Analele Universităţii din Oradea – Seria Geografie Tom **XX**, no. **1/2010** (**June**), pp. **58-64**
ISSN **1221-1273**, E-ISSN **2065-3409** Article no. **201106-496**

ASPECTS REGARDING THE RESISTANCE TO EROSION OF THE ROCKS FROM VALEA IADULUI DRAINAGE BASIN

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Abstract: The following paper presents information regarding the resistance to erosion of the rocks from Valea Iadului (Hell's Valley) drainage basin, based on the observation comprised by the geological sheets of Remeţi and Şimleu. Thus, one has determined the surfaces of volcanogenic-sedimentary formations dating from the Paleozoic, Mesozoic and Quaternary periods as well as their resistance to erosion, by means of Frewert's index (1955). Finally, the geological map of erosion has been drawn for the drainage basin of Valea Iadului, highlighting the small values of geological erosion which determines a high slope stability, a reduced landform fragmentation as well as a small quantity of alluvial deposits transported in suspension by the drainage network.

Key words: rock, resistance to erosion, drainage basin, Valea Iadului

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INTRODUCTION

Considering recent tendencies in geographical science, one notices an increase of the frequency of practical-applicative studies. This is also the direction embraced in the writing of this paper which highlights surfaces presenting different degrees of erosion resistance. The map we have drawn up represents an essential instrument for establishing the credit and business worthiness of terrains as well as for determining the surface of lands exposed in Valea Iadului to geographical risks.

DATA AND METHODOLOGY

The data compiled for the writing of this paper has been provided by geological sheets of Remeţi and Şimleu at a scale of 1: 200.000. These have also been used for the drawing up of the geological map of Valea Iaduilui drainage basin, highlighting the distribution of the geological formations comprised in this area (figure 1&2, table 1). We have also used Frewert's index (1955), adapted to the geographical conditions of the Carpathians by Sterlik (1970) and introduced in Romanian specialized literature by Zăvoianu (1978) [1] as well as the values of the geological resistance for all types of rocks present in the studied area and their erosion coefficient (table 2) in order to draw up the map of erosion for Valea Iadului drainage basin (figure 3).

RESULTS

From a geological perspective, Valea Iadului drainage basin is superposed on two units: Bihor- Vlădeasa Massive and Pădurea Craiului Mountains.

Bihor-Vlădeasa Massive is a volcanic geological complex formed through a succession of paleogenic and upper cretaceous eruptions. The first manifestation was characterized by andesite flows and was followed by a second manifestation of magma emissions which created riolites. In marginal areas, the rocks coming in contact with the Mesozoic sedimentary are breccia riolites, including enclaves of calcites, quartzites and crystalline schists. Also, one can frequently find riolites with a rubanate and breccia structure. Less frequently, in deeper valleys, one can also find a variety of intrusive rocks (Orăşeanu, 2002).

Pădurea Craiului Mountains are mostly composed of crystalline schists covered by depositions of sediments. The breccias and Permian conglomerates made up of blocks of crystalline schists and quartzites contained in a red-violet violet sandy clay loam are located in the Bulz – Ponoare Hill are. The Triassic saw the birth of argillaceous shale schists and limy sandstones developed on limestones which, due to the action of the clay have become shale-limestone. During the Jurassic appeared siliceous sandstones, white and red quartzites, brown and white massive limestone, partially coralligenous (Cheile Brătcuței and Remeți) (***, 1992).

The lithological formations present in the basin as the result of a succession of diverse sedimentation conditions, having different levels of resistance to the action of exogenous agents, as well as their stratification patterns determine the importance and the intensity of the manifestations of certain current processes.

The southern half of the drainage basin is dominated but the presence of volcanogenic-sedimentary formations of the *upper Cretaceous* and *Senonian*, comprising riolites, having a hypo-crystalline structure, a fluidal texture and an acid chemism. On a lesser scale, the same volcanogenic formations comprise *tuffites*, a pyroclastic material resulted from the combination of volcanic ash and sedimentary materials.

In the south-western area of the basin several types of rocks can be found grouped: *breccias, conglomerates and sandstones,* characteristic to the *Permian* era, cemented detritic sedimentary rocks, rudites, *Triassic* formations belonging to: the upper *Campilian (limestones and massive dolomites), the Anisian (limestones, dolomites, shale, argillaceous schists), the Norian (massive limestone, grezous limestone)* as well as to *the Neocomian (marly limestones)*. A large part of the northern half of the basin corresponds to the *Someş series of the upper Anteproterozoic* represented by the *superior and inferior micaschist complex*, metamorphic rocks presenting a high degree of metamorphism, a schistic texture and a lepidoblastic structure.

The central part of the basin comprises *Paleozoic* deposits characteristic to the *Arada series*, *Triassic* deposits of *limestone* and *dolomites* dating from the *lower* and *upper Campilian*, *conglomerates, sandstones, argillaceous schists of the Seisian*, *Jurassic* deposits of *conglomerates, sandstones, clays, Sinemurian sandstones, spatic limestones and Oolite (Bajocian) limestones, massive limestones* and *Callovian stratified limestones, Cretaceous – Barremian deposits of limestone and Requienia,* a limited area of *Senonian riolites, Paleocene diorites as well as alluvial deposits* (gravel, boulders) dating from the *lower Pleistocene* as well as the recent alluviums of the alluvial plain which are characteristic to the *Holocene*.

The southern part of the drainage basin is characterized by the uniformity of deposits, a large surface comprising Senonian riolites and *tuffites* typical to the *upper Cretaceous* but also *Permian breccia* deposits, *conglomerates*, *sandstones* and grouped *Campilian dolomites* and *limestones* as well as *Barremian limestones* (figure 1).

A quantitative analysis of the geological formations from Valea Iadului drainage basin points out that almost half of the basin's surface corresponds to volcanogenic-sedimentary riolitic formations (99,1 km^2), followed by the superior micaschist complex (41,7 km^2), while other geological formations occupy smaller surfaces as shown in the table (table 1) and graphic representation below (figure 2).

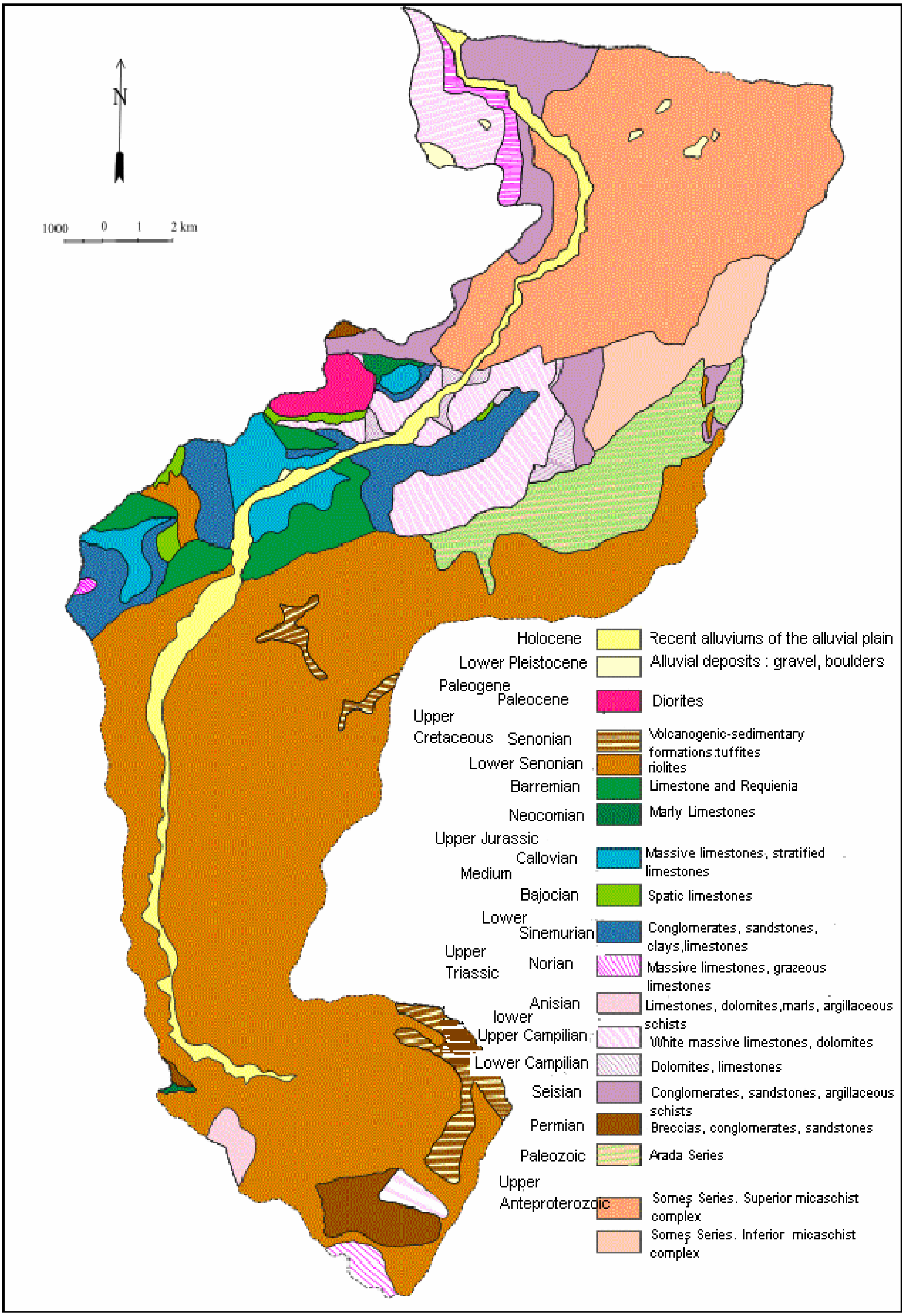

Figure 1. Valea Iadului. Geological Map (based on the Geological map of Romania)

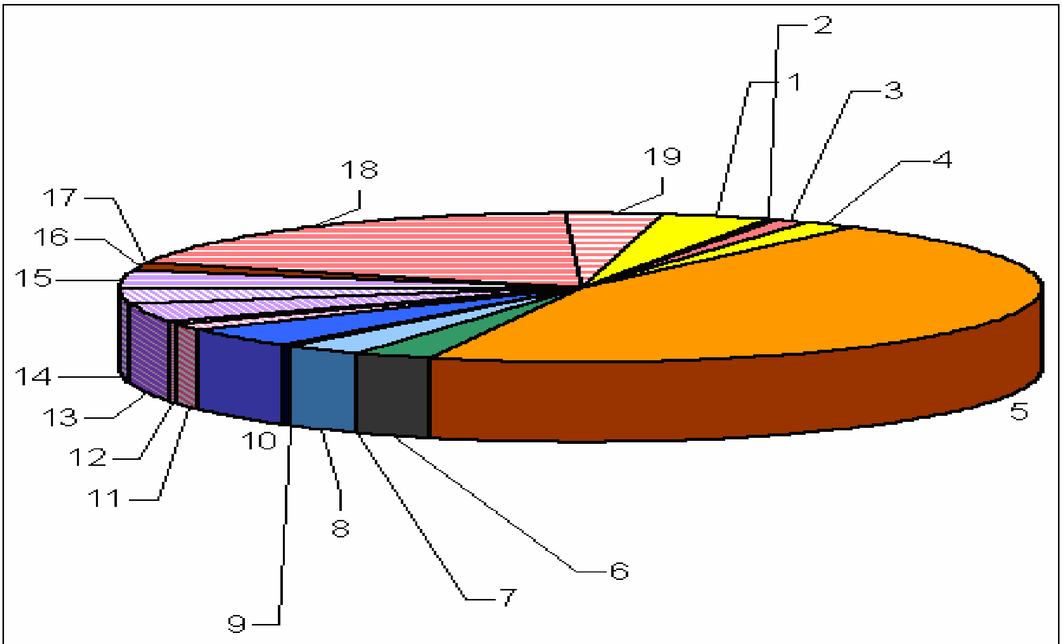

Figure 2. Repartition of the geological formations in Valea Iadului drainage basin (%) (see table1)

Table 1. Distribution of the geological formations in Valea Iadului drainage basin
(Source: data collected from the geological sheets of Remeți and Şimleu)

Nr. crt.	Age	Geological Formation	Surface Km^2	Surface %
1	Holocene	Recent alluviums of the alluvial plain	8,708	3,958
2	Lower Pleistocene	Alluvial deposits : gravel, boulders	0,574	0,261
3	Paleocene	Diorites	2,112	0,960
4	Senonian	Volcanogenic-sedimentary formations: tuffites	4,794	2,179
5	Lower Senonian	Volcanogenic-sedimentary formations: riolites	99,186	45,085
6	Barremian	Limestones and Requienia	6,220	2,827
7	Neocomian	Marly limestones	0,114	0,052
8	Callovian	Massive limestones, stratified limestones	5,702	2,591
9	Bajocian	Spatic limestones, oolitic limestones	1,050	0,477
10	Sinemurian	Conglomerates, sandstones, clays, limestones	9,762	4,437
11	Norian	Massive limestones, grezous limestones	2,799	1,272
12	Anisian	Limestones, dolomites, marls, argillaceous schists	1,063	0,483
13	Upper Campilian	White massive limestones, massive dolomites	9,660	4,391
14	Lower Campilian	Dolomites, limestones	6,702	3,046
15	Seisian	Conglomerates, sandstones, argillaceous schists	8,962	4,073
16	Permian	Breccias, conglomerates, sandstones, schists	3,572	1,623
17	Paleozoic	Arada Series	0,001	0,000
18	Anteproterozoic	Someş Series. Superior micaschist complex	41,712	18,960
19	Upper Anteproterozoic	Someş Series. Inferior micaschist complex	7,148	3,249

The geological substrate represents an important component for any drainage basin due to the fact that landforms and their characteristics are greatly influenced by the geological resistance of the constituent rocks which ultimately also influence the soil as well as the vegetation. The rock is itself subject to the actions of the subaerial agents, responding according to its physical and mechanical properties. Several research teams have tackled the issue of determining an index that would reflect the behavior of rocks facing the action of subaerial agents, therefore mirroring the rock's resistance to erosion. The first mathematical expression of the rocks' resistance to erosion was obtained by Americans and was translated as an index of values ranging from 0.70 to 1.40, starting from rocks with a low resistance to erosion towards less permeable rocks, with a high resistance to erosion. R.K. Frewert was the proponent of the index of erosion in America, in 1955. The idea was then borrowed and adapted to the Czechoslovakian Carpathian region by O. Stehlik in 1970. Both authors are quoted by I.Zăvoianu in 1978. Due to the similarity of the Czech, Slovakian and Romanian Carpathian regions, we have used the geological indices adopted by Stelhik (1970) for the study of Valea Iadului drainage basin. Introducing the appropriate indices and the data obtained through the charting of the area in the following formula:

$$R_g = \frac{R_{g1} \cdot f_1 + R_{g2} \cdot f_2 + \ldots + R_{gn} \cdot f_n}{F} \quad (1)$$

Where R_g stands for the average coefficient of geological resistance, R_{g1}, R_{g2}, … R_{gn} represent the geological resistances of the formations composing the surface of the basin, chosen according to the prepared classification, f_1, f_2, … , f_n represent the surfaces corresponding to each formation and F stands for the surface of the entire basin (Zăvoianu, 1978), the obtained value of the average coefficient of geological resistance for Valea Iadului draining basin is R_g = 1.151. Table 2 presents the values of the geological resistance, those of the coefficient of geological erosion for Valea Iadului draining basin as well as the surfaces of various types of rocks present in the studied area.

By analyzing and interpreting the data shown in table 2, we can conclude that 47 % of the surface of Valea Iadului draining basin, 103.98 km^2 more precisely, corresponds to a coefficient of ***1.20*** , 36% of the surface of the basin, 79.1 km^2, corresponds to a ***1.10*** coefficient, 11 % or 23.9 km^2 correspond to a 1.30 coefficient while only 4.2 % of the surface, meaning 9.2 km^2, corresponds to a coefficient of 0.70. These values are consistent with a low average of values reflecting the geological erosion of Valea Iadului drainage basin.

These low values of the index of geological erosion reflect the stability of the slopes, a low landform fragmentation and also a reduced quantity of alluvial deposits transported in suspension by the drainage network.

The geological configuration imprints different characteristics to the liquid flow of the Valea Iadului drainage basin. Thus, in the southern half of the basin, dominated by volcanogenic-sedimentary rocks (riolites, tuffites, breccias, conglomerates and Permian sandstones), rocks which present a reduced permeability, one can observe a faster reaction of the torrential streams as well as a tendency of channeling the flow on the slopes towards the collecting streambed. The areas of Campilian limestones are an exception, which allow infiltrations thus modifying the flow on the slopes and inducing a delayed reaction of the flow from the streambed. These areas are sources of subterraneous alimentation, active in the periods where the alimentation provided by precipitations is scarce.

For the northern half of the basin, the presence of various types of limestone formations allows a higher infiltration of precipitation waters and implicitly, the creation of subterraneous storage capacities, thus affecting the surface flow.

After determining the geological erosion coefficient for each geological formation, we could finalize the charting of Valea Iadului drainage basin according to the erosion resistance of its different areas. This map represents an important instrument for establishing the geographical risk of Valea Iadului drainage basin (figure 3).

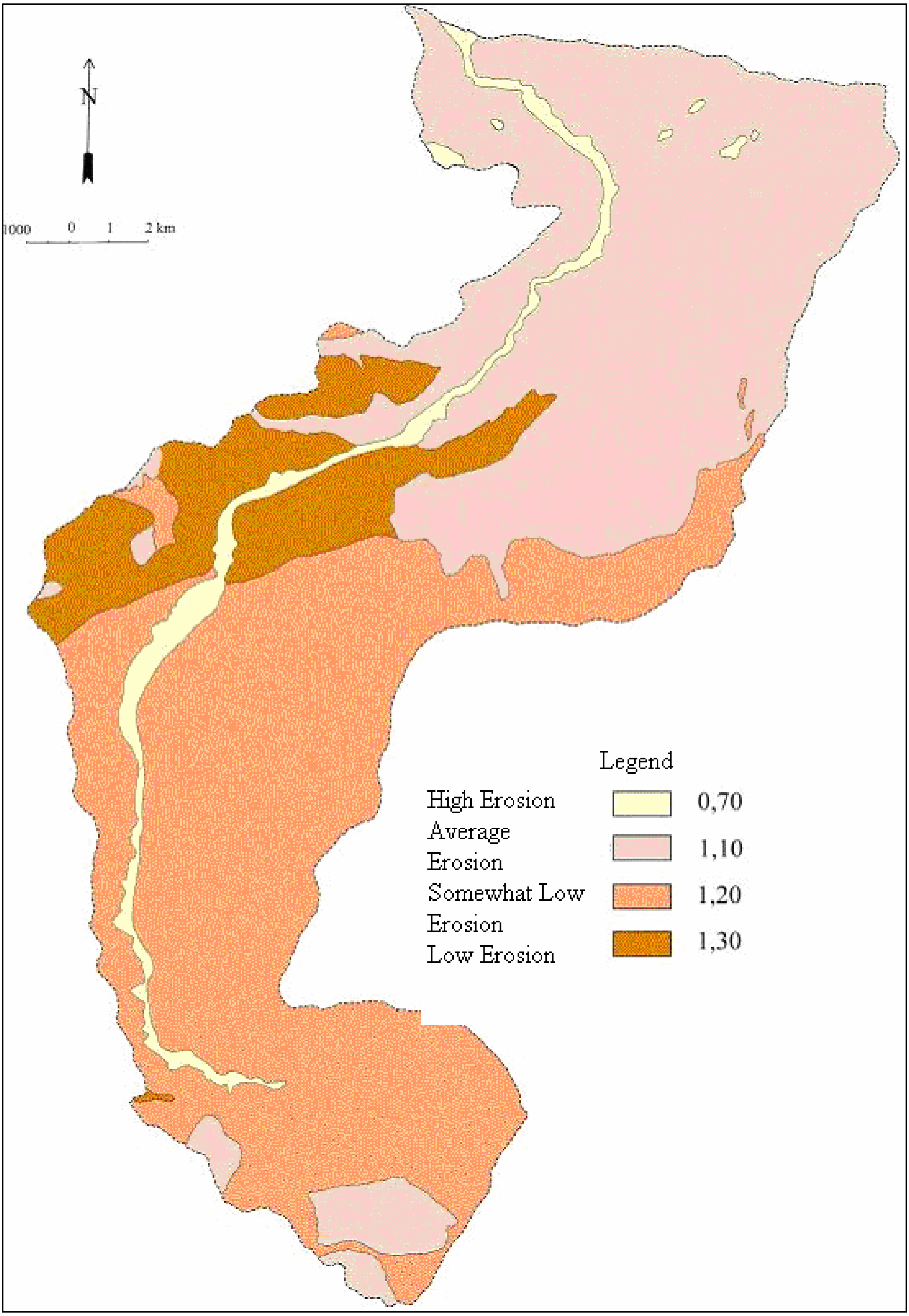

Figure 3. Valea Iadului. Geological Map of Erosion

CONCLUSIONS

As a result of the conducted study, the following conclusions can be drawn:

a). Valea Iadului drainage basin possesses a varied petrography, differentiating four sectors: the *southern area* is dominated by volcanogenic-sedimentary formations (riolites, tuffites, breccias, conglomerates) characteristic to the upper Cretaceous, the Senonian and the Permian; the *central region* comprises Paleozoic, Triassic, Jurassic, Pleistocene and Holocene rocks (the Arada series, limestones, dolomites, sandstones, conglomerates, clays, riolites, diorites, gravel, recent alluviums); the *northern sector* dominated by Anteproterozoic metamorphic rocks (micaschists); the *south-western area* comprising Permian and Triassic sedimentary rocks (breccias, conglomerates, sandstones, limestones, dolomites, marls, argillaceous schists).

b). The predominant rocks of the basin are volcanic, followed by metamorphic rocks, while sedimentary formations are found on limited areas.

c). The values of geological erosions are small for most of Valea Iadului drainage basin, 94 % of the area registering a coefficient of erosion comprised between 1.10 and 1.30, while the surfaces registering a high erosion coefficient (0.70) are limited to 4 % of the total area.

d). The small value of the geological erodibility for Valea Iadului drainage basin is reflected by a high slope stability, a reduced landform fragmentation and the small quantities of alluvial debris transported in suspension by rivers. .

e). The geological configuration imprints different characteristics to the liquid flow of the Valea Iadului drainage basin where, in its southern half, volcanogenic-sedimentary rocks presenting a reduced permeability frequently allow the formation of torrential streams as well as the channeling of the flow on the slopes. However, for the northern half of the basin dominated by sedimentary limestones, the surface flow is less focused due to the subterraneous drainage caused by the infiltration of water generated by precipitations.

f) The geological map of erosion drawn up for Valea Iadului drainage basin represents an essential instrument for determining the possible geographical risks of this area.

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Submitted:	Revised:	Accepted:	Published online:
January 15, 2010	March 30, 2010	June 24, 2010	June 30, 2010