LANDSLIDES AS MORPHODYNAMIC FACTORS OF HILLSLOPES EVOLUTION – CASE STUDY, LANDSLIDE SYSTEM FROM BALAIA (ROMANIA, BIHOR COUNTY)

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Abstract

The landslides represents one of the main dynamic factors which directly influence the evolution of the slopes. The conditioning factors are responsible for creating the conditions for the appearance of the landslides but sometimes, the human factor are directly responsible for these processes. Although the landslides from the Western Hills are not as big as the landslides from Transsylvanian depression, the effect upon the slope evolution and dynamic are quite significant. The morphodynamic landslide system from Balaia represents an atypical example of landslide system both in terms of dimensions and in terms of dynamic. The aim of this study is to reveal some of the conditioning factors which cause the active state of this landslide. The depth of the sliding surface and subsequently the weight of the materials above are triggering factors. Tthe use of penetrometer try to determine the depth of sliding surface.

Key words: landslides, hillslopes, penetrometer, sliding surface.

INTRODUCTION

The genesis, dynamic and the type of landslides are the result of the interference and conditions among structural, geological and morphological formations and deposits (I. Mac, I.A. Irimuş, Mihaela Rapeanu, 1996). The main factors which constitute the causing factors for the landslides could be divided in two main cathegories: preparatory factors and triggering factors Iuliana Armas, 1999, with modifications.

Table 1

Contributing factors of landslides

Preparatory factors	**Triggering factors**
Factors involved in increasing of shear force	
Undermining of the lateral support through erosion or increasing the value of slope	Fluvial erosio, previous landslides, faults
Factors which remove the substrate	The loss of share through sediment exploitation
The overloadf of the slope	The weight of vegetation, constructions
Laterral pressure	Water from cracks, the freeze of water in cracks, the inflation of water in clays
Factors involved in reducing shear force	
Efects of erosion	Desintegration of rocks, infaltion of clay materials
Change of water pressure in soil pore	Saturation
Structural changes	Cracks in clays
Effects of organic nature	Roots decomposition, animal paths

The landslides represents a constant of present-day morphodynamic, with a high frequence, in various conditions, certifies the conclusion the they are a normal process of rhytmic evacuation of material from slopes.

MORPHOLOGICAL AND GEOLOGICAL CONDITIONS. TYPES OF SUBSYSTEMS

The morphodynamic landslide system from Balaia represents a atypical, unique case from the landslide types among the landslides from the hills in Bihor county. The upper part of Almas valley is an amphitheater likearea affected by mudflows and areal landslides. If the general pattern of the landslides in the hilly area are reduced as size, this complex is characterised by large size, morphology and dynamic.

The landslide system is consisted of three different subsystems:

a) the subsystem of mudflows
b) the subsystem of landslides
c) the subsystem of scarps

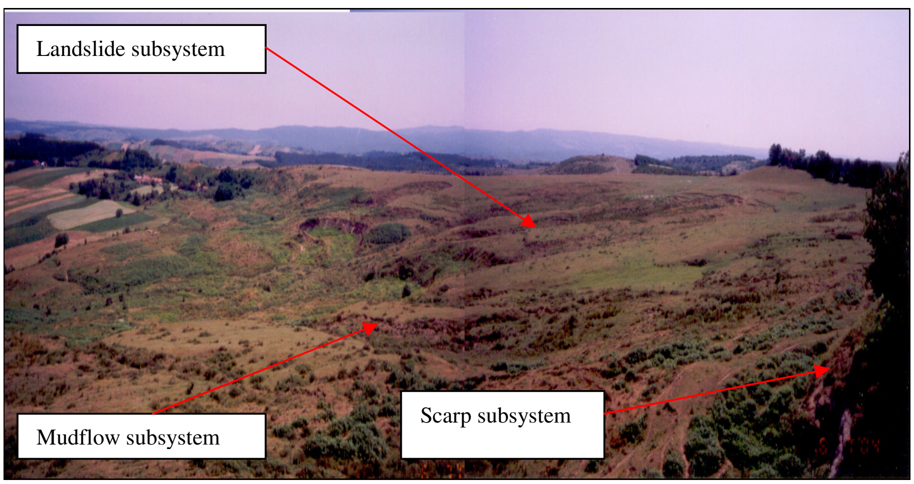

Photo 1. Morphodynamic landslide system from Balaia (source, Stelian Nistor)

a) *The mudflow subsystem* is the most active subsystem. The genesis, the evolution and the dynamic could be linked by the presence, at relatively low depth, of the groundwater. The morphological and geological particularities of the upper part of Armas valley causes a high hydrostatic level, at about 0.50-0.80 cm from the surface

The high hydrostatic level is completed with a row of springs situated at the contact between the scarp subsystem and the landslide subsystem. The observations made during a two years period and the data collected from the peasants revealed that these springs are constantly supplied with water even in dry years.

Photo no.2 Spring which supply with suplimentary mass the mudflow subsystem (source Nistor Stelian)

The existence of this subsystem is directly linkek by the slope value (2^o-5^o) and the geological conditions (sands, sandy clays, sandy marls) which supports the presence of water within these deposits for a long period of time thus causing the appearance of mudflows.

b) *the subsystem of landslides* is situated the eastern part of the area and it is indirectly conditioned by the groundwater.The evolution of this subsystem is directly conditioned by the presence of a impermeable clay horisont which consist the sliding bed for the landslides. The other favorable condition is given by the presence of the permeable materials, situated above, which allows the rapid vertical movement of the rainfall waters. The permeability of the deposits is increasesd by the presence of a coal layer (at 3-3.5 m depht) which allows a more rapid vertical movement of the waters.

From typological point of veiw one could notice several types of landslides. The regresive ones characterises the upper part of the sliding system, the rotational ones the bases of the sliding system. From morphometric point of view both scarps and the slided mases are relatively small in terms of dimension (2-3.20 m) and the distance between the slided masses is 0.7-1.7 m. The scarp of the slides are different in terms of age and morphometry. The lower scarps are old, 1-3 m in height and the front of the scarps are affected by small scale falls and surface erosion.

The upper scarps are disposed in fan-like shape and constitutes the most active part of the subsystem. The regressive direction of movement causes the very rapid advance towards the interfluve and, if the present-day rate of withdrawal will continue, the opposite slopes of the interfluve between Crisul Repede river and Barcau river will intersect.

c) *the scarp subsystem* overlaps from geological point of view a cimented sandstone layer which consist the intervluve between Crisul Repede and Barcau river. This subsystem interpose the mudflow subsystem and tle landslide subsystem. This conditioning state is hydrological, at the base of this subsystem appears a line of springs which supplies and turn into unstable the other two subsystems. There is also a morphological conditioning, this subsystem "split" the sliding process and causes the appearance of delapsive slides in the upper part, from dynamic point of view energetically conditioned by the 8 m scarp.

MATERIAL AND METHODS

The samplings were made from two different locations in order to observe the differences which constitutes the base of the present-day dynamic of the sliding process. A first set of samplings were made outside the sliding system (drill 1) in order to observe the undisturbed strata and the second set of samplings were made within the sliding mass (drill 2) in order to observe the disturbed strata as a result of the sliding process.

The suplimentary check of the geological strata was made by using the penetrometer, thus confirming the number and the thickness of them.

Samples were made whenever physical conditions changed trying to identify each horisont from physical point of view. Samples were taken from different depths (see tab. 2)

Table 2

Sampling depths

	Depht of sampling		Depht of sampling
Drill no. 1	1,0 m	**Drill no. 2**	1,0 m
	2,0 m		3,0 m
	3,40 m		4,0 m
	4,80 m		5,0 m
	6,0 m		6,2 m

An interesting aspect is given by the fact that the drill no. 2 intercepted between 3.0-3.4 m depth a coal strata with a thickness between 10-15 cm at different evolutive stages. The existence of this coal strata at the baze of a sandy clay strata causes suplimentary infiltration conditions, on the one hand, and creates more facile conditions for the dynamic of the slope, on the other hand.

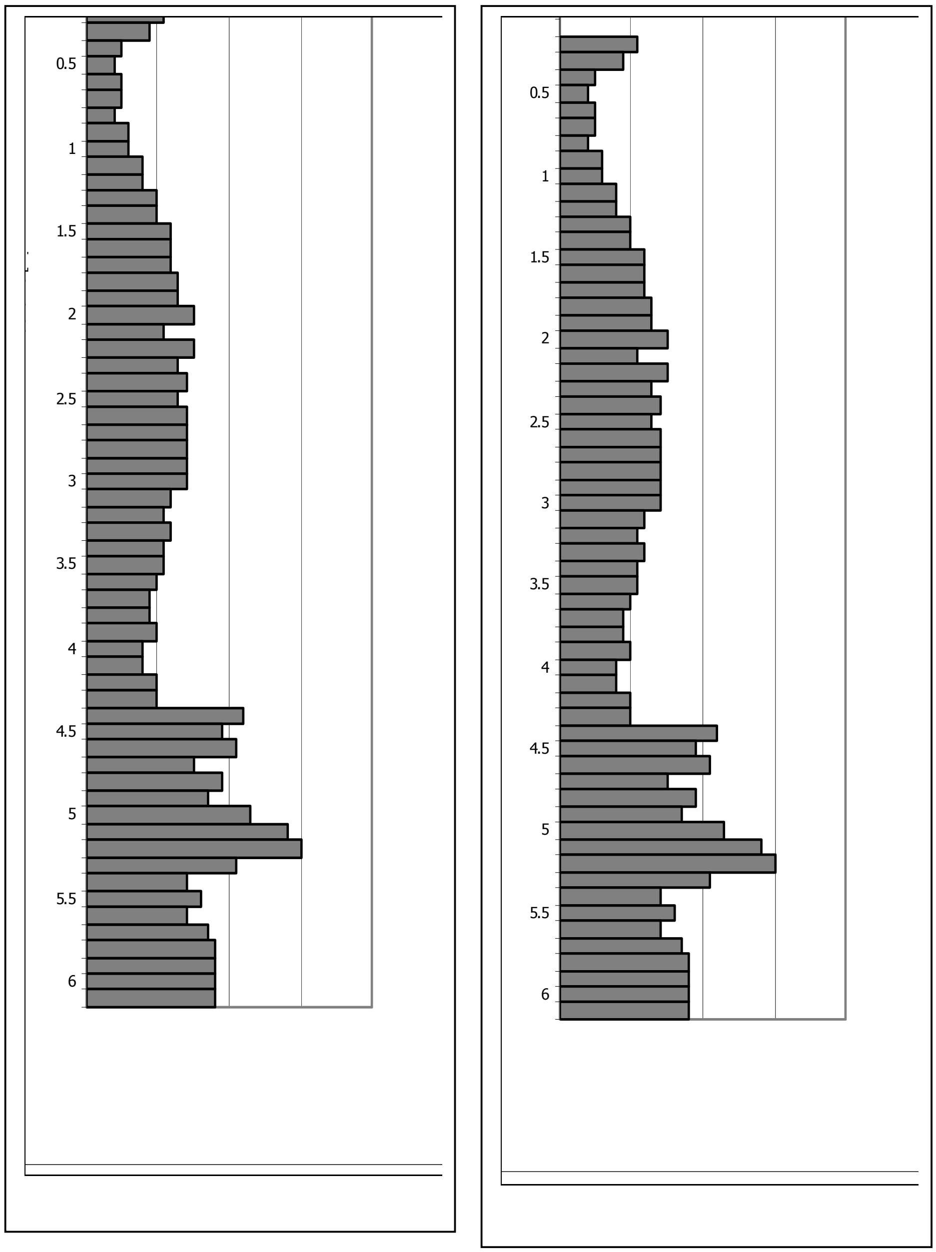

Fig. 1. Penetration diagrams for the drill no. 1 (left) and the drill no. 2 (right)

CONCLUSIONS

The results clearly shows that the stata undisturbed by any kind of sliding movement is stable and the stability remains as long as the steady state is characteristic for the slope. As soon as the stata are disturbed, the steady state is quickly replaced by a dynamic state.

At this temporal moment the human factor could be involved in the preservation of slope s steady state with specific measures (reforestation, drainage of the excess waters, a.s.o) finally giving the slope a steady state for the longest period of time. This is an importanta factor taking into account that the sustainable use of the slopes are possible just in a steady state of them.

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