THE SUSCEPTIBILITY OF THE IARA DEPRESSION TO CONTEMPORARY GEOMORPHOLOGICAL PROCESSES

G.M. RUS[1], I.A. IRIMUŞ[1], S. ROŞCA[1]

ABSTRACT. – The susceptibility of the Iara Depression to contemporary geomorphological processes. Identifying the susceptibility of the land to contemporary geomorphological processes is an essential aspect to be pursued within the proper territorial planning process of the Iara Depression. Recently, within the Iara Depression, multiple areas were affected by geomorphological processes and these had both natural and anthropogenic triggers. In the present study, we choose to assess the Iara Depression exposure to hazards by including its territory in the landslides probability occurrence classes defined by the 447/2003 Governmental Decision, using GIS technology that allows the running of this type of complex analyzes. To obtain the necessary specialized information, we used geomorphological mapping on site and in the laboratory, to detect the contemporary geomorphological processes, which than was used as a validation method for the obtained results.

Key-words: geomorphological processes, landslides, ravines, susceptibility, Iara Depression

1. INTRODUCTION AND STUDY AREA

Located in the southern part of Cluj County, at the contact of Massif Muntele Mare with Agrişului Hill's, Ocoliş-Poşaga Depression and the Buru Gorge, Iara Depression is constituted as a well individualized geographic unit, less exploited scientifically in terms of a complex geomorphologic studies. The researched area has a high geomorphological and tourist potential, which isn't exploited as it should be today.

The Iara Depression has a complex geographic landscape, the defining component being the fluvial axis of the Iara River, which becomes the main genetic promoter of the depression's spatial functionality.

[1] Universitatea Babeş-Bolyai, Facultatea de Geografie, Departamentul de Geografie Fizică şi Tehnică, Strada Clinicilor 5-7, 400006, Cluj-Napoca, România, rusgeorgemihai@yahoo.com

The Iara Depression overlaps on the territory of two territorial administrative units, namely Băişoara and Iara. The aim of the present study is to make a radiography of the existing situation, regarding the contemporary geomorphological processes in the study area (Fig. 1).

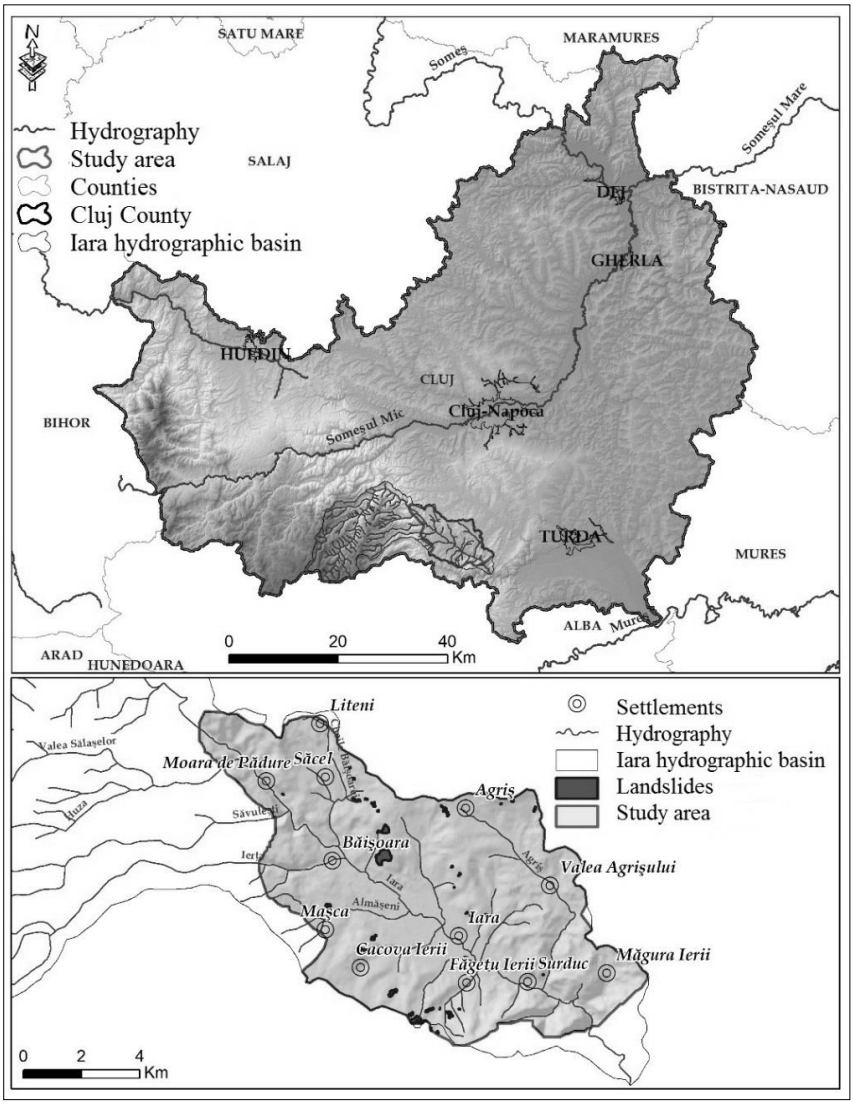


Fig. 1. Study area geographical location

In this respect, we have delineated the study area in two categories, namely: (1) areas susceptible to geomorphological processes and (2) areas where geomorphological risks are not present.

The main resources in the subsoil of the region (quartz sands, dacite, silver, lead) played a key role in the economic development of Băişoara and Iara territorial administrative units until 1996. Thus, if until 1996 in the Iara Depression there were several ore mining sites, at present there is only a quarry for the extraction of the industrial dacite, in Băişoara, the raw material is used in the road network infrastructure, for the construction of roads and highways (example: Transylvania Highway, Gilău-Campia Turzii). We must mention the fact that until 1996 mining was the main activity field of the male population in the Iara Depression, after 1996 there was an economic decline, thus between 1996-2016 a post-industrial period followed; as a result, the unemployment rate has risen among the population and the emigration rate also.

As a direct result of the mining activity in the Iara depression, many tailings dumps resulted, which have a strong negative influence on the environment, since they have not been properly preserved. In the future, better preservation is desired and subsequently one hopes to introduced them into the future tourist circuits (similar actions have been carried out in the German Silesian region).

The results of this study will be useful in future spatial planning. We would like to mention that in the future there must be a territorial resilience regarding the economic activities within the Băişoara and Iara communes, through the transition from the mining activities (conducted until 1996) to tourism and agrotourism (considered non-polluting fields of activity). Iara was an important point in pottery, but today only one person is dealing with this craft. In this sense, people could be trained in practicing this craft, which can be an activity on which the tourism from the area could rely.

Placing the Iara Depression in the territories which are characterized by a medium and high probability of landslides is mentioned in some works which aimed to classify the landslides probability classes of the Transylvania Depression (Mac and Tudoran, 1977, Surdeanu et al ., 1998, Petrea et al., 2014) or the entire national territory (Bălteanu and Micu, 2009).

Knowing the terrain's susceptibility to geomorphological processes induced by the landslides probability is essential in the process of spatial planning, (Benedek, 2004, Surd et al., 2005). The micro- and macroscale approach to the present problem involves a zoning of the territory on qualitative and quantitative criteria (Benedek and Man, 2016).

By analyzing the existing situation at the level of the Iara Hăşdate Depression, Moldovan, C.S., 2014, performs a SWOT analysis to develop a local development strategy together with objectives, proposals and projects for a better economic capitalization of the studied area.

In an applied geography survey regarding the settlements in the mining areas of the Apuseni Mountains (Veronica, Constantin, 2011), geographic features, accessibility and territorial structure were highlighted, the author asserting that "... the Iara depression occupies the middle basin of the Iara River between its exit from Muntele Mare and the entrance to the Surduc gorge ... ". It also highlights "aspects of the mining activities and their impact on the environment", and in this regard, the author mentions that "... mining activities were mainly related to the iron ore extractive and production industry and of quartz sands ... ".

The Iara Depression, located on the middle course of the Iara River, is a unit whose geological constitution is made up of Inferior Eocene striped clays. Thus, this explains that the researched area represents an area where contemporary geomorphological processes are present in many points (landslides, ravines and rill erosion).

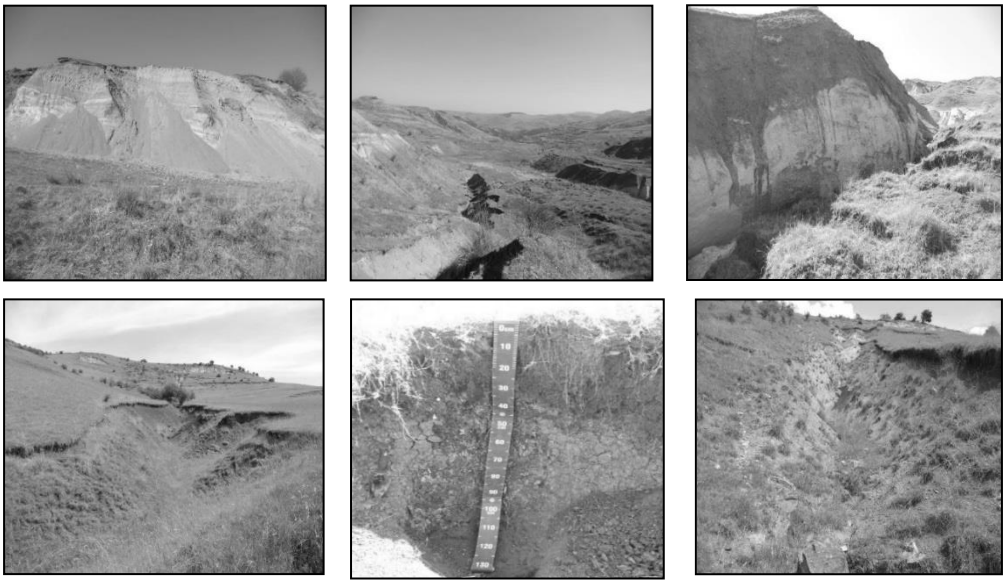


Fig.2. Contemporary geomorphological processes in the Iara Depression

After the analysis of topographic maps and satellite imagery we identified areas affected by landslides, both surface and in depth, as well as lands affected by ravines and rill erosion. The field research also analyzed the areas that were identified as problematic in the map of the landslides probability. Thus, in this way, all the current geomorphological process from the Iara Depression were identified.

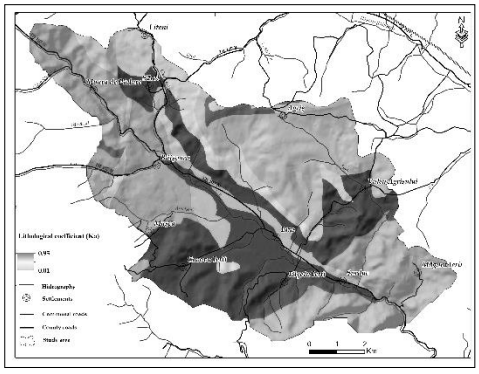
2. DATA AND METHODS

The mapping and spatial GIS analysis technique were useful in creating the maps of the landslides hazard coefficients (lithologic, geomorphologic, anthropic, hydrogeological, structural, forest and seismic coefficients) (Fig. 3).

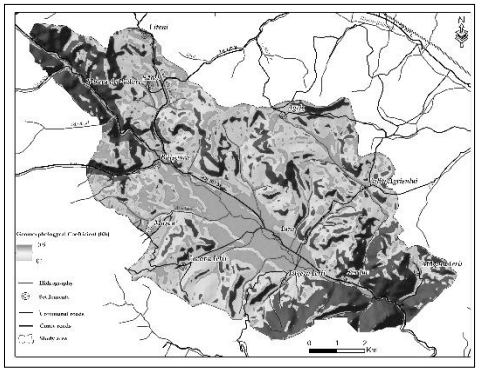
Using GIS spatial analysis techniques like interpolation and reclassification we created a 10 m resolution coefficient data base (Ka, Kb, Kc, Kd, Ke), the resolution is similar to the original digital elevation model (DEM).

For the mapping of the lithological coefficient map (Ka), we digitized the geological classes using the Romanian National Geological Map at 1: 200.000 scale. The geomorphologic coefficient (Kb), was computed from the 10 m-resolution DEM and created a slope map with classes correspondent to the specific probability classes as regulated by the 447/2003 Governmental Decision.

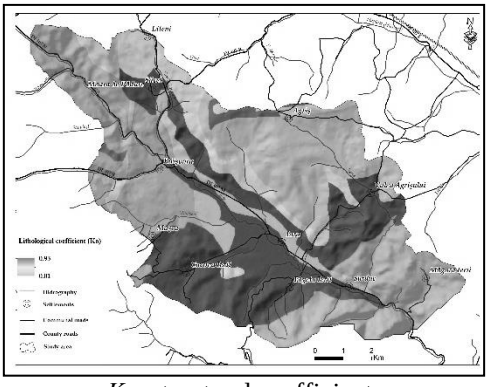
The Corine Landcover 2012 database was indispensable for mapping the land use classes needed to generate the forestry coefficient map (Kg), with emphasis being placed on the areas occupied by deciduous, coniferous and mixed forests.



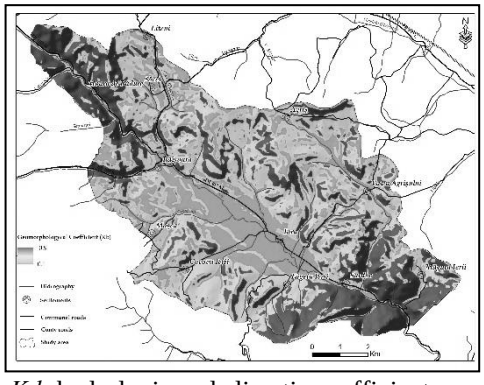
Ka- lithologic coefficient



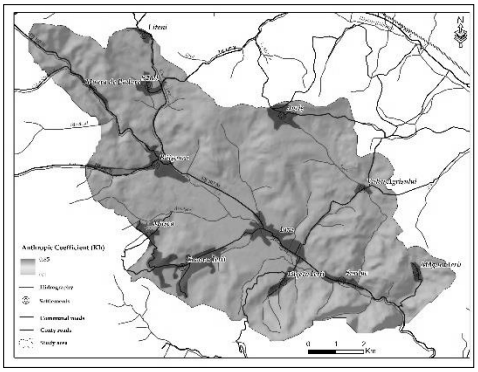
Kb- geomorphologic coefficient



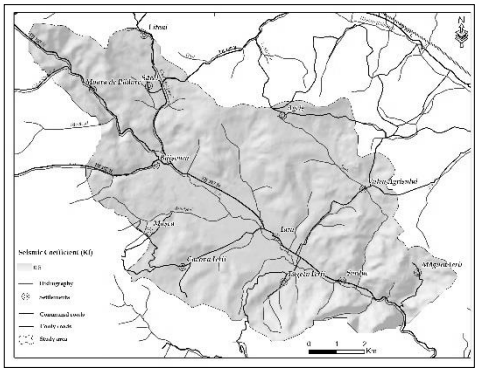
Kc- structural coefficient



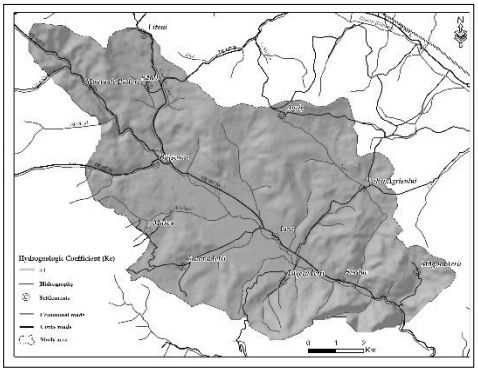
Kd- hydrologic and climatic coefficient



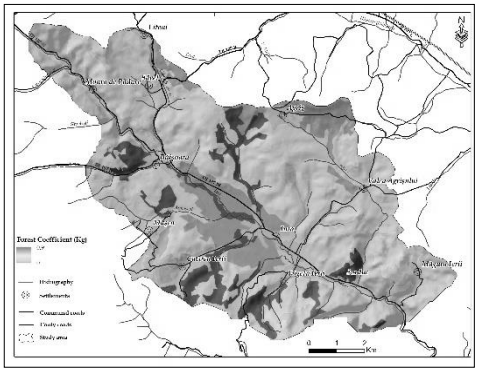
Ke- hydrogeologic coefficient



Kf- seismic coefficient



Kg – forestry coefficient



Kh – anthropic coefficient

Fig. 3. Maps of landslide occurrence factors

To obtain the mean hazard ratio (Km), formula (1) was used:

$$Km = \sqrt{\frac{K_a * K_b}{6}} * K_c + K_d + K_e + K_f + K_g + K_h, \qquad (1)$$

where: Ka – lithologic coefficient, Kb – geomorphologic coefficient, Kc –structural coefficient, Kd – hydrologic and climatic coefficient, Ke –hydrogeologic coefficient, Kf –seismic coefficient, Kg – forestry coefficient, Kh –anthropic coefficient, Km – mean hazard ratio.

In the present study, a GIS technique was used for framing the territory of the Iara Depression on landslides occurrence classes, and was endorsed by the natural hazards' methodological norms (GD 447/2003) regarding landslides maps elaboration and their content.

Also, numerous field studies have been made to confront the geographic reality with the results assessed through the GIS technique, al for-data adjustments and additions.

To support this thought thread, numerous similar topics have been reviewed, a part of them, used in the analysis, are found in the bibliography. In a similar study (Colniță et al., 2016) they identified the areas affected by geomorphological processes and counted the houses affected by landslides, by various risk classes (low, medium and high). The study is of great importance in terms of spatial planning and in avoiding the development of residential areas in the zones affected by hazardous geomorphological processes.

In another study, at the Somesean Plateau level, the authors identified the areas affected by geomorphological processes (landslides) (Bilaşco et al., 2011) and later they classified these territories into classes of landslides probability occurrence (low, medium, high and very high risk). The study shows utility in future spatial planning policies, and in the future, risk situations will be avoided in terms of damage to residential zones, and the development of safe residential areas. Also, the various fields that will be included in the agricultural circuit could be carefully selected.

Table 1: Landslide occurrence probability

Landslide occurrence probability	Area	
	km^2	%
Low (0.01 - 0.1)	34.1	37.3
Medium (0.1 - 0.3)	23.4	25.6
High (0.3 - 0.5)	30.4	33.2
Very high (0.5 - 0.64)	3.6	3.9

3. RESULTS AND DISCTIONS

Following the analysis of the landslides probability map of the Iara Depression, it is noted that the areas with medium and high risk of landslides prevail (25.6% and 33.2%), which are grafted near the Agriș Hills, respectively on the terraces of the Iara River and the contact with the Muntele Mare Mountains. Territories with a very high risk of landslides occupy only a 3.9%, and are located on the upper terraces and slopes of the Iara River, the low-risk areas to landslides occupy a 37,3% overlapping on the mountain area (Muntele Mare and the Surduc gorge) and the Iara River's meadow. Seemingly, as it should be, the mail factor which influences the landslide probability in the Iara Depression is the slope.

Along with the landslides, other geomorphological processes, such as ravines and rill erosion, affect numerous fields within the study area (Fig.4). The main causes behind the initiation of the contemporary geomorphological processes

are the natural ones (geology, hydrogeology, slope etc.) and anthropic ones (in the former quartz sand quarry upstream of Făgetu Ierii, on the river with the same name, appeared a landslide of anthropogenic origin, we must also mention overgrazing). A significant part of the land affected by the above-mentioned geomorphological processes were removed from the original land use circuit (agricultural land) or their destination was changed.

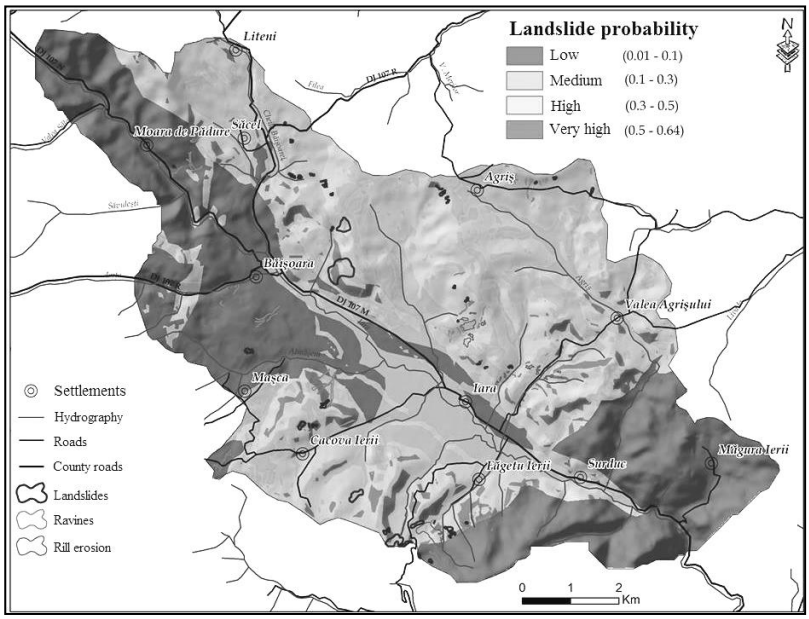


Fig. 4. Landslide occurrence probability map

To validate the final results regarding the classification of the Iara Depression into probability classes, using the methodology regulated by the Governmental Decision 447/2003, we choose the method of computing the affected areas ratio by active landslides in every probability class, the active landslides were identified by recent satellite imagery analysis and by field campaigns.

Table 2. Fractionation of active landslides on probability classes

Probability class	km^2	%
Low	0.02	4.18
Medium	0.05	11.55
High	0.39	84.27
	0.46	100.00

It is noteworthy that out of the total area affected by active landslides (0.46 km^2), most of them belong, according to the analysis, in the high probability class (0.39 km^2), which represents 84,27% of the total area affected by landslides (Rosca, 2015).

4. CONCLUSION

In the present study, by using GIS techniques, we categorize the territory of the Iara and Băisoara communes, from the Iara Depression, according to their probability of landslides occurrence. The used methodology is reinforced by the national methodological norms elaborated for creating and contents of the natural risk maps regarding landslides (GD 447/2003). It is noteworthy that the areas with high and medium risk of landslides prevail (33.2% and 25.6%), while the territories with a very high probability of landslides have a share of only 3.9%. Low risk area represents the highest value, 37.3 % (Tab. 1).

Regarding the classification of the active landslides by probability classes, we can see that those with a high probability predominate (84.27%), and those with low and medium probability hold 4.18% and 11.55%.

Iara Depression, a perimeter affected by numerous contemporary geomorphological processes (landslides, ravines, rill erosion), in which the main economic activity was mining and now is agriculture, holds, in the present study, a diagnosis of the current situation regarding the territories susceptible to geomorphological processes. As mentioned above, mining activity has had negative implications on the environment and on several areas (through non-certified tailings dumps) that have been removed from the original land use circuit. In the future, it is desirable to avoid hazardous situations regarding the contemporary geomorphological phenomena and the present study should be useful in theid direction for future spatial planning within the Băişoara and Iara territorial-administrative units within the Iara Depression.

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