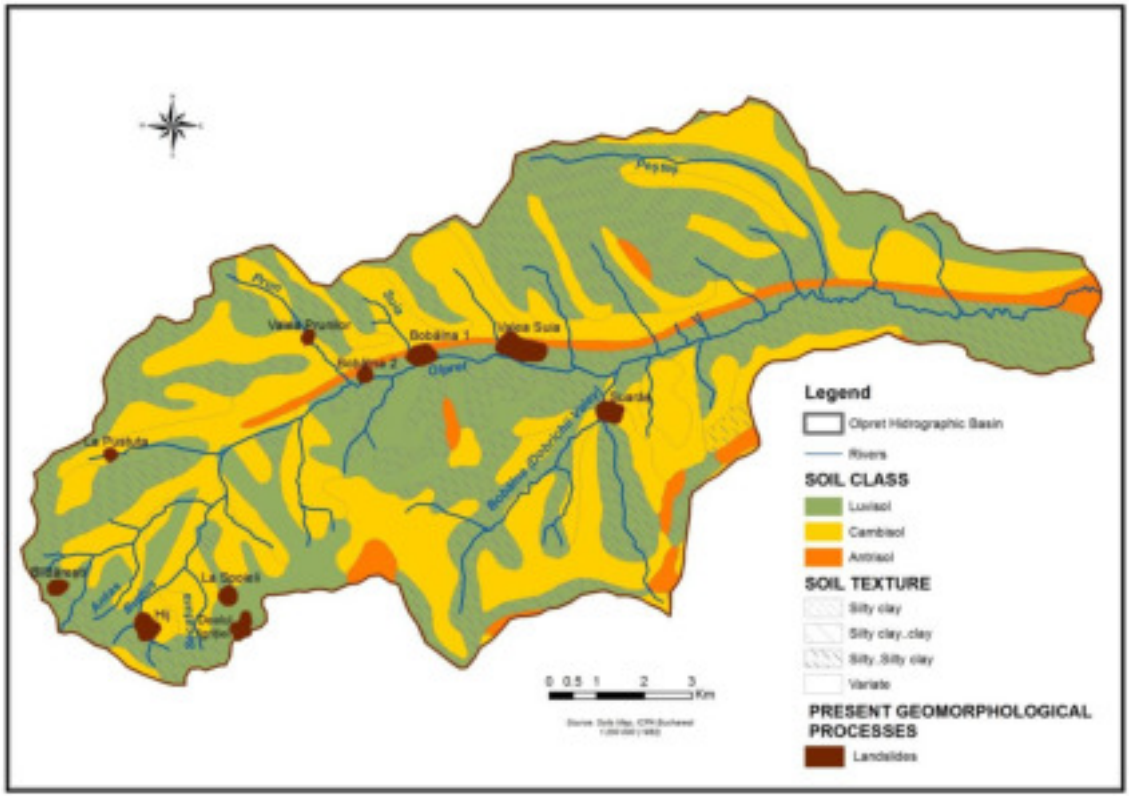

Fig. 3. **The map of active landslides in the Olpret morphohydrographic basin**

3. Results

3.1. Old landslides of glimee type

● Such a slip is the one on the left slope of the Suia valley, stabilized at the moment, due to the settling of a perimeter of pine, locust and buckthorn plantations in the period before 1989. This slide isthe largest in size, with a detachment front of about 1.500 meters.

● On the left of Olpret valley, in Bobâlna village there are three landslides, which are part of the old category of landslides. The first one is at the confluence of the Olpret valley with Prunilor valley (Photo 1). The ditch detachment has a front of 60 meters, where the presence of conglomerates with mollusc shells insertions and rough sandstone horizon could be observed. The length of the slip has a size of 170 meters and the difference in level between the ditch detachment and the sliding head is of 41 meters. The body of the slip is made of sandstone, sand and soil, and underbrush is planted in order to stabilize the slope.

● The second landslide in Bobâlna village is the one that affects the daily activity of most residents. The ditch detachment starts in the upper third part of the slope, as well as the slides mentioned above, and the body of the slip moved until the road embankment (Photo 2). Thus, the stability of 108 B county road is undermined. During the last 30 years and so, the road has deteriorated due to continuous sliding. A 230 m sector of the road has been affected by the slip and became bumpy compared to the rest and arched towards the stream. At the momen, works for drainage of excessive moisture from the sliding mass, as well as the reconstruction of the road embankment are executed. The sliding

body has a length of 164 meters, and the difference in level between the ditch detachment and the sliding head is of 27 m. It is a sliding made of several waves, which are with grass. The ditch detachment is hardly noticeable, being covered by vegetation. The first work to stop slipping development occurred between 1953-1954 and consisted in constructing a retaining wall at the contact between the floodplain and terraces of the first head of "Băbdiu stone" the Tuff toponym of Dej. This action proved to be ineffective as the slope affected by this slip is northeast oriented.

Photo.1. **Landslide on Prunilor street, Bobâlna**

Photo.2. **DJ 108 B, the section affected by slip**

● The third landslide is located at the end of Bobâlna village on the left side of the Olpret valley (Photo 3). It is very similar to the one within the village under the following aspects. The ditch detachment is in the upper third of the slope, not interfluve. It is a glimee type sliding. The sliding body consists of superficial deposits on the slope. The difference in level between the ditch detachment and the sliding head is of 26 m. With a length of 165 m and a width of 180 m it does not occupy a large area, but the damage they cause are major because it is located within the village, as the last two landslides mentioned in heavily populated areas. Waves slip are covered by vegetation, especially wild plum, pine groves and underbrush. It undermines the stability of the road, the asphalt and embankment are pushed and broken, indicating the direction of travel of the sliding body. The versant affected by the sliding faces south-east.

Photo. 3. **Lansliding at the end of Bobâlna**

Photo. 4. **Slipping from Spoieli, Vâlcele village**

● One of the most developed is the landslide at the source of Buduș valley, on the right side, entering Vâlcele village (Photo 4). The ditch detachment is insinuated at the top of the slope, on interfluve, which indicates the direction of the landslide development towards slope withdrawal. The toponym of this slide is "vătaştină" or "at spoieli", a name which came from the geological embodiment of the slip body, whose surface is made of clays and the base is made of marls. The name derives from the rocks that were used locally in the early twentieth century, to paint houses. It is a deep slip developed in the rock of the place, of glimee type. The body of the slip is very explicit in the landscape. The difference in altitude between the slipping foot and its crest is of 65 m, with a length of 185 m and a width of 105 m, obviously occupying a larger area compared to the slides described above. The area where the slip lies, is bounded by wire fences. Pine trees were planted at the top of the ravine detachment and the sliding body. In addition to these, spontaneous vegetation consisting of hair and wild apple, wild rose and blackthorn also grew. Between the ditch detachment

and slipping body, as well as the front part of the sliding body rush and reed grow, indicating the presence of water in the substrate. This slide does not affect the local community too much, being outside the precincts of the village, in an area used as pasture. On the left side of the slope the retreating slip is obvious by the appearance of saddles, used practically as a cattle trail. The versant affected by the sliding- faces southwest.

● The landslide that occupies the largest area in the Basin of Olpret Valley is located on the right valley Secătura, a left tributary of Buduș valley. It is a glimee type sliding developed under the edge of a hill called Hij (Photo 5). It is a reactivated slip, highlighting more multi-stage sliding, shaped by tougher horizons of sandstone. These steps are grassed and with bushes of wild rose, blackthorn and wild hair. The versant affected by the sliding faces southwest.

By taking these steps, we can talk about the emergence of a sliding slope. It covers a length of 306 m and a width of 154 m. The lake between the ditch detachment and the sliding body is clogged. In the southwestern end of the detachment ravine, the sliding is enabled. The detachment ditch in this sector is well illustrated, having layers of clay arranged homoclinely, with delluvials at its base. Only one landslide, a mound consisting of rock is present. The difference in level between the upper and lower parts of the slipped body is of 27 m. The lake behind the slipping wave is clogged. The composition of delluvials is dominated by the presence of sandstone, sand as well as Sarmatian sarsen stones. To stop the development of the slip, the base part was planted with underbrush. Although it occupies a noticeable area, the impact of this slide is minor, being outside the village precincts.

Photo.5. **Landslide from Hij, Vâlcele village**

Photo.6. **Ditch detachment of the landslide detachment from Suarăș.**

3.2. Recent Landslides

Shallow landslides were called those having a thickness of less than 2 m deposits affected (Surdeanu, 1998). The left side of the Olpret valley has frequent slope ruptures, early- shallow slope landslides derived from the cornice. Landslides affect mainly head cuestas tributary valleys of the Olpret oriented west-southwest. These valleys have subsequent character because of the general direction tilting strata, east-northeast. The left side slope of Olpret valley shows frequent breaks, early and shallow slips derived from the cornice of the slope. Because of the position, mainly southern, the insolation is stronger. The tilting of this slope, which is large enough, determined its terracing on numerous parts for planting fruit trees. The upper part of the terraces is affected by raindrop impact and deep erosion (gullies). The upper third of both slopes of the Olpret valley is generally wooded. Therefore, mass movements start on this part and they creep towards the base of the slopes.

Early shallow slips are ubiquitous on the left side of the valley. In order to stop the development of these processes, in the period before 1989, the affected areas were planted with pine, spruce, locust and buckthorn. This aspect is obvious across the following villages: Maia, Răzbuneni, Bobâlna, Oşorhel, Vâlcele, Antăs or Pustuta.

● On the right side Suarăşului Valley, a tributary valley subsequent to Olpret valley, there is a lenticular, recent slip (Photo 6). The residents date the starting time of the slipping in the 1987-1988, after long rains in large quantities. The slipping started at the edge of the cuesta. The sizes of the slipping are smaller, measuring 72 m in length and 85 m width. Behind the sliding lens there is a small pond, partially covered by hydrophilic vegetation (coltsfoot, horsetail). The detachment ditch is developing, being heavily fragmented by processes of runoff and starting gullying. The rocks on which the lansliding developed are clays at the base and marls at the surface.

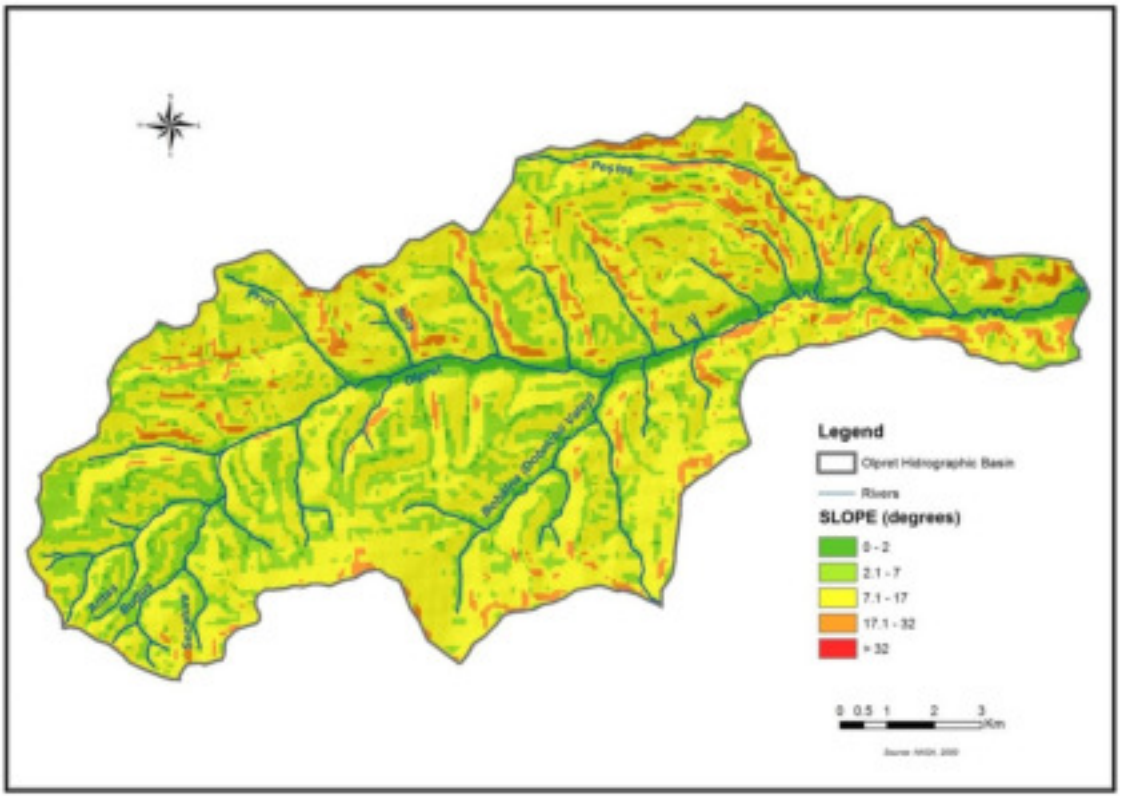

Fig. 4. **The map of gradient Olpret morphohydrographic basin**

● Another early slip is present at the head of the Antăş valley, a left tributary of Buduş valley, in the perimeter of the Blidăreşti village. The affected slope faces south-east. The difference in altitude between the top and the ditch detachment is of 35 m, its length of 179 m and its width of 52 m. It does not affect human activities, greatly being located outside the village, on land used for pasture. The territorial impact of these processes is very low because Blidăreşti village is one of the localities under stamping. Rural exodus in the years 1970-1980 was massive and it was not followed by return migration. Since the old agricultural economic structure fell apart, this territory became unattractive. Development opportunities are limited, so Blidăreşti village now has only six permanent residents.

● On the left side of Olpret valley, at the end of Pustuta village, there is a reactivated landslide. This sliding slope faces south-east. The length of the slip is of 210 m, the width of 200 m and the differences in level between the top slip and ditch detachment is of 34 m. The ditch detachment was formed in the lower half of the slope due to the higher slope and due to lithology. At the base the sliding body appears as a thin sandstone horizon over which thicker layers of clay, sand and sandstone overlapped. Although we tried to stabilize the sliding mass movement by planting acacia trees and underbrush, the slipping reactivated itself. The fact is demonstrated by the network of basins insinuated upstream of the ditch detachment.

On the steeply inclined slopes, used as pasture, furrows forming landslides are found, which affects only the grassy soil horizon, as it is the case of the left slope of Antăs valley.

● The base of Buduş valley is most likely to trigger new landslides, starting in the watershed of the Buduş valley and the Lujerdiului valley. The front detachment measures 400 m. The slope, facing north, favours the constant moisture maintainance in the substrate consisting of loose rocks. The slope is more than 15 degrees steeper (Fig. 4), and the use of land is low, being only used as pasture. Imminent formation of a landslide is given by the road layout. In some areas, at the top of the slope, the road enbankment is already uneven with approximately 10 cm. These ruptures are accompanied by downward movements of the terrain, on the low part of the fracture. Clearly, under conditions of high intensity rainfall on land soaked to saturation with water it is possible that a new landslide in this place to be triggered. Given the size of the ravine of detachment, we can say that this version will evolve as a sliding slope analogy Florina Grecu made in (2008) to describe this type of slopes.

4. Conclusions

There are two morphogenetic systems noticeable in Olpret Valley basin. The periglacial specific to Pleistocene, where the slopes were mostly shaped by processes of soil running (Ichim, *Geography of Romania, Physical Geography*, 1983). Frost and thaw alternation have favoured quasi-horizontal surfaces on structural surfaces on interfluvials or on higher structural surfaces, such as Bobâlna Hill. Its traces are present as eluvial deposits. The moving of mollisoll on the frozen substrate (permafrost) gave rise to a wavy or terraced relief, even on the slopes with low inclination. On slopes with higher inclinations, massive landslides were triggered.

With the warming of the early Holocene, the relief modeling system is temperate. On the surfaces which are slightly inclined by gelifluction processes, the later are replaced by those of wet-dry mechanical weathering (terms introduced by Mac, 1986). Weathering is no longer dominated by the disintegration, but chemical alteration represents a major part in the the creation of the alteration of the crust. Therefore, the Holocene eluvial deposits have a finer grain size. The transit of these materials in the production area (units 1, 2 the model of Dalrymple, Blong and Conacher, 1968, quoted by Grecu (2008) to the sedimentation (units 6, 7, 8, 9, the same authors) is no longer the preserve of gravitational processes mostly, but the river modeling. Old landslides develope, the trigger factor this time being dry periods alternating with extremely wet ones. Creeps of smaller dimensions than the periglacial ones are produced, but they show the same way of relief development. The overlap of the two morphogenetic and morphoclimatic systems are to be observed, offering this place a palimpsest character.

In conclusion, the processes of slopes development by mass movement of landslide type are significant in share in Olpret Valley basin. The lands used for agriculture occupy a much smaller area since 1990, so anthropogenic causes of slope development through slopes run-off, gullies, ravines, streams, are proportionaly diminished. However, detailed study of these processes, directly or indirectly linked to landslides, requires the use of the information gathered in the preparation of sustainable development projects.

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