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Articole/Papers

Landslides in the Plain Sector of the Jiu Valley

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Abstract. This sector of the Jiu valley lays downstream of Craiova, where the unit evolved asymmetrically on a width over 10 kilometres and to a depth of maximum 120 meters at Craiova. The right slope is steep and has a very active dynamic, while the left one has a step-up section and the alluvial plain has an average width of 4-5 kilometres. These general features of the section challenged a lot of researchers and in the literature there are given dispersed and succinct explanations in works that study the neighbouring regions.

The development of a piedmont plain in the north of the Oltenian Plain and of a terrace plain in the south, the erosion of the piedmont structures and the formation of a terrace plain occurred on the background of Pleistocene climatic changes, neotectonic movements and due to the deviation of the Danube to the right and the lowering of the base level.

Therefore, there are five terraces, the upper ones are covered by loess and yellow-reddish loessial deposits, while the bottom terraces and the alluvial plain have a complex morphology and which is covered by sand dunes.

All the events and the changes studied lead to a reconstruction of the formation stages and allow a synchronization of the morpho-hydro-climatic events as a premise for the present geomorphological processes.

Key words: landslides, slope, vulnerability, the Jiu valley

Rezumat. Acest sector al văii Jiului se desfăşoară aval de Craiova, unde valea s-a dezvoltat asimetric pe o lăţime de peste 10 km şi adâncime de maxim 120 m la Craiova. Versantul drept este abrupt şi are o dinamică foarte activă, versantul stâng are un profil în trepte, iar lunca are lăţime de 4-5 km în medie. Aceste trăsături generale ale profilului văii au trezit curiozitatea a numeroşi cercetători, iar în literatura de specialitate sunt explicate disparat şi succint în lucrări ce vizează regiuni vecine.

Dezvoltarea unei câmpii piemontane în nordul Câmpiei Olteniei şi a unei câmpii de terase în sud, erodarea structurilor piemontane şi formarea unei câmpii de terase s-a produs pe fondul oscilaţiilor climatice pleistocene, mişcărilor neotectonice, abaterii Dunării spre dreapta şi coborârii nivelului de bază.

Astfel există cinci terase, cele superioare sunt acoperite cu o cuvertură de loess şi depozite loessoide de culoare gălbuie-roşcată, iar terasele inferioare şi lunca au o morfologie complicată şi camuflată de nisipuri şi dune.
Toate evenimentele şi transformările studiate conduc la o reconstituire a etapelor de formare şi permit o sincronizare a evenimentelor morfohidroclimatice, ca premisă a proceselor geomorfologice actuale.

Introduction

The plain sector of the Jiu valley lays downstream of Craiova, separating the Băileşti Plain and the Romanaţi Plain, here the valley evolved asymmetrically on a width of 5-8 kilometres and a depth of maximum 120 metres (at Craiova). Thus, the right slope stays steep and has a very active dynamic, the left side generally occupies half of the width of the valley – having a step-up section and the alluvial plain sometimes exceeds the sum of the length of the riversides.

In the Romanian special literature landslides were studied more in the mountain and hilly regions with a high risk to mass movements and less into the plain areas where they are not so frequent. The studies treated morphological and morphodynamic aspects, the distribution, classification and the dependency regarding the land use, earthquakes, quantity of precipitations (Surdeanu, 1975, 1990, 1994, 1998, Badea & Bălteanu, 1977, Bălteanu, 1983, 1999, Bălteanu et.al 2010, Ichim & Rădoane, 1986, Surdeanu & Zemianschi, 1990, Vespremeanu-Stroe et al., 2006, Cioacă, 1996, Grecu, F. 1996, Ielenicz et al. 1999, Armaş et al., 2003, Boengiu et al. 2009).

In this sector, the palogeographic evolution lead to the formation of a piedmont plain in the north of the Oltenia Plain and of a terrace plain in the south. The erosion of the piedmont structures and the formation of a terrace plain occurred on the background of the Pleistocene climatic changes, neotectonic movements, the deviation of the Danube to the right and the lowering of the base level. Therefore, there are five terraces with a continuous outlay, the upper ones being covered by a loess layer and yellow-reddish loess deposits,

while the bottom terraces and the alluvial plain are covered by sands and dunes.

In the plain sector, the Jiu valley has two equal sections in length: the northen one between the Sălcuța and Leu-Rotunda piedmont plains; the south sector developed within the terrace plain.

In the north sector, the terrace system of the Jiu developed on one side, and in the south sector it has a bilateral terrace system. This fact suggests the direction of the influence under which they evolved (Fig. 1).

On the left slope, in the north sector, there are 5 terraces located at the following relative altitudes: the Rojiștea terrace (T_1 5-12 metres), the Malu Mare terrace (T_2 15-22 metres), the Bârza terrace (T_3 30-40 metres), the Șimnic terrace (T_4 40-60 metres), the Cârcea terrace (T_5 70-90 metres). They generally have a continuous outlay and they lose in the Danube terraces downstream of Padea-Mârșani (Coteț P., 1957), where the south sector of the Jiu valley was carved in the detriment of the Danube terraces. In figure 1 the Jiu terraces are represented with the absolute altitude.

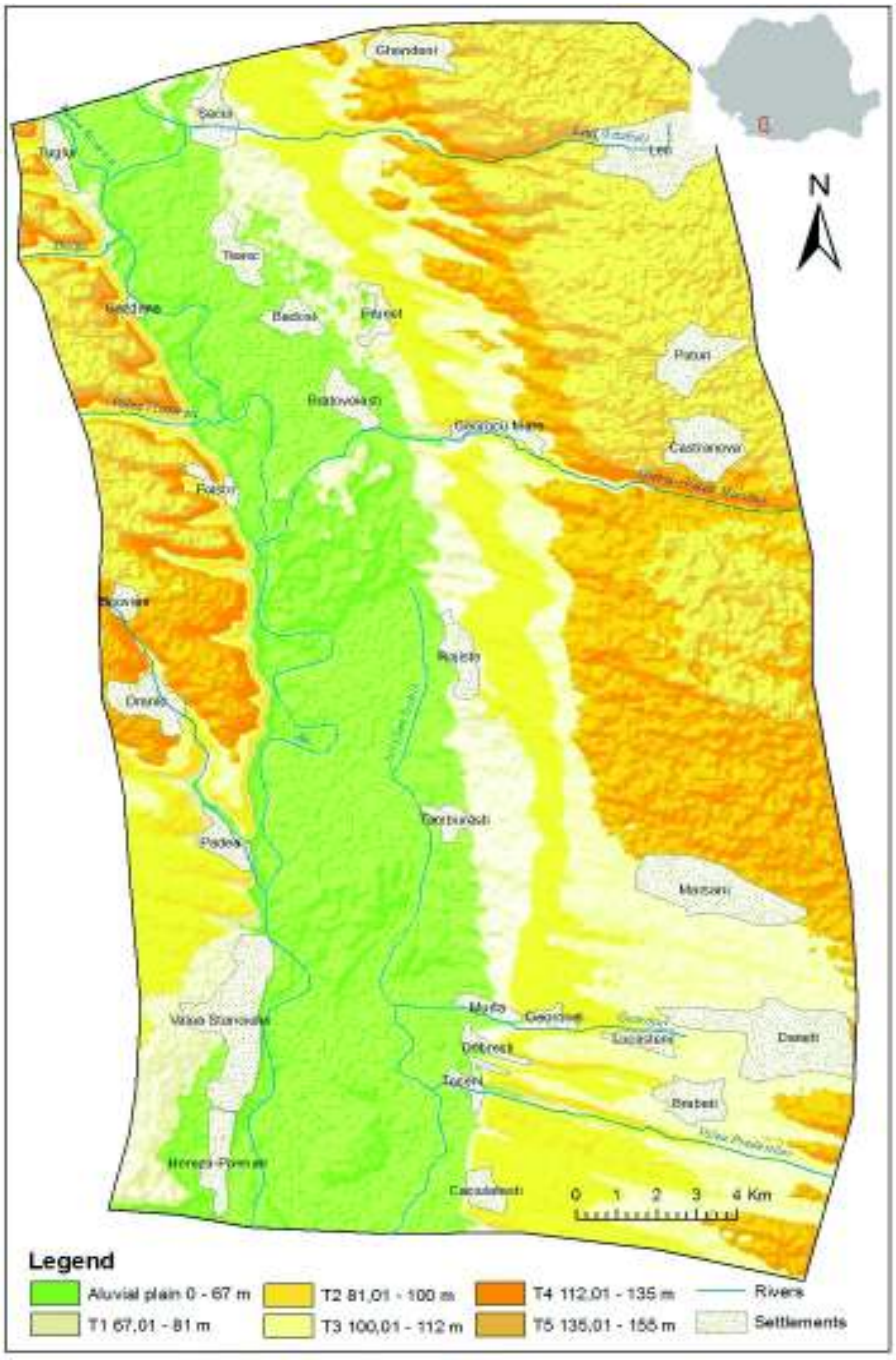

Fig. 1 **The morphological map of the Jiu valley in the plain sector**

The alluvial plain has an average width of 4-5 kilometres, is dominated by the terrace scarp of 5-12 metres on the left, and on the right side by steep slopes of 50-60 metres.

The general course of the Jiu is to build up the alluvial plain on the left side and to destroy the right side by lateral erosion. It has a monotone morphology, except for the sectors with old courses filled with alluvia or swampy areas and pluvial banks.

The altitude increases with 2-3 metres due to the presence of the alluvial cones and sand dunes. Downstream of Rojiștea, on the left side of the Jiu can be easily noticed an old course of the Jiu river – the Jieț stream.

Data and methods

The plain sector is 80 kilometres long, developing between the Podari – Cârcea line and the confluence with the Danube, having a share of 8% (800 km^2) from the surface of the basin and a slope of 0,3-1‰ (Savin C., 1990).

The neotectonic movements from the Pasadena phase (Middle Pleistocene) reactivated the Balş – Leu – Rotunda ascension, which interposed between the domain from the east and west of this ascension. This phenomenon forced the Jiu river to take its course to south and to slowly lower to south-west, leaving terraces only on the left side of the valley (Boengiu, 2009).

For the analysis of the present geomorphologic processes we evaluated the morphological, morphometrical and hydrographic features.

The relief was analyzed based on the topographic maps 1:25000, 1:50000, 1:100000 and SRTM DTM la 30 metres, the maps from the general studies of forestry management, the Corine Land Cover data and a series of Landsat 2000 satellite images in GIS, to which were added the ortophotoplans (1:5.000) for critical areas.

For the analysis of the climatic influence we used the values of the annual precipitations registered during the period 1961 – 2006 (Boengiu, 2009).

The observations made in the field tried to clarify and add new details that had not been surprised by the maps regarding the actual stage by mapping in the representative areas.

Results and discussions

The present geomorphologic processes within the studied sector can be grouped in processes that affect the slopes and processes that affect the alluvial plain. The slope processes are represented by landslides with areas only on the right side and aeolian processes manifested only on the left side. The bed and aeolian processes have a great occurrence in the alluvial plain.

During the entire stage of formation of the alluvial plain, up to its present stage, the Jiu river changed several times its flow direction, the present one being of a historic age. These discontinuities in the evolution of the Jiu course and alluvial plain have been, of course, the result of the climatic changes rebounded in the hydrological regime of the Jiu river, to which were associated the influence of the neotectonic movements (Curcan et al. 2009).

The Jiu river is now in a process of strong alluviation. In its minor course, the river bed is, on some sections, at higher levels compared to large surfaces from the alluvial plain.

The right side of the Jiu river, between Podari and up to south of Padea, is affected by landslides on several sections (Podari, Bâzdâna, Dâlga, Foișor, Drănic, Padea, Valea Stanciului, Horezu-Poenari), but the landslides from Bâzdâna and Drănic are among the most representative ones are (Photo 1).

Photo 1. **The upper part of the Bâzdâna landslide**

This slope has altitudes between 140-110 metres on its upper side (Bâzdâna Hill – 146,1 metres and La Izlaz Hill – 111,7 metres) and 60-40 metres at the bottom, resulting an altitudinal difference of 80 to 70 metres for the hill having the character of a cuesta. The permanent erosional action of the Jiu and the Romanian-Pleistocene deposits consisting of clays, marls and sands lead to the maintenance of a very steep slope with a slope over 65^0 that is very vulnerable to landslides.

The Bâzdâna landslide

The landslide is located on the area of the village with the same name and has two sections divided by the Bâzdâna stream (Fig. 2).

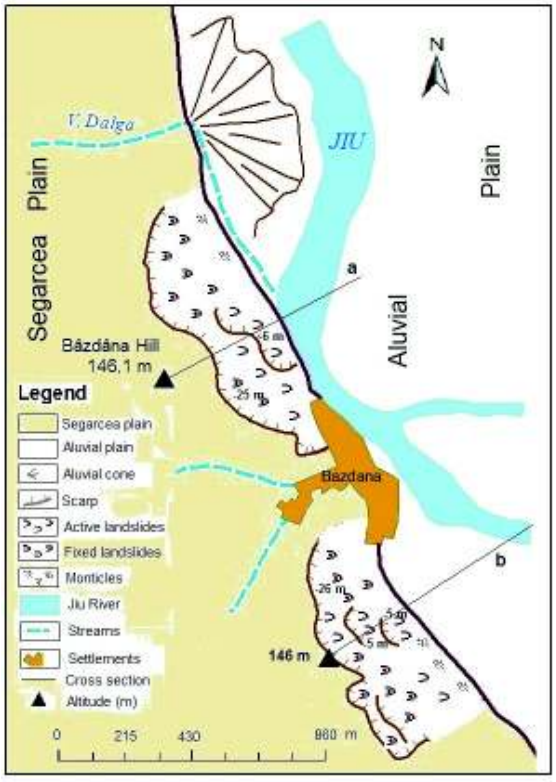

Fig. 2. **The sketch of the Bâzdâna landslide**

The landslide evolved on a general west-east movement direction, starting from 140 metres and reaching up to the minor river bed of the Jiu river at 60 metres, where it is perpendicular on the convexity of a meander of the Jiu. In the north part, the Jiu river was pushed toward east by the alluvial cone of the Dâlga stream, but the immediate return of the Jiu river under the slope determines the landslide to have a rhythmic evolution depending on the dynamic of the river bed. As the lateral erosion evacuates higher quantities of materials, the landslide is more active, these episodes being strongly correlated with the river flow synchronized with the excessive humectation of the deposits from the landslide steps.

The landslide is not unitary, in the north part having two steps outlined by the two scarps (Fig. 3, 4). The first scarp is 22-25 metres high, 940 metres long and 80-95 metres width (Photo 2), the movement of this step being performed almost without deranging the structure. The second scarp has 6-4,5 metres in height and is kept only on a length of 380 metres, because in the spring of 2006, the front part of the landslide was reactivated and important quantities of material were consumed by the Jiu river.

In the south part, the landslide has three steps very well evidenced by three scarps (Fig. 4), the first one being 26-22 metres, high and the second and the third one of 5 metres. The first scarp is 840 metres long and a width of maximum, the other two steps had been destroyed during the same spring in 2006 due to some complex reactivations.

Generally, the upper steps are structurally deranged only by inclination, while the bottom steps are strongly disordered and in the scarp of the landslide they have the aspect of a monticle.

Photo 2. **The scarp of the Bâzdâna landslide**

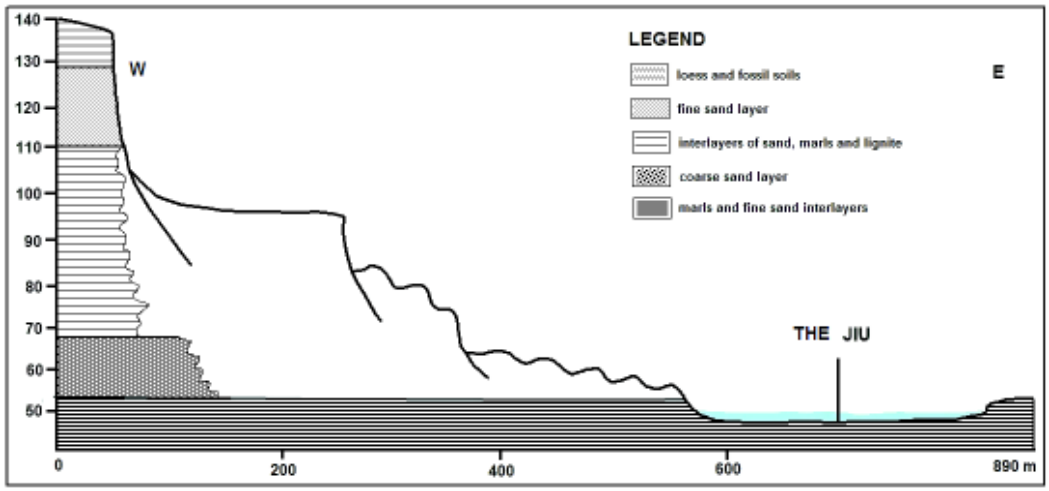

Fig. 3. **Cross section (a) in the north part of the Bîzdîna landslide**

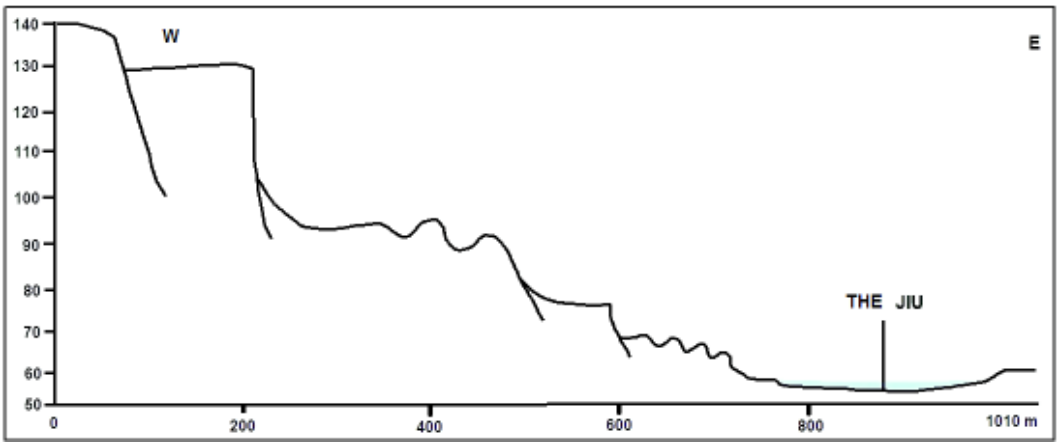

Fig. 4. **Cross section (b) in the south part of the Bâzdâna landslide**

The Drănic landslide

This landslide is located on the area of the Drănic commune in front of Padea village. The landslide evolved on a general west-east movement direction, starting from 111 metres and reaching the minor river bed of the Jiu at 40 metres (Fig. 5, 6). It has a single scarp in the shape of a semicircle, approximate 1,800 meters long and a width of 20-30 metres (Photo 3). The in the central part of the landslide the width reaches 210 metres and decreases constantly toward north and south. The mass of the landslide is entirely deranged structurally and moves rhythmically as small steps, furrows and monticles toward the Jiu riverbed where it is being consumed.

This landslide of great dimension is due to the intensification of the lateral erosion performed by the Jiu river upon the right slope because of the decrease of the flowing slope.

Upstream of this landslide, the Jiu has two ample meanders in the shape of the letter *m* which indicate a strong aggradation of the bed due to the river reduced power of transportation.

In front of this landslide of almost 2 kilometres, the minor river bed has the tendency to unplait, in the present having three branches with smaller and smaller flows to the face of the landslide.

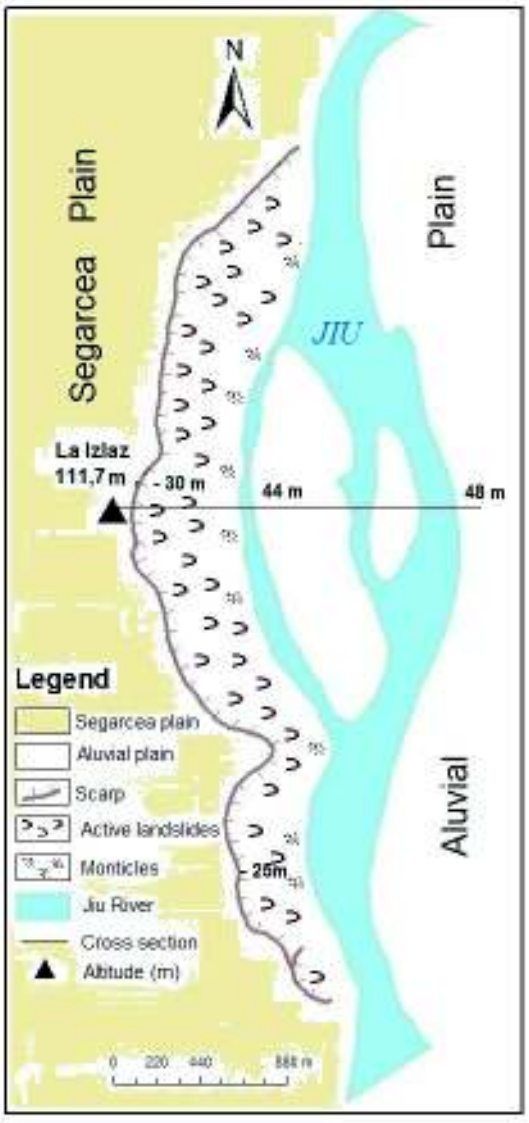

Photo 3. **The Drănic landslide**

Fig. 5. **Sketch of the Drănic landslide**

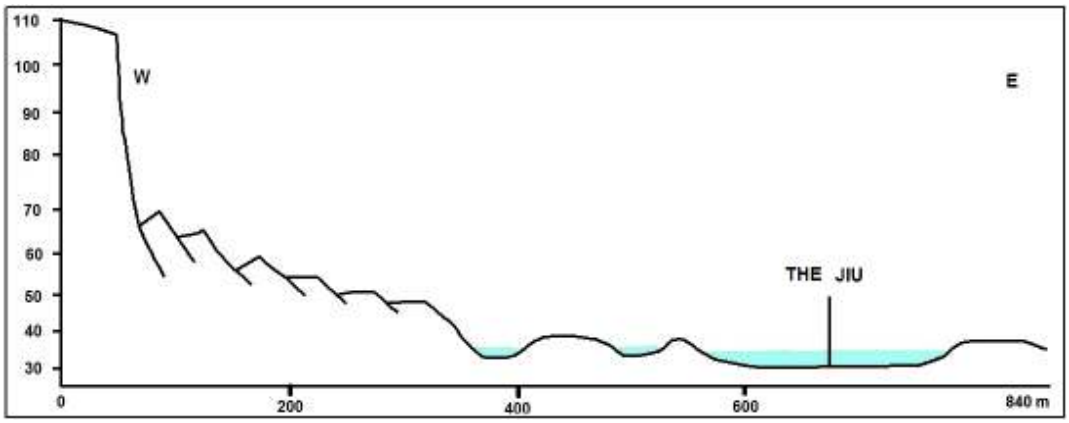

Fig. 6. **Cross section of the Drănic landslide**

Conclusions

The neotectonic movements of various directions and the climatic changes are indicated by the tendency of the Jiu river to go west, a direction kept also in the present. During the most part of the Holocene, the Jiu river strongly eroded the terraces on its left side. In a subsequent stage, the river left its old bed – the Jieţ river flows nowadays on this course – and began to flow on the right part of the alluvial plain. In the initial stage, when the alluvial plain of the Danube was formed, the erosion performed by the Danube river on the left side was strong enough. Thus, the bottom terraces had been eroded especially downstream of the confluence.
After leaving the old course, the scenario changed and the river strongly eroded the right side, destroying all the terraces that were surely also present here. The violent erosion of the right side caused the total transformation of the geomorphologic systems mainly by increasing the energy of the slope, cutting the confluent valleys (Boengiu S., 2008) and by lowering the river bed under the level of the Romanian clays and grey marls.

Nowadays, the entire slope is affected by mass movements (collapses and landslides) following a commune mechanism: where the convex part of the meander gets close to the slope, its vulnerability is increased and produces collapses and landslides, and where the slope is farther from the river course or it is near the concave part of the mender, the vulnerability is reduced and the at the base of the slope, where the transported debris is accumulated are formed glacises.

Most of the times, the Jiu river gets away from the right slope in front of the confluences with the tributaries on this side and immediately returns close to the slope.

This slope is under the direct influence of the Jiu river which, in the conditions mentioned above, periodically unbalances the slope maintaining an accelerate dynamics of the slope.

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