BABEŞ-BOLYAI UNIVERSITY, CLUJ-NAPOCA

F A C U L T Y o f G E O G R A P H Y

PHYSICAL GEOGRAPHY DEPARTMENT

Măhăceni Tableland – Geomorphological Study

Phd Thesis

-Summary-

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2010

CONTENTS

Key words: tableland, morphology, actual landform processes, morphogenetic factors, susceptibility, degradation processes on natural terrain, risk, regional geomorphology.

1. Introduction

The western border of the Transylvanian Depression is an area with a multitude of problems, mostly concerning the evolution of the Transylvanian Basin in relation to the Carpathians' uplift. As a contact area between the Trascău Mountains and the Transylvanian Depression, Măhăceni Tableland reflects the Miocene-Pliocene changes on the Transylvanian-western border, as a controversial territory which has been very poorly studied so far. The present paper: "Măhăceni Tableland – Geomorphological study" is the outcome of the research carried out between 2005 and 2010, with the **purpose** of pointing out the main features of the morphogenetic system of Măhăceni Tableland, thus offering a regional model within the knowledge of the marginal Carpathian structures from the western border of the Transylvanian Depression.

2. Methodology

The methodology of research and geomorphological analysis followed the dynamic and methods of research characteristic for the geography field and the connected disciplines. The contemporary geomorphological experience follows new correlative–synthetic directions of research in order to emphasize the aspects regarding the intimacy of the process-based morphology, highlighting the interdisciplinary character of geomorphology- as science.

In order to achieve the desired goal, the following **objectives** were established:

- The analysis of the morphogenetic basis of the studied area and its reflection upon the landform dynamic evolution of the area;
- Pointing out the specific morphological and morphometric characteristics of the studied area
- Analysing the dominant features of the present-day landform dynamics
- Becoming an efficient study by means of following the directions of regional geomorphology
- The analysis of territorial sensitivity to actual degradation processes.

3. Terminology and territorial bordering

Măhăceni Tableland represents a hilly contact unit, located in the folded carpathian margin from the western border of the Transylvanian Depression, representing a distinct morpho-structural assembly, geo-tectonically and morpho-lithologicaly limited, in comparison with the rest of the surrounding units. Located at the "basis" of the Trascău Mountains, the Măhăceni Tableland comprises within its morphogenetic structure, piedmont formations, which were intensely poli-cyclically eroded and transported by the initial hydrographical network, ulterior being adapted to the Arieş and Mureş Rivers. The imprint of this piedmont is still found today in the western higher part of the tableland which corresponds to the erosion level of 550 m. The hilly sector belonging to the level of 300-400m, is representative for the analysed area with a tableland-type characteristics, stated by the presence of the erosion levels of 360-400 m and 450 m, which represent two thirds of this entire studied unit. Therefore, from a morpho-tectonical point of view, Măhăceni Tableland can be considered as a folded peri-carpathic unit, petrographically and paleoevolutionally it can be regarded as an intensely eroded piedmont, but from a morphological and functional point of view, the analysed unit represents a distinct tableland unit, well individualized and geo-tectonically and morphologically separated by the Trascău Mountains and by the Transylvanian Tableland, mainly by its two important arteries represented by the Arieş and Mureş rivers, as well as by the adjacent system of crustal faults.

The studied area–Măhăceni Tableland lies in the central north-western part of the country, as a contact area between the Trascău Mountains and the Transylvanian Depression, being a part of the marginal hilly and depressional carpathian units at the border of the Apuseni Mountains. The surface of the analyzed area is 421.7km², a territory geo-tectonically and morpho-structurally delimited from the surrounding units, therefore representing a distinct, well individualized area. Towards the west, Măhăceni Tableland splits from the Trascău Mountains, throughout a small sector of defile of the Văleni valley and continues with the contact depressions from the alignment of the Pietroasa – Podeni – Lopadea localities (Fig. 1). To the north and east, Măhăceni Tableland is bordered by the Arieş river valley, respectively by the crustal fault along which the Arieş River flowed. The southern limit is given by the Mureş river valley, while the south-western limit is represented by the Aiud river valley (Geografia României, Vol. III, 1987) which corresponds to a sector of intense sinking.

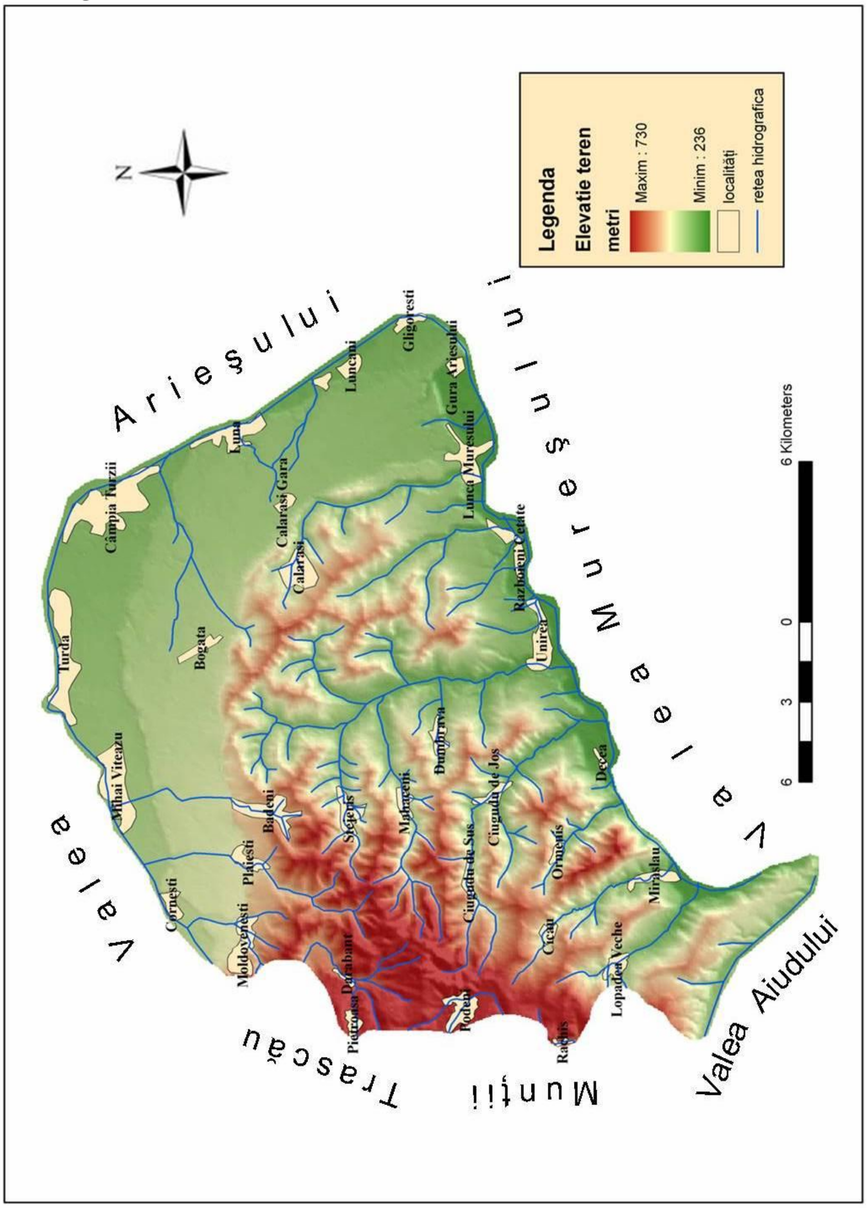

Fig.1. Măhăceni Tableland- territorial bordering

4. The geological support of the region

The geology of Mahaceni Tableland is characterized by the complications revealed by this contact area, between the Apuseni orogene and the basin unit corresponding to the Transylvanian Basin, being a poorly studied subject, with fractioned, non-uniform character and low morfology corelations, if compared with the many studies published since the middle of the XIX-th century. Moreover, the adequate cartographic materials are missing, (the only available geological area map is the 1:200000 scale map, 1967 edition) as well as drillings, detail profiles, etc..

Therefore, in order to reveal the region`s geotectonic support' evolution, as a basic factor within the morphogenetic evolution of these miocene formations, which lay in nearly parallel bands, the Badenian, Sarmatian and Pannonian structures, it was necessary to consider the Transylvanian Basin`s geotectonics as a whole, with adjustments from recent literature, together with field observations and tests.

In this context, the general geological map (Fig. 3) was built following the synthesis of several cartographic materials: Geological Map 1:25000 (Filipescu, 1996), Geological Map 1:20000–Turda Sheet (1967 ed.), geotectonic profiles (Krézsek, Bally, 2006), seismic profiles (SNGN Romgaz SA, 2009), together with field validations.

4.1. Paleoevolution

The main features of the studied area, reveal complications at the folded area at the Transylvanian Depression western border, in whose development three factors are involved: the post-Cretaceous Transylvanian Basin development in relation to the Pannonian Basin, Carpathians' uplift and the presence of salt. This territory has been intensively modelled exogenously by external and endogenous agents, by lifting and folding movements. This system of folds, together with the Miocene-Pliocene geotectonic register of Măhăceni Tableland, are *the basic premises for the entire geomorphosystem of the studied area, clearly intervening in this contact area`s morphology*.

Măhăceni Tableland' endogeomorphosystem comprised, in its Neogene evolution, two elements that have acted opposite: on the one hand, the Miocene-Pliocene lifting and folding movements of the Western Carpathians, and on the other hand, the diapirism influences, especially in the presence of salt massifs (Fig. 2).

The exogeomorphosystem of the studied has revealed a strong erosion which removed most of the piedmont formations, strongly reducing the interfluvial surfaces, thus facilitating the development of erosional basins.

The resultant of the two systems` action is the current landform system of Măhăceni Tableland, with a high degree of fragmentation, particularly on a west-east direction.

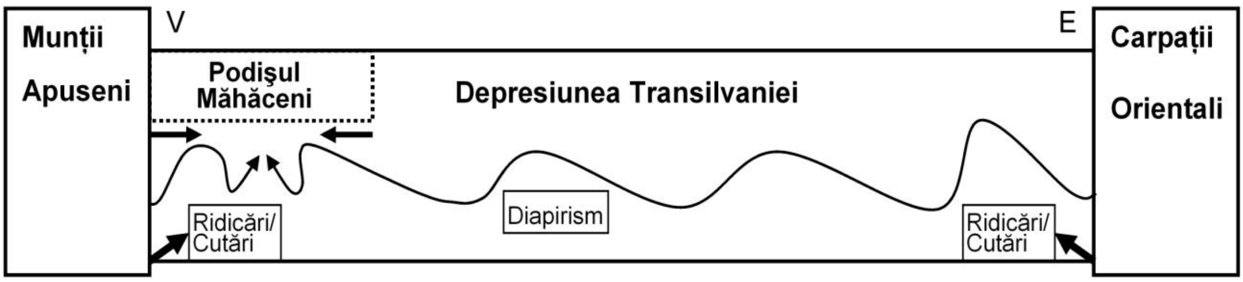

Fig. 2. Schematic evolution of the Neogene endogeomorphosystem of Măhăceni Tableland

4.1.1. Upper Miocene cycle

a) The Badenian

Within Măhăceni Tableland, the Badenian litoral-recifal facies is well represented, including limestone conglomerate with Lithotamnium (Ciupagea et. al, 1970), and occupies a well-individualised strip along the alignment of Moldovenesti-Pietroasa-Podeni-Rachiş villages (Fig. 3), overlying the Trascău Mesozoic diabases.

The Badenian deposits are in direct contact with the oldest formations of the foundament, demonstrating the existence of a significant transgression of the Badenian sea (M. Ilie, 1958).

In addition to coastal sedimentation, in the distant areas of the coastal zone, there is an accumulation of detritic rocks mixed with limestone and Lithotamnium, sufficient enough to prove the existence of a neritic shallow regime. This regime carried out at the east border of the coastal facies, on the alignment of Podeni-Lopadea-Pietroasa villages, causing salt and gypsum lenses that appear today in the sector corresponding to the extension of the continental ridge. The presence of salt and gypsum lenses of Sarmatian complex was explained by the same phenomenon of the lagoon system, due to subsidence.

b) The Buglovian shows a marly facies (which continues with a marly-sandy onee with a reducing sand quantity) and includes the layers' complex that was developed between the Ghiriş Tuff and Borsa-Turda Tuff, or the Spiralis marles on the upper part of the Badenian. At the east and south of Turda, the Buglovian was identified by the Ghiriş Tuff and Hadareni Tuff, which show up on the Măhăceni-Ormeniş (Fig. 4), Turda-Ocna Mures, Viişoara-Hădăreni structures. In these areas, the Buglovian is generally marly.

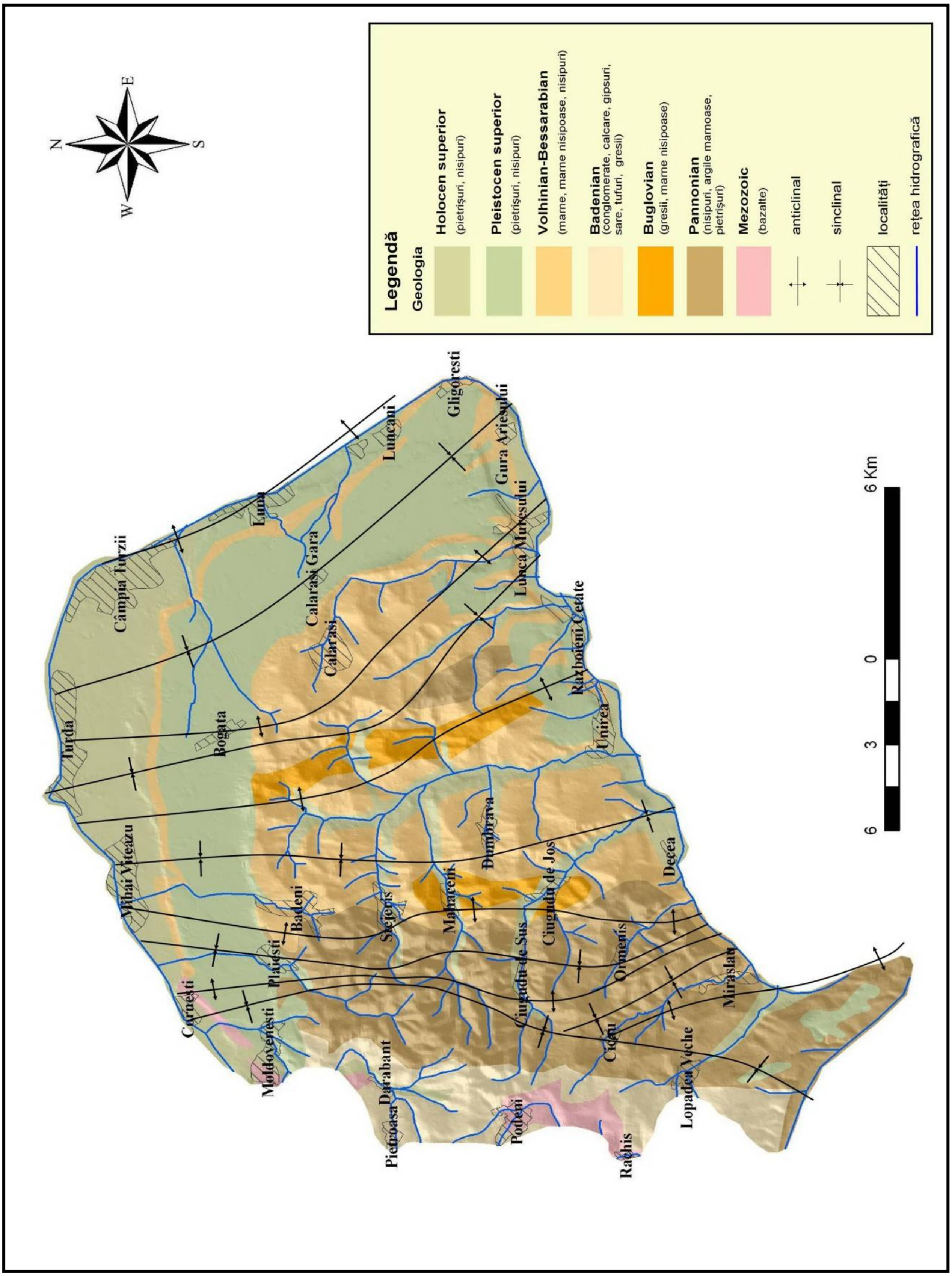

Fig. 3. Măhăceni Tableland - General Geological Map (acc. to: Geological Map 1:200000-1967; Geological Map 1:25000-Filipescu, 1996; geotectonic profiles-Krézsek, Bally, 2006; seismic profiles-SNGN Romgaz S.A., 2009)

Fig. 4. Ghiriş Tuff-identificat in Măhăceni anticline

c) The Sarmatian lies in continuously sedimentation with the Buglovian, separated by the Ghiriş Tuff, in the central and western Transylvanian Basin, revealing only the average and lower members (Volhinian and Bessarabian). In terms of lithology, we mostly find: intercalations of volcanic tuffs, which thicken towards the lower part of the formations, thin intercalations of dolomitic limestone, marl intercalations of white stripes, generally seen on the upper part of the formation.

Fig. 5. Sarmatian sandy clays belonging to the Măhăceni formation on the left slopes of Ciugud valley

Fig. 6,7. Sarsen stones at Ormeniş (Sarmatian)

4.1.2. The Pliocene cycle

The Pliocene around Măhăceni Tableland and throughout the western border of the Transylvanian Basin, was identified on fauna content. Its deposits overlay, on the eastern part of the Apuseni Mountains, the Cretaceous Paleogene and Miocene deposits and the Mesozoic eruptive. In this region, different types of Pliocene rocks alternate, which present themselves in the following aspect: black-gray clays, sandy clays, gray sandy marls, dark grey marls, thin sandy marls, some fossil clays, micaceous sands with acarce gravel concretions, thin-blocked sandstoness, gravels and fossil limestone conglomerates with elements from the Apuseni massif (Ciupagea et. al, 1970, p. 92).

Fig. 8. Pannonian sands nearby Plăieşti

4.1.3. Quaternary

The oldest terraces are to be found at Lopadea Veche, Ciugud. Lower terraces lie between Moldoveneşti and Bădeni and gradually pass to the floodplain deposits through glacises. The basic components of the terraces are gravels and sands. During the Holocene, debris fans were formed at the foot of steep slopes (in Mesozoic formations), the alluvial fans laid by torrents (in Mesozoic and Neozoic formations), landslides (in Pannonian and Sarmatian formation) and the recent alluvium. Since the Pannonian, due to the basin silting, very few deposits have been sedimented on significant surfaces, the erosional factors being more active (Krezsek, Filipescu, 2005).

4.2. Măhăceni Tableland stratigraphy

The Miocene sediment register of the Transylvanian Basin is diverse, with different periods of transgressions and regressions, complicated by the Oriental and Apuseni Mountains` uplift, the Miocene-Pliocene volcanism and the diapire movements. The sequence of the deposits is ordered as follows: in the foundation there lies the Bedeleu Nape (upper Jurassic-Cretaceous ophiolites), followed by the Râmeţi Formation (turbidites and upper Cretaceous limestones) , upwards, the Gârbova de SusFormation (with marls and the dominance of Podeni bioclastic limestone, of lower Badenian), the Cheia Formation (middle Badenian evaporites) which supports the Pietroasa Formation (containing upper Badenian tuffitic marls), the following is the Măhăceni Formation (Sarmatian sands and sandy clays) and at the upper part, there lies Lopadea Formation consisting of Pannonian clays (Fig. 10).

The *Pietroasa Formation* lies between the Cheia Formation and the Sarmatian silt clays. It consists of gray-green marls with intercalations of silt clays and tuffites clays, with a thickness of 10-15m, plus the Lithotamnium limestones marking the most advanced Badenian transgression (Fig. 11, 12).

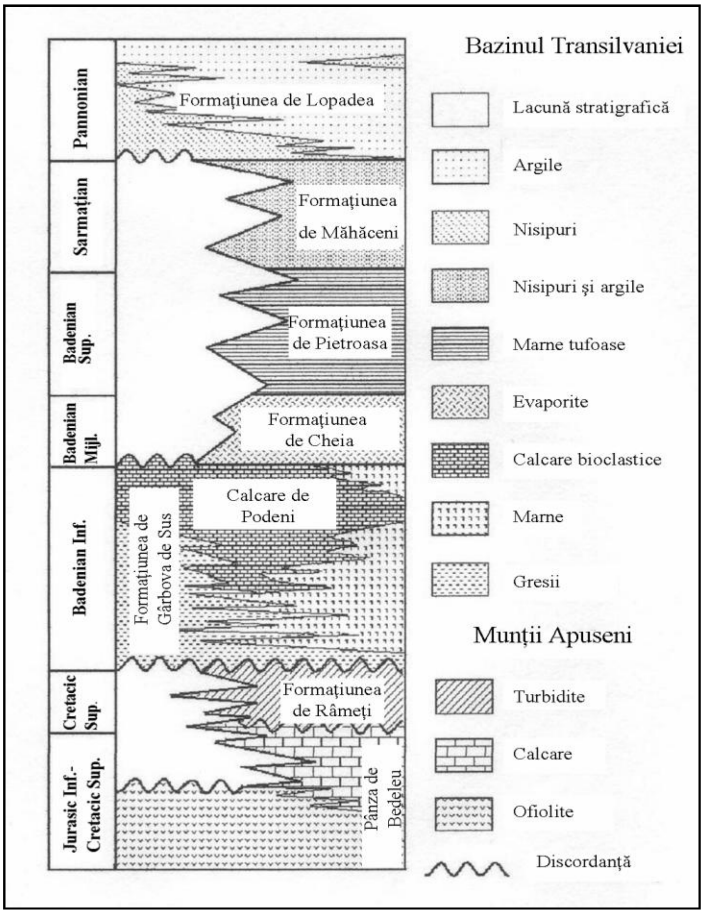

Fig. 10. Litostratigraphy of Măhăceni Tableland (modified from Filipescu & Gârbacea, 1997)

The Măhăceni Formation

A further degradation of the marine environmental conditions with normal salinity occurred at the Kossovian-Sarmatian limit. The gradual brakishing of the water also influenced the faunal associations, giving them both qualitative (loss of stenohaline forms) and quantitative change (biomass depletion).

Fig. 11, 12. Pietroasa Formation-marked by the Badenian transgression

Sarmatian deposits of the western border of the Măhăceni Plateau are covered by the Pannonian deposits. To the east, the Sarmatian deposits outburst under the Pannonian ones in the anticlines: Ciugud - Măhăceni - Bădeni, Ocna Mureş-Turda and Călăraşi.

In the out crops from Bădeni, Dumbrava, Măhăceni, Ciugud and Mirăslău surroundings, fine sediments are added to sands, sandstones and volcanic tuffs. Tuffs' presence may be a criteria for the identification and correlation of these deposits. The Măhăceni Formation may be equivalent to f Feleac Formation (Filipescu, 1996).

The Lopadea Formation

The Pannonian deposits have a monoclinal position, being croped by the western tributaries of Mureş (eg. Lopadea Valley, Aiud Valley, Gârbova Valley, Teiuş Valley) and include sandy clays, alternating with sands, marls and fossil micaceous clays (7-8m), purple schist clays, massive sandy clays and very micaceous fine gray sands (5-6m).

Fig. 13, 14. Lopadea Formation with Pannonian fan deposits and gravels and coal alternations

4.3. Măhăceni Tableland tectonics

The tectonics of Măhăceni Tableland reflects the active dynamics of the Transylvanian Basin related to the evolution of the Carpathian Orogen, the geotectonic complications being determined by: the carpatic uplift during the late Neogene, the retroarc volcanism and the salt diapirism, which were largely coevolutive (Krézsek, Bally, 2006).

Măhăceni Tableland's expansion within the fold beam at the western border of the Transylvanian Basin, along with the diapirism phenomenon at the contact of the Apuseni Mountains with the Transylvanian Basin, complicates the number and development of the anticlines and sinclines. They appear in the specific literature literature in a quite chaotic description, together with a lack of large-scale cartographic material, drillings, etc., that would allow a correct interpretation and good correlation with morphology. Under these conditions, we have synthesized information from more detailed works on the studied area: Mircea Ilie (1958), 1:200000 geological map – 1967 edition, 1:25000 geological map (Filipescu, 1996), geotectonic profiles (Krézsek, Bally, 2006), seismic profiles (SNGN Romgaz SA, 2009), together with field validations and correlations with the morphology. In this way, we could establish a delimitation as close as possible to the field reality-for the folds' system, which are well expressed in Măhăceni Tableland's morphology.

From west to east 12 folds appear: 6 sinclines and 5 anticlines, plus Viişoara-Hădăreni outer anticline (Fig. 3). The lack of large-scale cartographic materials (for the study area, there is only the 1:200000 scale geological map, 1967 edition) and of drillings in the area, required the consideration of seismic profiles with high accuracy.

Such a seismic profile on a west to east section, crosses the entire width of Măhăceni Tableland, between Podeni depresion and Arieş Valley, on a distance of 26 km, realized by SNGN Romgaz SA, Targu Mures (Fig. 19).

This profile highlights the presence of normal folds and those affected by diapirism, defines the two folded sectors, through the tectonic-morphological corridor of Unirea valley, defines levels of Sarmatian tuffs – with a role of stratigraphic markers and highlights very clearly the strong influence of the pre-badenian, badenian and post-badenian crevices system on Măhăceni Tablelend's geomorphology.

All these geotectonic components are reflected in the studied area geomorphosystem and the information provided by this profile has been validated in the field, in particular by identifying levels of Sarmatian tuffs: Hadareni Tuff (in the Calarasi anticline) and the Ghiriş Tuff (in the erosional basins of Măcicăşii and Lenceş and in Măhăceni-Stejeris anticline).

4.3.1. Salt tectonics

The problem of the diapire manifestation, brings about some more complications and querries along the evolution and geotectonic composition of the area. The large scale salt migration, along with the manifestation of the Eastern Carpathian's volcanism and the Apuseni uplift, together with the tilting of the Transilvanian Basin on a south-south-west direction, represents an important tectonic and stratigraphic marker for Mahaceni Tableland. For this reason we synthesize some aspects of new works on the field (Sanders, et., al, 2002, Krézsek şi Filipescu, 2005, Krézsek şi Bally, 2006, Rasser et., al., 2008) where fision tracking and 3D lythospheric modelling were used.

The mid continental collision in the Eastern Carpathians led to the uplift of the Transilvanian Basin's margins. This uplift, together with the differential uplift of the orogen and the high heat flow induced by the miocene-pliocene retroarc volcanism of the Eastern Carpathians and together with the overload of the volcanic rocks, triggered the miocen-pliocene sliding of the post-salt structures. The late deformations of the Transylvanian Basin (the western part) are associated with the rising and the basement thrusting of the Apuseni Mountains (upper Pliocene-Quaternary). These were coevolutive with the latest phase of gravitational gliding of the post-salt strucutres(Krézsek, Bally, 2006). The south-westward tilting of the Transylvanian Bbasin, was induced by the rising of the North-Eastern Carpathians, as the radiometric and 3D lythospheric modelling results show. The westward salt sliding towards the western border of the Transylvanian Basin, stopped along with the risings of the Apuseni Mountains (upper Pliocene-Quaternary), thus, diapirism has a lower influence than in the eastern part.

By means of correlation with geolythology, Măhăceni Tableland's morphology and field validations, we identified 2 diapire anticlines, westward from Unirea valley: Ocna Mures-Turda anticline and Calarasi anticline (Fig. 19, 20). Those are directed un the last 2 diapire folds with salt core, belonging to the the western Transylvanian border beam.

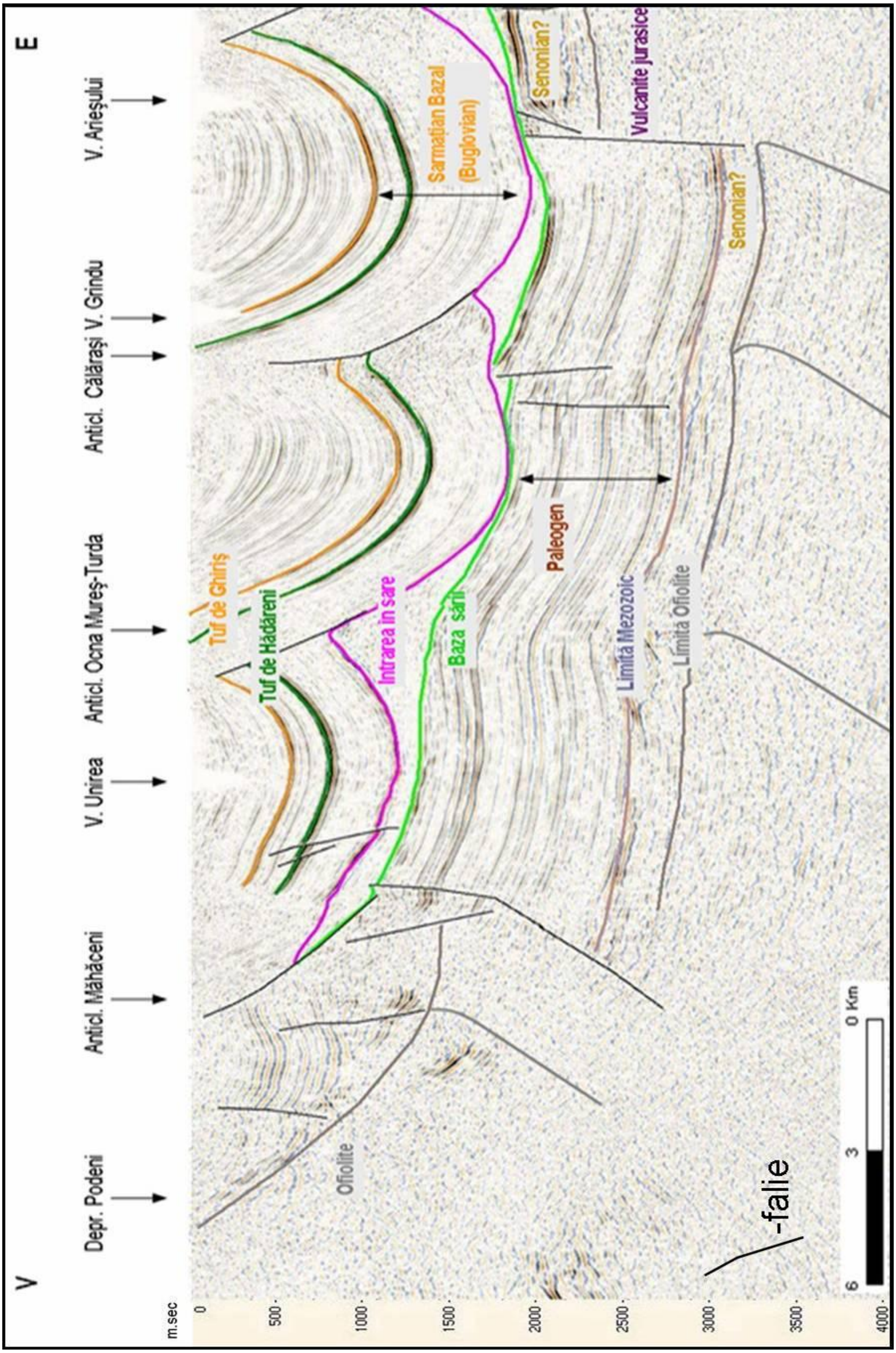

Fig. 19. Seismic West-East profile **between** Podeni and Arieş Valley
(addapted from după SNGN Romgaz S.A., 2009)

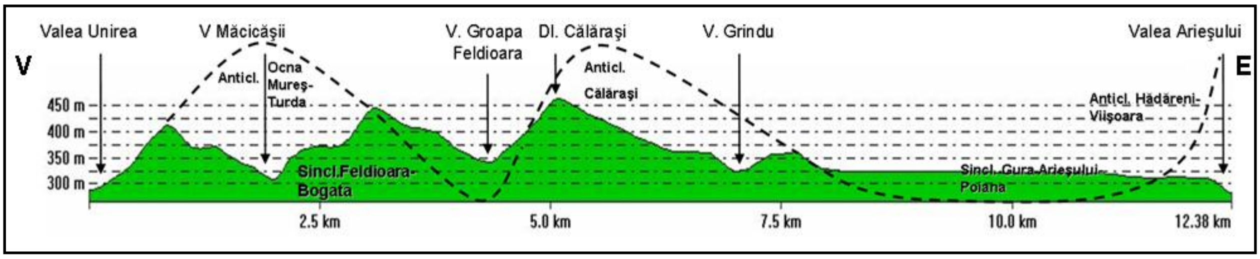

Fig. 20. Exagerated geomorphic profile in correlation with structure between Unirea Valley and Arieş Valley

The influence of the diapirism reflects itself throughout Măhăceni Tableland's endogeomorphosystem with the following characteristics: eastward deviastion of the anticlines' axis, the folding and uplifting of the post-salt deposits, changing the orientation of Calarasi and Ocna Mures-Turda anticlines, which get a north-west – south-east, in comparison to the north-east – south-west orientation of the rest of the folds, given by the Apuseni uplift.

In conclusion, Mahaceni Tableland geotectonics strongly reflects itself in the morphological system, through the following:

- the sedimentary Miocene register lies in almost parallel stripes, Badenian, Pannonian and Sarmatian formations;
- the stratigraphy of Mahaceni Tableland belongs to the 3 formations: mahaceni Formation, Pietroasa Formation, Lopadea Formation and comprises weak deposits which have developded strong erosion;
- the morphological structure of Mahaceni Tableland supports both: the miocene-pliocene uplifts of the Apuseni uplifts and the diapire ones;
- the limit for the western penetration of diapire folds with salt out crops is given by the tectonic-morphologic corridor of Unirea valley, which follows a base Badenian fault, thus separating normal folds on the west and diapire folds on the east;
- the diapire influence is revealed in the landform structure by the Ocna Mures-Turda and Calarasi anticlines;
- the Apuseni uplifts are to be revealed by the normal anticline folds westward from Unirea valley: Ciugud-Mahaceni-Badeni anticline, the Miraslau-Ciugudu de Sus-Dealul Plaiesti anticline, the Aiud-Miraslau-Miraslau valley anticline;
- the westward benting of the anticlines' axis colud explain the Miocene-Pliocene salt migration on east-west direction;
- the presence of the fault system has got a great influence upon the morphological and structural system of Mahaceni Tableland;
- seismic profiles have shown the presence of the Hadareni and Ghiris tuffs as stratigraphic markers within Asarmatian deposits;
- data offered by seismic profiles, along with the existing cartographic support, have facilitated a good correlation with Mahaceni Tableland morphology.

5. Măhăceni Tableland landform

5.1. Morphological and morphometrical characterization
5.1.1. Morphology

The Măhăceni Tableland landform system, delievers the main morpho-structural and geo-lihological subunits, from west to east, in the form of strips showing a simmetry of arrangement relatively parallel to the Trascau Mountain's alignment and to the Aries River and Mures River on the outside. Three main morphological and structural sectors are revealed from west to east: the bordering sector, which performs the morpho-structural, tectotnic and petrographic contact with Trascău Mountains, the h propper hilly sector with folded landform and smooth erozional surfaces (intensly eroded towards saddled structures) and the extern passing sector towards the Arieş and Mureş rivers, represented by glacises and mostly by the wide terraces, belonging to Arieş and Mureş rivers (Annex 1). Four erosional surfaces are overlain: the high contact level (650m), the piedmontan level (550m), the mid interfluvial level (450m), the low hilly level (360-400m) and moreover, the terrace and alluvial plain sectors belonging to Arieş and Mureş (200-300m).

The slopes show active duynamics, the most widely extinction being proper to the complex modelling slopes, where, the dominant processes are mass wasting (especially landslides), gully erosion and sheet erosion (Annex 1). Glacises occupy vast sectors at the external part of the studie area, marking the passing towards terrace or flood plain levels. Terraces highlight the evolution of Măhăceni Tableland, as long as the perfection of the hydrographic net took place, since the Pleistocene up to the Actual. The actual landform preserves a terrace level of 25-30m (rel. alt.) belonging to Arieş, well expressed by its platform which is continuous on a 72 km distance (Annex 1)

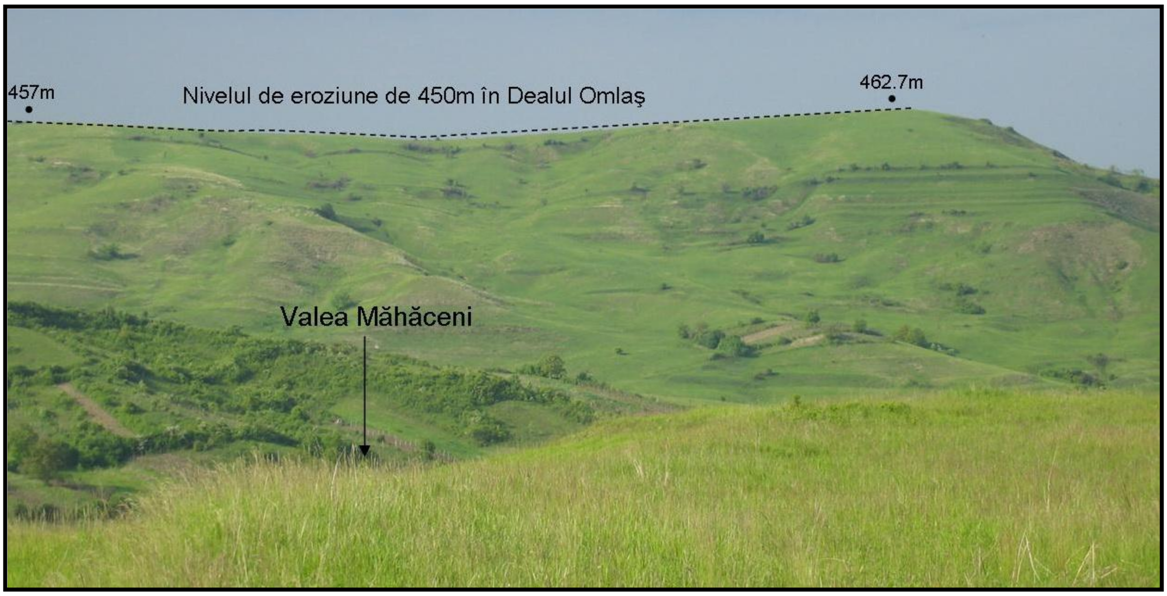

Fig. 24. The 450m erosional level east from Măhăceni village

5.1.2. Morphometry

5.1.2.1. Fragmentation depth

Fragmentation depth has a strong relation to the valley generations, the intensity of tectonic uplift, lithology, and the hydro-climatic conditions, gradually differentiated on field. The highest values (200-260m/km²) occupy small areas and stay close to 1% (0.95%) of the total study area. The widest surfaces (except for the terrace and flood plain sector) belong to 100-150m/km² interval totalizing 33.18%.

Table 7. Relief energy weighted classes

Adâncime fragmentare	**Arie (km²)**	**Pondere (%)**
0-50 m\km²	142,21	33,72
50-100 m\km²	98,44	23,34
100-150 m\km²	139,93	33,18
150-200 m\km²	37,21	8,82
200-260 m\km²	4,00	0,95

5.1.2.2. Fragmentation density

Throughout the whole studied area, high values of fragmentation density are to be found on an area of over 20 km², which corresponds to the small stripe of the high territory on the contact area with the mountain. The widest sector (over 340km²), is represented by low values of fragmentation density, which is particular to the terrace and alluvial plain sectors of Arieş and Mureş rivers, to the glacises, cuesta reverses and low gradient surfaces.

Table 8. Fragmentation density weighted classes

Densitate fragmentare	**Arie (km²)**	**Pondere (%)**
<1 km/kmp	233,26	55,30
1-2km/kmp	116,57	27,64
2-3km/kmp	50	11,85
3-4km/kmp	18,97	4,50
>4 km/kmp	3	0,71

5.1.2.3. Slope gradient

Most of the slopes (40.58%) belong to the interval of 6-17º (Fig. 27), which is a favorizing factor in the development of actual landform processes, especially landslides and gully erosion.

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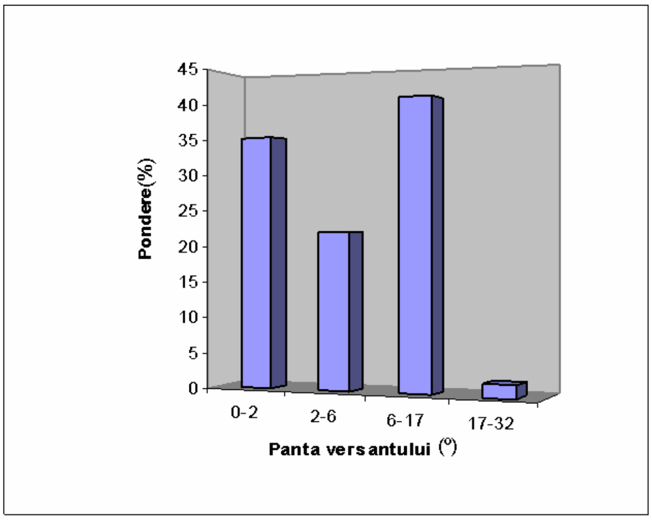

Fig. 27. Slope gradient weighted classes

5.1.2.4. Slope aspect

Out of the total area, there is a predominance of north-east slopes (19.26%) and east slopes (16.06%), followed by southeastern (14.84%) and northern ones (13.24%). For the south, south-west, west and north-west aspects, surfaces stay under 11%, with a quite same range (Fig. 29).

Expoziţie	Arie (km²)	Pondere(%)
N	55,84	13,24
NE	81,23	19,26
E	67,74	16,06
SE	62,57	14,84
S	46,04	10,92
SV	46,19	10,95
V	30,20	7,16
NV	31,99	7,58

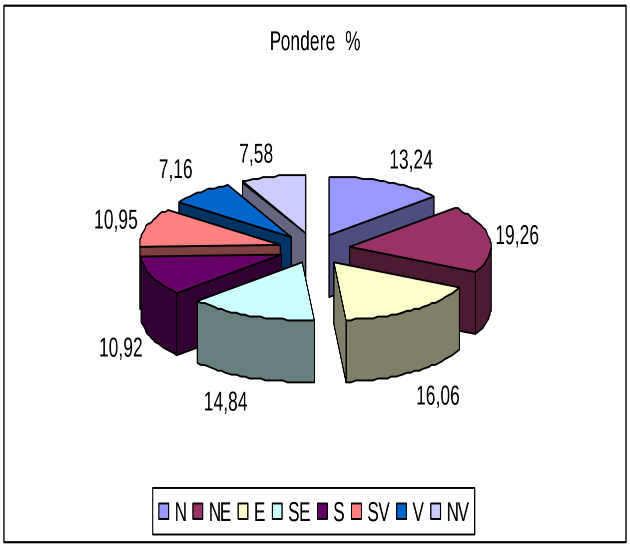

Fig. 29. Slope aspect weighted classes

5.1.2.5. Geomorphic profiles

The morpho-tectonic evolution of Măhăceni Tableland at the Trascău margin, reflects the Miocene-Pliocene changes from the western border of the Transylvanian Basin. This area has been intensively modelled through exogenetic agents and folding and upplift movements. Figure 31 shows a transversal crossing section on a WSW-ENE direction, which covers the entire width of Măhăceni Tableland, between the contactsector and Arieş Valley.

The western morphological contact sector, is formed by the Văleni corridor (with a small defile sector at the discharge towards Arieş), the contact depressions, such as Podeni depression and the high hills belonging to the erosional level of 650m (Dumbrava Hill- 662m).

The next sector is the proper piedmont area, which corresponds to the 550m erosion level (Feţii Peak- 543m) and is kept within the actual landform, through a continuous stripe on the whole length of Măhăceni Tableland, at the contact with tha high hills from the Trascău contact margin.

The actual hilly tableland sector of Măhăceni, belongs to the 450m erosional level (Omlaş Hill- 473,1m), which is the most fragmented, whith sheet erosion, mass movements and gully erosion. This level continues to the 360-400m erosion level, also very fragmented, with smoothing surfaces reduced to ridges.

Eastwards from Unirea valley, thgere is a dominant diapire influence, with the presence of the 2 folds with salt out crops: the Ocna Mureş – Turda anticline and the Călăraşi anticline.

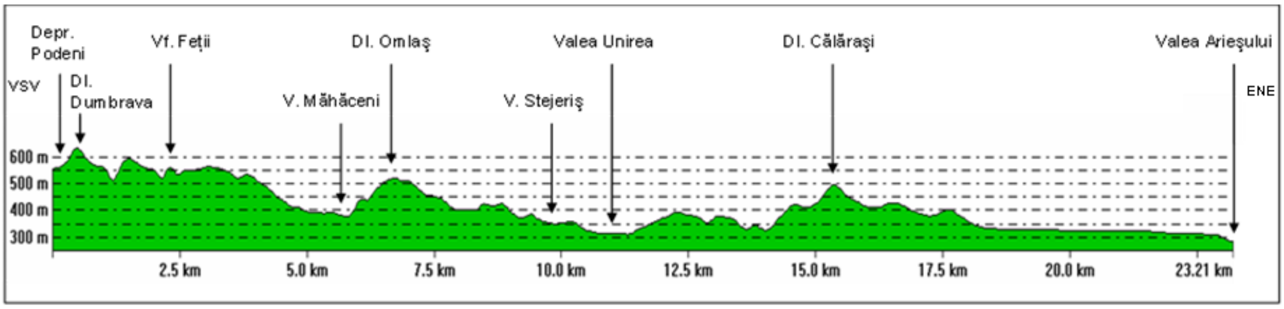

Fig. 31. Geomorphic profile WSW-ENE between Podeni depression and Arieş valley

5.2. Genetic type of landform

5.2.1. Structural and petrographic landforms

The structural landforms are represented by structural surfaces, which have oly been preserved on small areas on the present landform, due to intense erosion, structural steps, cuesta, contact depressions, the folded net. Small structural surfaces are still to be found on Badenian limestone (Pietroasa, Podeni) or supported by Sarmatian tuffs (eg. On the line of Ciugud - Bădeni – Măhăceni anticline). Cuesta are found mostly on the right slopes of Văleni valley, in Călăraşi anticline, sinking areas with defile aspect are to be found within the upper sector of Văleni valley. The contact depressions mark the contact sector with the mountain (Pietroasa, Podeni, Rachiş) and the folded net is strongly reflected within the morphology by 11 folds, out of which, 2 are diapire anticlines: Ocna Mureş – Turda and Călăraşi.

The petrographic landforms

The Mesosoic magmatites (basalts and diabases) show up on a narrow section at the exit of Valeni Valley towards Moldoveneşti village, marking the limit between Trascău Mountains and Măhăceni Tableland. Badenian limestones lie on a narrow strip at the boundary of Măhăceni Tableland with Trascău Mountains, marking the marine transgression, and are revealed in relief by structural surfaces or plates, structural steps, which can be found at east and south of Pietroasa and south of Lopadea Veche. Sandstones, sandy marls and Sarmatian sands have been heavily eroded by the primary hydrographic network and its tributaries, thus forming secondary basins (Meghieşi, Dumbrava, Lenceş, Măcicăşii, Feldioara, Grindu). Sarmatian volcanic tuffs (Ghiriş Tuff and Hădăreni Tuff) support erosional surfaces belonging to the 450m level, which have been preserved as narrow sections on the alignment of the Ciugud - Bădeni – Măhăceni anticline, and eastwrds from Unirii Valley, on the Ocna Mureş - Turda and Călăraşi anticline. The Pannonian deposits, predominantly crumbling rocks (sands, marl clays, gravels), carry out a relief marked by erosion and fragmentation, where the valleys have rapidly widened, perpendicular to the anticline`s axis, thus creating depression basins.

5.2.2. Sculptural landforms

5.2.2.1. Denudational landforms

Water as the main modelling agent, is acting on the slopes both by unorganized drainage (rill wash, sheet erosion, etc.) and by organized drainage (linear erosion, gully erosion). The denudational relief in Măhăceni Tableland is very is very well represented by all the specific forms: ruts, gutters, gullies and torrents, under a brittle lithology and a low vegetating coverage, thus showing a powerful contemporary gully dynamics.

Gullies are most predominant and they are centered mostly in the 300-500m elevation stage and the 6-17˚ slope range. They are in various evolution phases: from the early-intermediary one (east of the Unirea Valley - e.g. Măcicăşii, Lenceş basins), to the advanced and torrential one (west of Unirii Valley - e.g. Măhăceni, Ciugud, Mirăslău, Aiud basins).

In the studied area, 144 gullies were identified, and they show different different shapes (linear, dendritic, compound, continuous and discontinuous), affecting natural terrain on a total area of 350.46-hectares, representing 0.83% of the total studied area. In the gullies’ study, 5 catchments were considered were gullies have a great frequency: Dumbrava, Măcicăşii, Stejeriş, Mirăslău and Aiudului.

Here measurements were made for 43 gullies regarding the main morphometric elements for those in the early stages and the advancement rate for the developed ones. The gullies in these basins totalize an area of 1120658,82m², a cumulated length of 19170,66m and an average length of 445,83m. Most of them are long gullies (300m-1000m length) - 24 gullies, then the short ones (under 300m) - 17 gullies and two very long gullies (over 1000m).

Table 9. Morphometric elements of gullies from Măcicăşii catchments

	Nr. ravenă	Lungime (m)	Lăţime (m)	Perimetru (m)	Suprafaţă (m²)	Adâncime (m)	Pantă (º)	Expoziţie
Bazinul Măcicăşii	1	1284.02	44.60	2786.04	23480.63	3	2-6	S
	2	297.6	13.93	853.14	3506.79	2	6-17	SV
	3	243.82	10.23	502.78	1610.32	1.5	6-17	S
	4	169.51	12.60	393.79	1672	1.9	6-17	SV
	5	159.86	13.07	352.03	1458.78	2.3	6-17	SV
	6	497.87	27.96	1203.16	7220.22	2	6-17	V
	7	120.'06	9.95	249.40	942.56	1.2	6-17	SE
	8	664.25	32.30	1365.61	12701.45	4.1	6-17	N
	9	242.98	14.47	508.45	2304.82	1.8	6-17	NE
	10	329.09	15.85	765.14	5262.40	1.5	6-17	NE
	11	346.22	39	938.21	7905.10	6	6-17	V
	12	274.72	16	577.09	3650	2.7	6-17	V
	13	182.55	20.96	407.59	2985	2	6-17	SV
	14	114.96	14.7	251.24	1603.38	2	6-17	SV
	15	176.40	82.43	509.52	9300.03	22	6-17	S
	16	123,88	6,7	311.79	725.51	1,7	6-17	SE
	17	451.37	35.93	927.52	6451.18	3.3	6-17	N

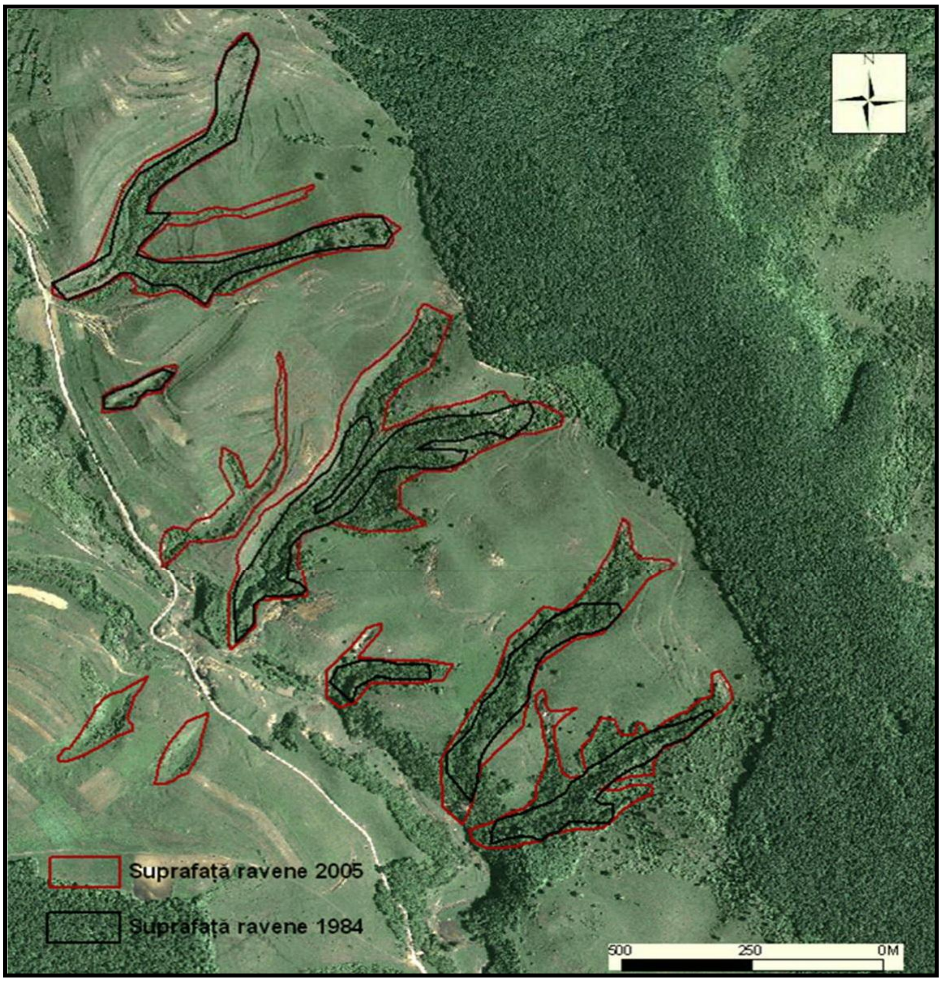

Fig. 41. Advancement rate for the gullies in Mirăslău catchments

5.2.2.2. Fluviatile landform

Fluviatrile landform is very poorly represented in Măhăceni Tableland, the rivers having a very low capacity (many being seasonal) and morphometric characteristics which include them in the creek category. The hydrographic network evolution in Măhăceni area is quite complex, being determined by both: the structure and the paleogeomorphological evolution in the region, which presented, in addition to lifting and folding, a slight subsident southern tilt of the Transylvanian basin. The Arieş tributary hydrographic initial network, which flowed on a west-east direction, then has then changed its direction towards south, adapting to the lower base level of Mureş.

The hydrographic network of Măhăceni Tableland was described in terms of 15 hydrographic basins, which belong to the two great collectors: Arieş and Mureş rivers. Most watercourses in the studied area have low debit and some semi-permanent nature.

Tabel 12. Morphometric elements of the streams in Măhăceni Tableland

Râu	F bazin (km²)	L (km)	i (‰)	H med (m)	Q mediu (m³/s)
Plăieşti	17,29	11	23	460	0,070
Bădeni	13,54	9	17	450	0,033
Unirea	130,78	15	12	392	0,324
Stejeriş	11,88	7	30	425	0,026
Măhăceni	18,25	10	32	445	0,044
Grind	37,53	18	8	349	0,083
Groapa Feldioara	14,95	8	18	366	0,021
Ciugud	35,30	15	22	420	0,075
Mirăslău	15,55	8	29	411	0,031
Lopadea	16,32	8	42	405	0,037

Source: (A.N.A.R., 2009)

Regarding the river network ranking in the Horton-Strahler system, three 4-order basins were defined (Unirea, Măhăceni, Mirăslău), 10 3-order basins (Plăieşti, Grindu, Stejeriş, Groapa Feldioara, Măcicăşii, Dumbrava, Ciugud, Ormeniş, Lopadea, Meghieşi) and two 2-order basins (Bădeni and Lenceş). Regarding the basin shape factor, the shape ratio was calculated using the formula $Rf = F/(P/4)^2$ (Zăvoianu, 1978). All of the hydrographic basins of Măhăceni Plateau fall into the category of elongated ones. The only basins that come close to the rounded shape, are Meghieşi and Măcicăşii basins (Table 13).

Table 13. The shape factor for the hydrographic basins in Măhăceni Tableland

Bazin hidrografic	Suprafață (m^2)	Perimetru (m)	Raport de formă
Bădeni	13541300	20113,50	0,54
Plăieşti	17289300	25062,20	0,44
Unirea	130780000	57055,04	0,64
Grind	37530000	28460,59	0,74
Lenceş	8964100	13093,00	0,84
Stejeriş	11878200	16623,20	0,69
Groapa Feldioara	14953900	20008,20	0,60
Măcicăşii	5164910	9477,87	0,92
Măhăceni	18253300	24021,90	0,51
Dumbrava	6440320	11092,60	0,84
Ciugud	35295000	32745,40	0,53
Meghieşi	3973240	8095,68	0,97
Mirăslău	15545900	19790,40	0,64
Ormeniş	12373300	15980,40	0,78
Lopadea	16321700	19186,50	0,71

6. Actual landform dynamics in Măhăceni Tableland

Actual landform processes reveal a dynamics which is very well expressed within the morphogenetic system, with favourable premises of initiation and development from both sides: the natural factors and the anthropic ones. Those processes have interrelations and interconnect within the landform modelling system, with a certain degree of agressivity for some specific areas.

6.1. Contemporary landform processes

The concept "contemporary landform processes" follows the approaches to intensify the studies on quantitative and experimental geomorphology (Maria Rădoane, Rădoane. N. 2007), referring to the period of the last centuries within human experience, where the volume of observations on natural phenomena has increased and improved.

6.2. Actual landform dynamics- a component of regional geomorphology

The studfy of actual landform processes in Măhăceni Tableland has got 2 major features: functionality and reliability. Functionality folowed: the dominant processes (e.g. landslides, gullying) process-based morphodinamics and their inner relations, referring to the way in which they condition themselves within their show-up and their evolution (agressivity relations of morphodynamic factors, process-based relations and systemic relations). Reliability has followed> the aplicability of the model within the ralationship: natural system-anthropic system, following the actual tendences of territorial monitoring, short and mid term prediction and geomorphic risks induced by actual landform processes within the context of sustainable development. Regional geomorphology studies rely on contemporary territorial planning approaches, through predictive actions, in order to reduce the negative effects of actual landform processes, which act more and more agressively, in the context of anthropic intervention and global climatic change.

6.3. Premises for the initiation and evolution of actual landform processes

6.3.1. The geo-lithological factor

The geolitologic and paleoevolution factor has got premises for the contemporary development of those processes, with a great implication along their character and specicity. The geological factor determines a certain specificity for the study area, not only lithologically speaking, but especially by structure and tectonic. The main features of the studyt area reveal the compications of the folded western Transylvanian border, in whose evolution, three major factors interfear: the evolution of the post Cretaceous Transylvanian Basin in relation to the Panonic basin, Carpathians' uplift and the presence of the salt. This area has been intensively eroded by exogenetic and endogenetic agents, by uplift and folded movements, thus reflecting the Miocene-Pliocene changes at the western border of Transylvanian Depression.

6.3.2. The climatic factor

For Măhăceni Tableland, the climatic factor imposes itself especially on actual degradation processes, especially landslides and gully erosion, through both: thermic regime and precipitations.

Temperature brings about important influence upon aactual landform processes, as a factor that enables their dynamics. Analizing observation data from the main metheorological ststion for the study area (Turda Station) on a period since 1971 to 2001, reveals a mean annual temperature of 8,86ºC, with a falling tendency towards the mountain area. The mean annual amplitude for Turda ststion is 24,2ºC.

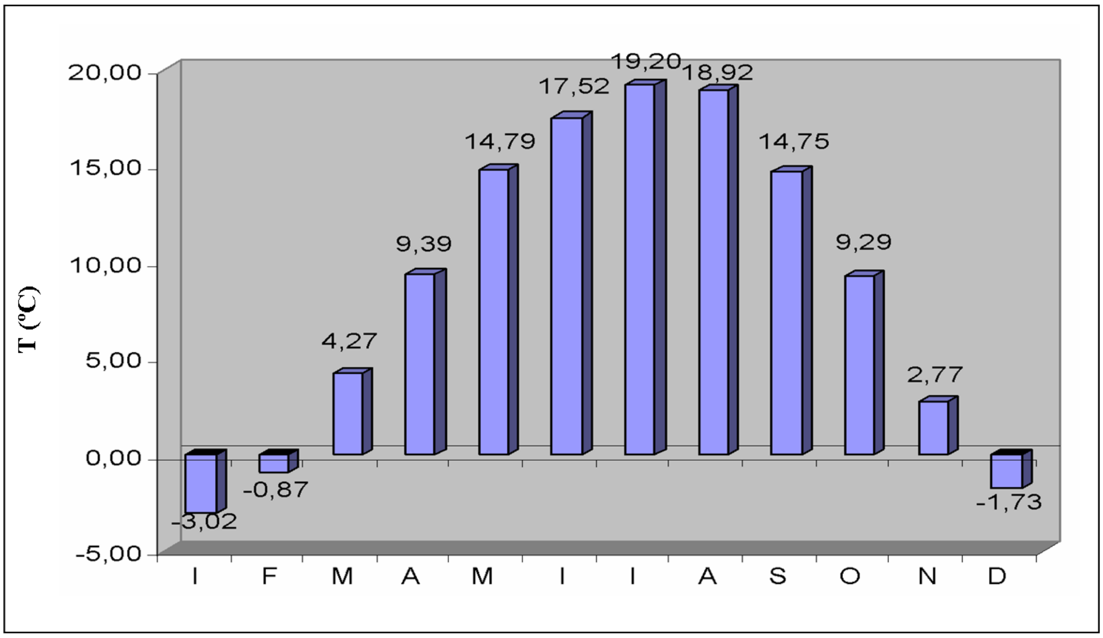

Fig.51. Mean monthly multiannual temperature values at Turda Station (1971-2001)

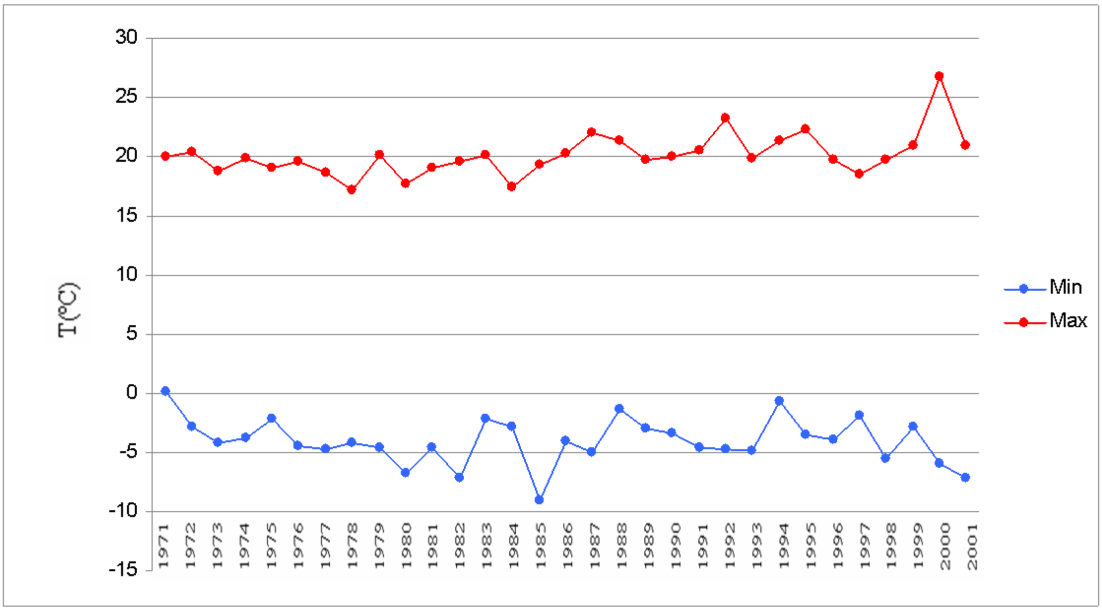

Fig. 52. Maximum and minimum annual temperature values for Turda Station (1971-2001)

The precipitation factor reflects itself within the contemporary slope morphodynamics in Măhăceni Tableland, especially by the multiannual regime but also by the seasonal one. This factor expresses itself throughout actual landform dynamics, by two ways: the cyclical caracter and the oscillatory values (Fig. 53-55).

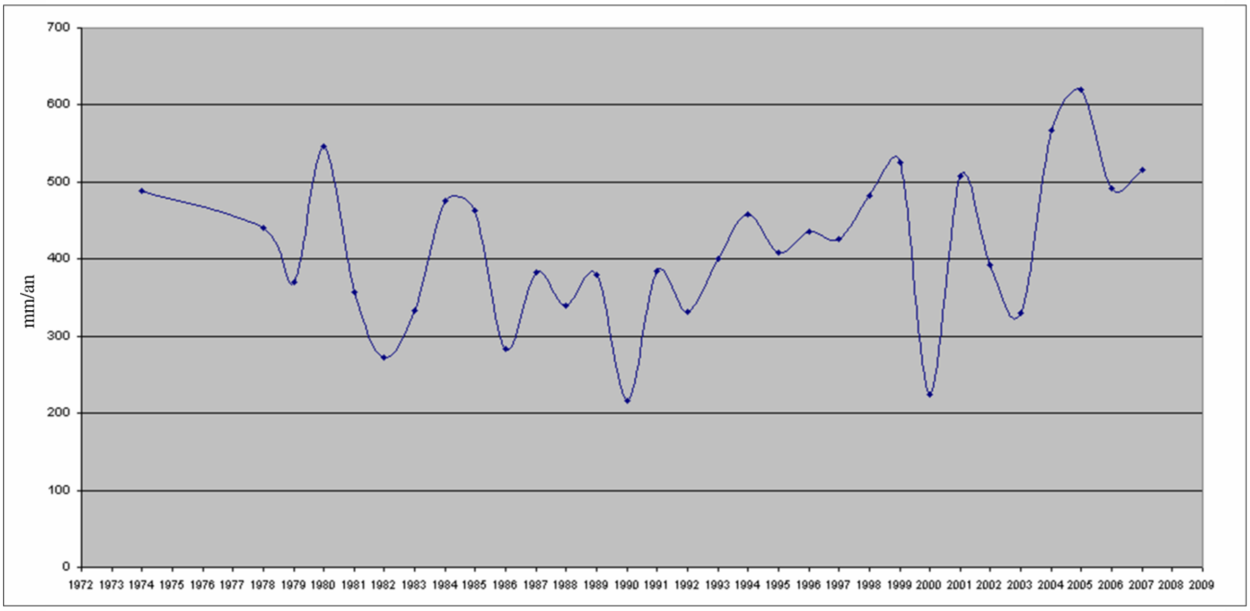

Fig. 53. Măhăceni Tableland- multiannual mean precipitation values in the interval: 1974-2007 (Turda Station)

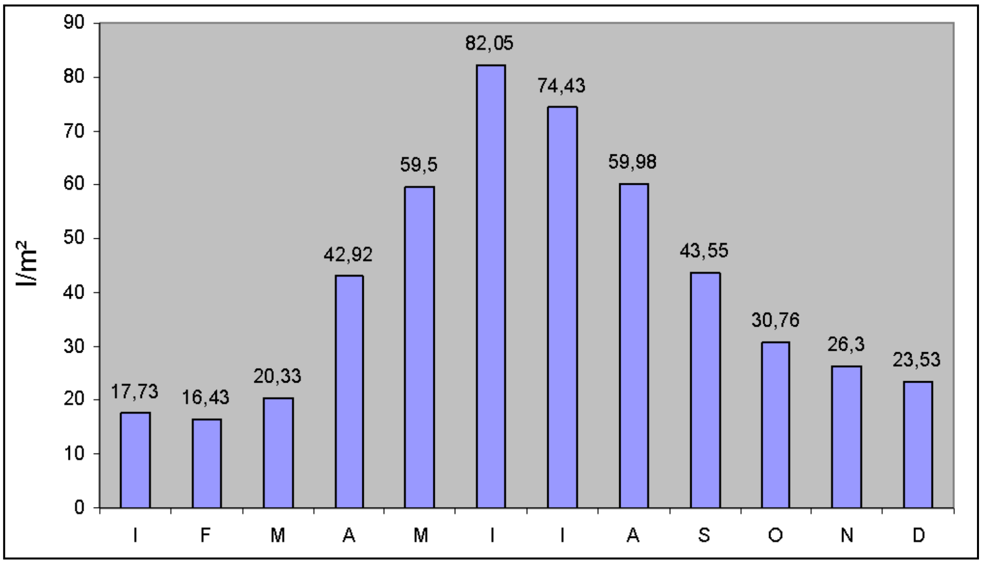

Fig. 56. Multiannual monthly mean precipitation values at Turda Station (1974-2007)

6.3.3. The Hydrological factor

The Hydrological factors act by mmeans of their hydrodynamic forces, thus becoming causal factors in the triggering and maintainance of actual slope and channel processes. Water as a modeling agent sets uot as a major element within the dynamics of the running processes, especially in the slope-channel area, with a multiple role: modeling, coordinating and triggering (in case of landslides). The modeling act has a complex character and shows specific forms: sheet flood, gully erosion, fluviatile processes, in an interaction with anthropic action.

6.3.4. The soil and vegetation factor

The characteristic soils of Măhăceni area are representative for much of the Transylvanian Plain, which owse much of its actual features, due to human intervention. As a result, in this region where the forest and forest steppe soils should be predominant, we face the bit forming of forest steppe-steppe soil, which are normally found in our country, at lower latitudes and alttitudes. The dominant soil group for the study area isrepresented by black earth soils (Fig.59.). They associate with alluvial soils and cambisoils. Natural vegetation is currently represented only by degradated pastures on the western and southern slopes, mainly consisting of xerophyte associations and in the lower part of the slopes, one can find wet grasslands made of hygrophilic associations.

6.3.5. The anthropic factor

The anthropic intervention has had a complex setting with different degrees of intensity, in general depending on the economic interest, but the long-term effect has been felt within both: the structure and the dynamics of actual landform processes. In Măhăceni Tableland one can see unadequate landuse, together with some other anthropicactions that facilitate the development of actual landform modelling processes: cart roads, sand, clay and gravel exploitation, military activities, and activities related to waste production and neutralization.

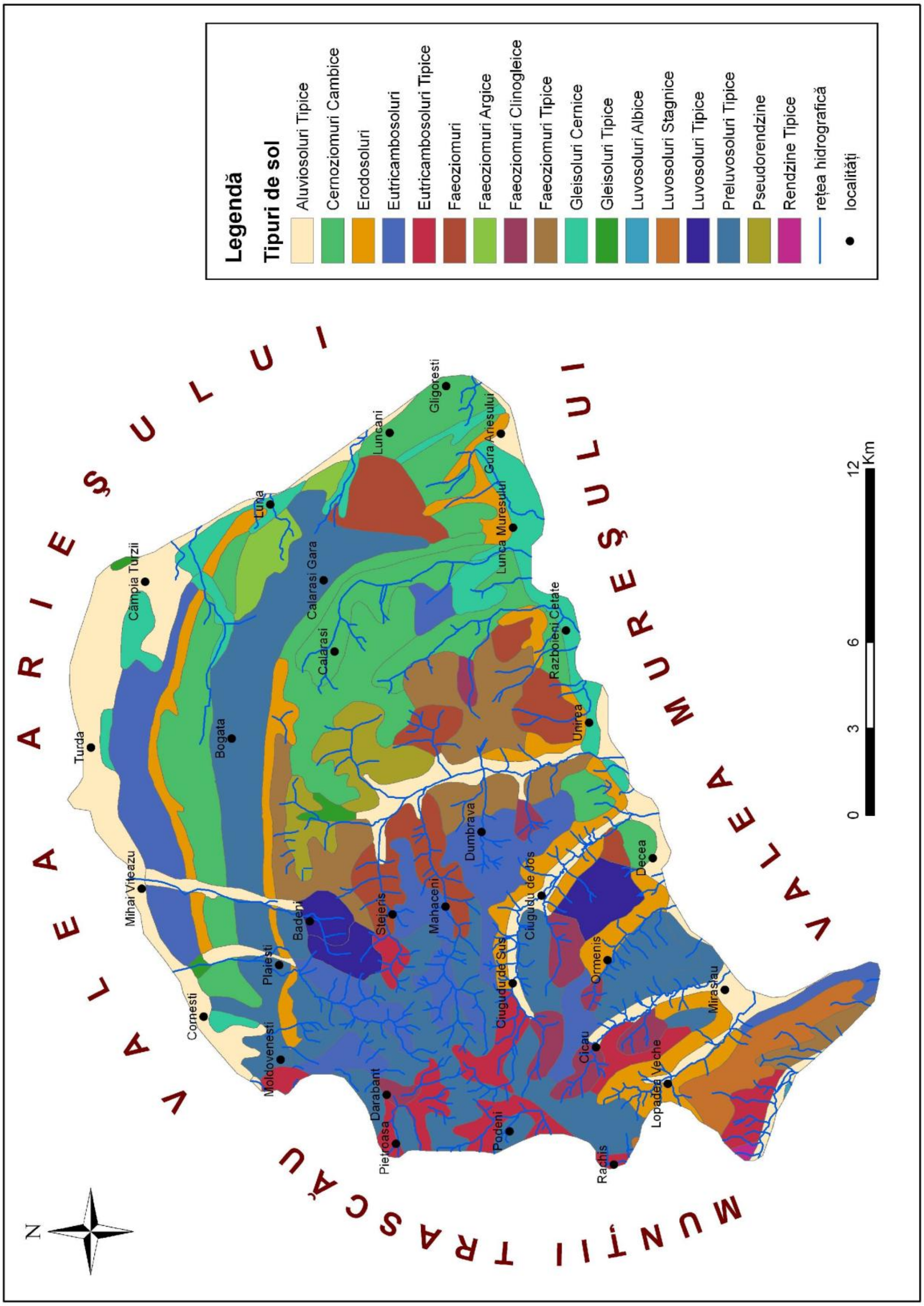

Fig. 59. Măhăceni Tableland – Soil Map

6.4. Relations between actual landform processes

Modelling processes are active and they function on systemic relations of the type: process-form with feed-back circuits with a regressive and progressive character. The main feature of the actual landform proceses' dynamics in Măhăceni Tableland is the widely course of those processes within the territory (especially slope degradation processes) and the lesser dominance of a certain process within the morphological systems and sub-systems, but the *interrelationing and self-conditioning of the modelling processes*, which in fact, enables their function and evolution. For a good exemplification, we considered three catchments which are representative for the contemporary landform dynamics of the study area.

In *Măcicăşii* catchment there is a strong relation and association for actual modelling processes. Here one can find a new generation of gully erosion products, which have been advancing on the delluvial deposits of stabilized landslides, which were deposited at the lower part of the slopes and they advance regressively towards the upper part of the slopes. There are also cases when gullies have been installed within landslides and they advance regressively towards the erosion level of 450m. (Fig. 79).

Fig. 79. Măcicăşii catchment-relations betwen actual landform modelling processes (landslides and gully processes)

6.5. Mass movements

6.5.3. Landslide dynamics in Măhăceni Tableland

In Măhăceni Tableland, landslides have a great spread-out (Fig. 81). A number of 324 active and stabilized/partial stabilized landslides were identified, for a total surface of 3,33 km², out of which, most are stabilized/partial stabilized landslides (89%), and 11% are active landslides, covering a total surface of 0,37km².

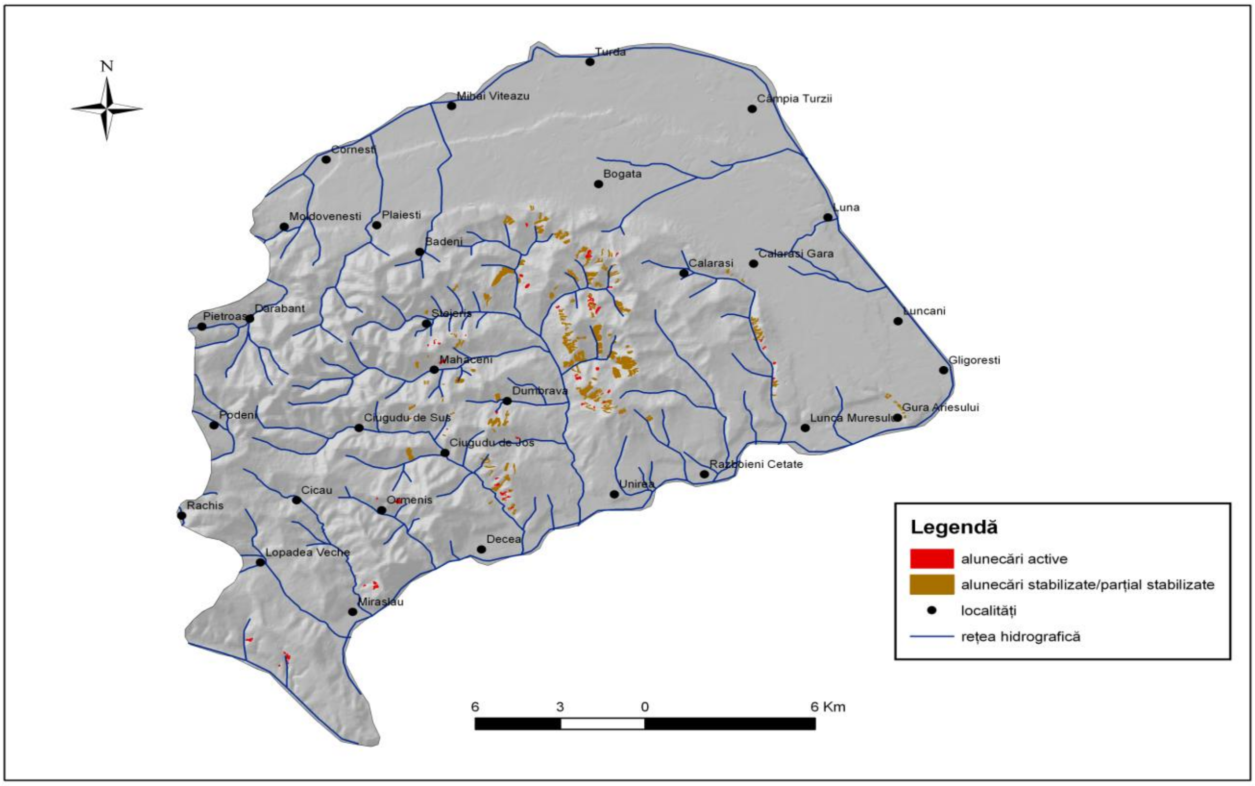

Fig. 81. Măhăceni Tableland – Landslide distribution map

In the present paper, the measurements on landslide morphometric elemnts, follow the nomenclature proposed by IAEG (International Association on Engineering Geology) in 1990 (Bulletin no. 41). This contains terms referring to the main components which can be identified on field: scarp, main body, foot, toe (Fig. 82). For revealing the morphometric features of the landslides, 9 catchments were considered, where landslides are predominant: (Aiud, Măcicăşii, Stejeriş, Măhăceni, Dumbrava, Ormeniş, Ciugud, Lenceş, Unirea), here measurements were made for 37 active landslides concerning the main morphometric elements: (S)-surface, (Hm)-height, (Hc)-scarp height, (Ld)-main body length, (Lr)-rupture surface length, (Wr)-rupture surface width, (Wd)-main body width.

For the stabilized/partial stabilized landslides, due to specific deformations which came out until the present, we weren't able to identify all morphometric elements, thus partial mesurements were made, for 16 landslides, for maximum length, surface and main body width.

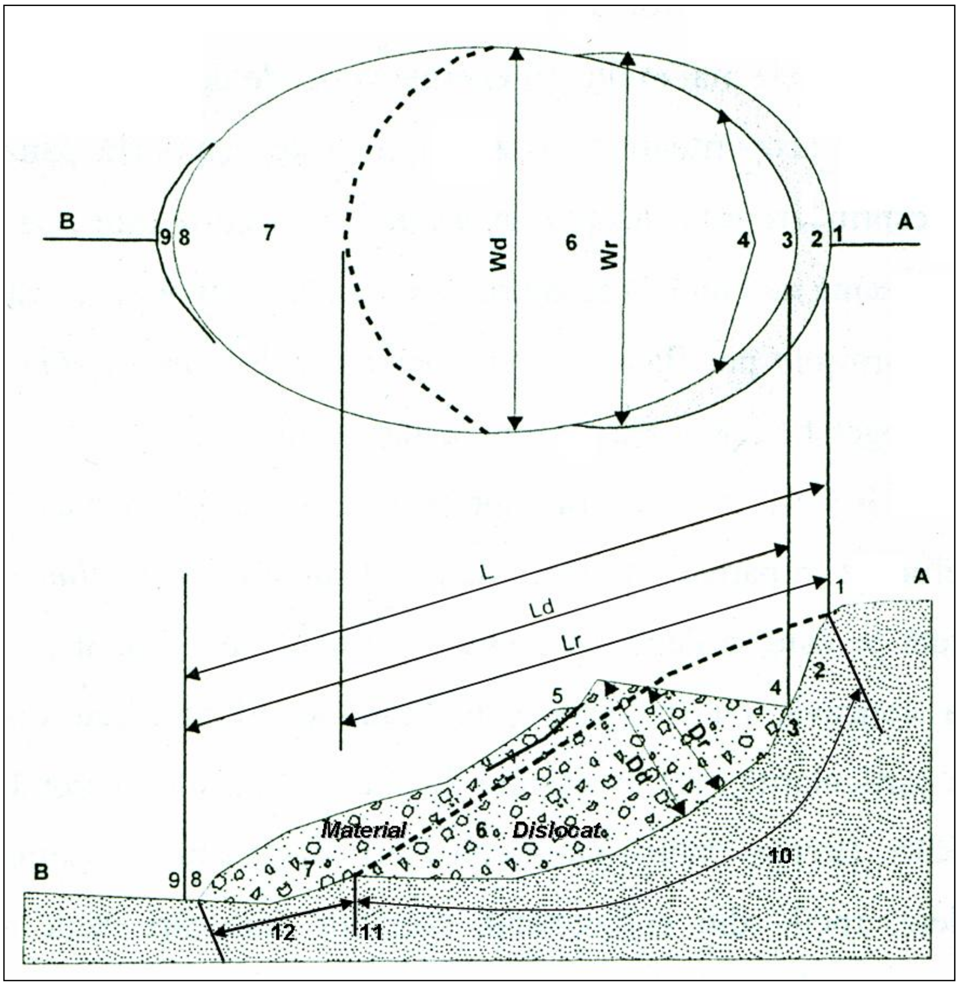

Fig. 82. Landslide nomenclature proposed by IAEG (1990)

Wd - main body width; Wr - rupture surface width; Dr – rupture surface depth; Dd – main body dapth; Lr - rupture surface length; Ld - main body length; 1. crown; 2. main scarp; 3. top; 4. head; 5. minor scarp; 6. main body; 7. foot; 8. tip; 9. toe; 10 surface of rupture; 11. Toe of surface of rupture; 12. Surface of separation.

Table 18. Morphometric elemnts of landslides from Măhăceni catchment

	Nr. Alunecare	Lmax (m)	Hc (m)	Hm (m)	S (m^2)	Ld (m)	Lr (m)	Wr (m)	Wd (m)
Bazinul Măhăceni	1	61,8	3	27	1547,75	38,14	23,36	12,48	22,96
	2	155,78	18	49	7656,86	116,74	66,33	79,64	89,51
	3	316,16	77,82	53	53529,37	228,9	146,19	38,88	252,86
	4	118,99	3	35	4737,86	100,26	32,31	52,26	51,26
	5	40	1,2	12	720,03	29,9	12,09	16,58	23,67
	6	24,27	1,5	10	278,71	17,06	14,36	7,72	16,14

Concerning deep-seated landslides, there is a lack of data in the special literature, for the Măhăceni Tableland area, with suggestions of trhe lack of deep-seated "glimee" type landslides. However, we identified in field, an area with deep-seated landslides, with 39 landslide bodies, covering a surface of 16619,66m², dispersed on a mean distance of 315m from the main scarp. The scarp lies in the erosion level of 360-400m, in La Şezuinţi Hill (424,5m), and the landslide bodies have a north-west – south-east orientation, according to the general aspect of the slope.

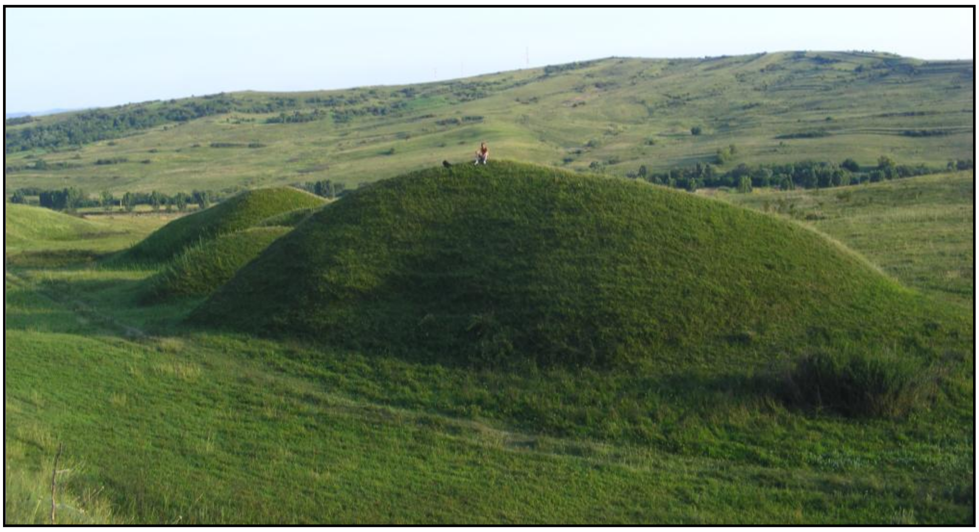

Fig. 84. Deep-seated "glimee" type landslides in La Şezuinţi Hill

Causes for initiation and evolution of the deep-seated landslides from thie area are hart to identify, though, in their dynamic throughout time, we colud consider at least three elements with a major influence: the geolithology (the alternation of crumbling Sarmatian deposits with tuffs- the Ghiriş tuff), slope (2-6º) and the structure (cuesta back side).

6.6. Assessment of degradation processes susceptibility on natural terrain

Within Măhăceni Tableland, actual modelling processes have a stong dynamice and reaslize a close mutual relation, with a higher degradation degree for soome areas. Landslides, gully erosion processes and sheet erosion are the most active processes with the highest damage potential. These conditions lead to a decrease in the production capacity of land and the underrating of soil quality. The assessment for studying the degradation processes susceptibility on natural terrain, has the purpose of identifying areas with terrain subject to degradation due to actual erosion and mass movement processes and the setting of main approach directions within actual slope processes in Măhăceni Tableland.

This sub-chapter offers an analytical model for the evaluation of terrain liability to actual degradation processes, with the purpose of constructing the degradation processes susceptibility map for Măhăceni Tableland.

In general, within the prediction of actual landform modelling processes, it is necessary to consider that their occurence is determined by certain related factors and the future landform produces will occur under the same conditions as the past ones. In determining landslide and gully susceptibility on natural terrain, we used the Frequency Ratio Model (Aykut A. et al., 2007) and for the determination of sheet erosion, the USLE (Universal Soil Loss Equation) model was used, adapted for the ROMSEM variant (Moţoc M, Sevastel M., 2002). Finally, we obtained, after reclasifivation, the susceptibility values for all these three processes cummulated, being able to construct the degradation processes' susceptibility map for Măhăceni Tableland. Using GIS, we calculated the susceptibility values for the class of each factor that has a major influence on landslides and gully erosion, to which we added the values for sheet erosion calculated by USLE. Tha last phase meant the regrouping and wheiting of all values for all three processes, in order to obtain a new superior degradation susceptibility class for natural terrain (Fig. 107).

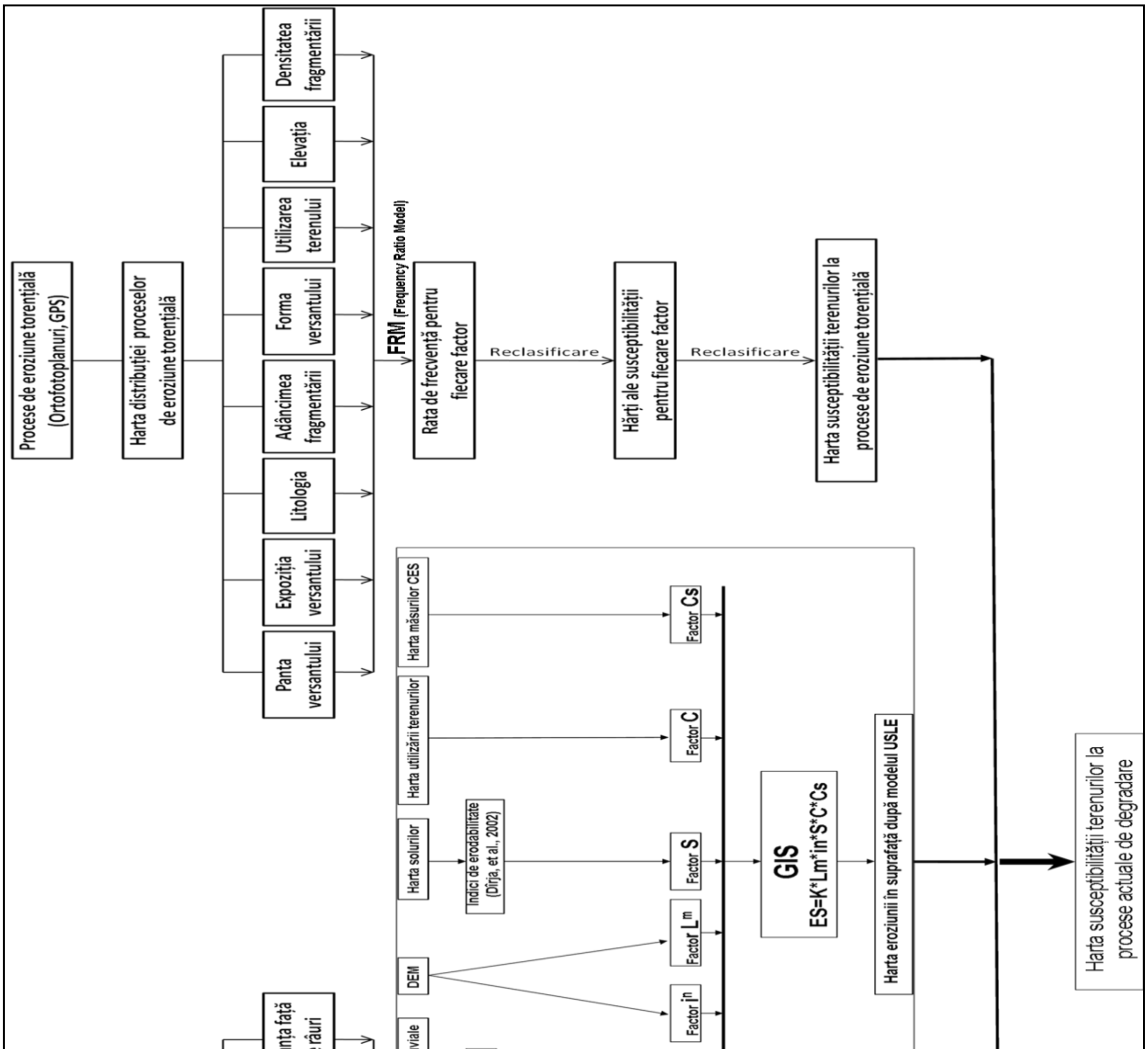

Fig. 107. The methodology used for analizing degradation susceptibility for natural terrain in Măhăceni Tableland

The frequency ratio model relies on the studied relations between the distribution of erosion and landslide produces and every dominant parameter in their distribution, in order to realize the correlation between the location and the parameters that control their appearance in the study area. The frequency of the processes is given by the report of the process'area and the total area, thue a value of 1 is a medium value. If the value is over 1, it means that the percentage of the process is higher than the one of the area and refers to a higher correlation and values under 1 show a lessre correlation. In this study, we considered eight factors in zoning landslides and gully erosion processes: slope gradient, lithology, elevation, slope aspect, land use, distance from drainage, fragmentation depth (fragmentation density for gully erosional processes) and slope curvature.

6.6.1. Landslide susceptibility

For calculating the frequency ratio, we determined the area frequency for each parameter's class which has got an influence in their initiation. Thus, the landslide distribution map (realized with a Magellan Explorist 600 GPS) was overlaid with tematic layers and we calculated an area rate for each parameter's class, as a report to the total area (fig. 93). According to the landslide susceptibility map, 54.3% of the total area shows low and very low susceptibility. The areas with medium and high susceptibility represent 28.2% and 14.9% of the total area. The areas with very high susceptibility stand for 2.5% of the total study area and 17,4% where the landslide susceptibility index had a high value (high and very high susceptibility), could explain 97.03% of the total landslides.

Table 29. The calculation of landslide frequency ratio for the dominant factors in in their initiation and evolution

Litologie	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
nisipuri, argile marnoase, pietrişuri	90386550	21,43	7625	15,08	0,70
pietrişuri, nisipuri	179655875	42,59	4950	9,79	0,23
bazalte	7193725	1,71	0	0,00	0,01
conglomerate, calcare, gipsuri, sare, tufuri, gresii	23824300	5,65	0	0,00	0,01
gresii, marne nisipoase	22179850	5,26	1025	2,03	0,39
marne, marne nisipoase, nisipuri	98546775	23,36	36975	73,11	3,13
Pantă	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
0-2°	149560800	35,46	0	0,00	0,01
2-6°	93173175	22,09	3525	6,97	0,32
6-17°	171159500	40,58	45100	89,17	2,20
17-32°	7894900	1,87	1950	3,86	2,06
Expoziţie	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
nord	55844325	13,24	18375	36,33	2,74
nord-est	81225725	19,26	7475	14,78	0,77
est	67735650	16,06	75	0,15	0,01
sud-est	62573600	14,84	0	0,00	0,01
sud	46039850	10,92	7850	15,52	1,42
sud-est	46185600	10,95	1825	3,61	0,33
vest	30195125	7,16	7350	14,53	2,03
nord-vest	31988500	7,58	7625	15,08	1,99
Adâncime fragmentare	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
0-50 m\km²	142205650	33,72	0	0,00	0,01
50-100 m\km²	98444900	23,34	7375	14,58	0,62
100-150 m\km²	139929525	33,18	20725	40,98	1,24
150-200 m\km²	37213100	8,82	14625	28,92	3,28
200-260 m\km²	3995200	0,95	7850	15,52	4,00
Curbură versant	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
concav	182522250	43,27	27175	53,73	1,24
plan	60039100	14,23	2650	5,24	0,37
convex	179227025	42,49	20750	41,03	0,97
Utilizarea terenului	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
Zone urbane	40592650	9,62	0	0,00	0,01
Arabil neirigat	220767625	52,34	0	0,00	0,01
Livezi	4848275	1,15	0	0,00	0,01
Păşuni	101723675	24,12	49525	97,92	4,06
Păduri de foioase	44872300	10,64	0	0,00	0,01
Păduri de conifere	34700	0,01	0	0,00	0,01
Păduri mixte	892475	0,21	0	0,00	0,01
Vegetaţie arbustivă de tranziţie	7919600	1,88	1050	2,08	1,11
Tarenuri mlăştinoase	135775	0,03	0	0,00	0,01
Elevaţie	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
236-300 m	52695600	12,49	0	0,00	0,01
300-400 m	247529100	58,69	35050	69,30	1,18
400-500 m	86191650	20,43	15525	30,70	1,50
500-600 m	27697625	6,57	0	0,00	0,01
600-731 m	7674400	1,82	0	0,00	0,01
Distanţă faţă de reţeaua de drenaj	**Arie (m²)**	**Pondere(%)**	**Arie alunecări(m²)**	**Pondere(%)**	**Rata de frecvenţă**
0-200 m	119404025	28,31	32975	65,20	2,30
200-400 m	99582175	23,61	11900	23,53	1,00
400-600 m	75266750	17,84	5700	11,27	0,63
600-800 m	47454000	11,25	0	0,00	0,01
> 800 m	80080125	18,99	0	0,00	0,01

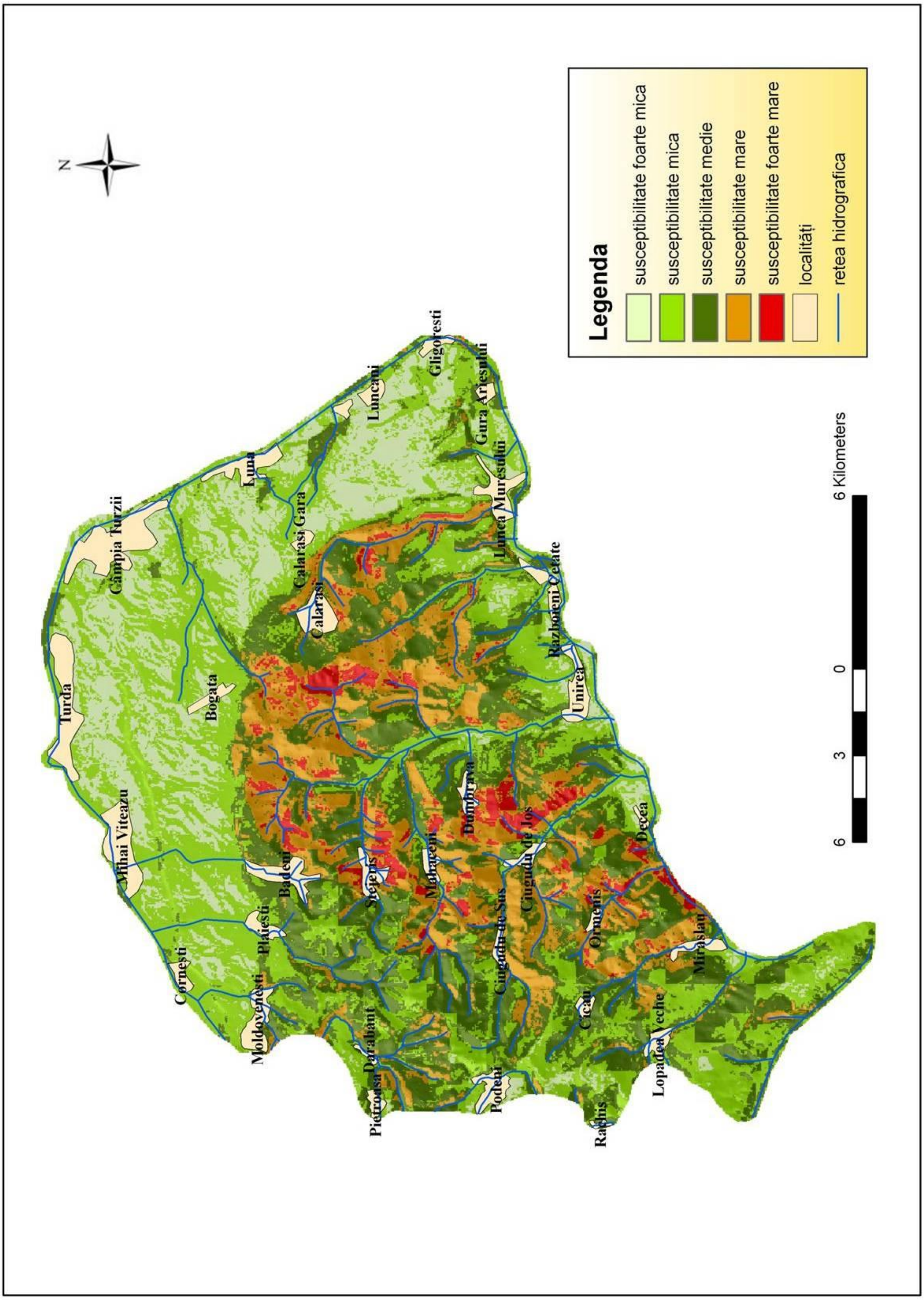

Fig. 93. Măhăceni Tableland – Landslide susceptibility map for natural terrain

6.6.2. Gully erosion processes susceptibility

In determining the oprobability of initiation and evolution of gully erosion processes, the frequency ratio was calculated, depending on 8 factors with a great influence in their initiation and distribution (Table 25): slope gradient, lithology, elevation, slope aspect, fragmentation depth, slope curvature, fragmentation density and land use. After calculating the frequency ratio for each corresponding class, we obtained the weighted values for the susceptibility classes to gully erosional processes on natural terrain. Frequency ratio maps for the coupled classes, of the frequency ratio of the factors, were overlaid and finally, the gully processes susceptibility map in Podişul Măhăceni, was obtained. According to it, 73,9% of the total area, stands for low and very low susceptibility areas and 21,6%, covers territories with medium susceptibility. Natural terrain with high and very highsusceptibility, stands for 4,5% of the total area of Măhăceni Tableland, covering 19,19 km^2.

Table 25. The calculation of gully erosional processes frequency ratio for the dominant factors in their initiation and evolution

Litologie	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
nisipuri, argile marnoase, pietrişuri	90386550	21,43	2162450	62,22	2,90
pietrişuri, nisipuri	179655875	42,59	200525	5,77	0,14
bazalte	7193725	1,71	9650	0,28	0,16
conglomerate, calcare, gipsuri, sare, tufuri, gresii	23824300	5,65	479200	13,79	2,44
gresii, marne nisipoase	22179850	5,26	124525	3,58	0,68
marne, marne nisipoase, nisipuri	98546775	23,36	499025	14,36	0,61
Pantă	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
0-2°	149560800	35,46	50625	1,46	0,04
2-6°	93173175	22,09	781625	22,49	1,02
6-17°	171159500	40,58	2523575	72,61	1,79
17-32°	7894900	1,87	119450	3,44	1,84
Expoziţie	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
nord	55844325	13,24	244875	7,05	0,53
nord-est	81225725	19,26	340725	9,80	0,51
est	67735650	16,06	324575	9,34	0,58
sud-est	62573600	14,84	508950	14,64	0,99
sud	46039850	10,92	529625	15,24	1,40
sud-vest	46185600	10,95	821500	23,64	2,16
vest	30195125	7,16	502225	14,45	2,02
nord-vest	31988500	7,58	202800	5,84	0,77
Adancime fragmentare	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
0-50 m\km^2	142205650	33,72	6275	0,18	0,01
50-100 m\km^2	98444900	23,34	621825	17,89	0,77
100-150 m\km^2	139929525	33,18	1819125	52,34	1,58
150-200 m\km^2	37213100	8,82	918000	26,41	2,99
200-260 m\km^2	3995200	0,95	110050	3,17	3,34
Curbură versant	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
concav	182522250	43,27	2454350	70,62	1,63
plan	60039100	14,23	85925	2,47	0,17
convex	179227025	42,49	935000	26,90	0,63
Utilizarea terenului	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
Zone urbane	40592650	9,62	55400	1,59	0,17
Arabil neirigat	220767625	52,34	1141425	32,84	0,63
Livezi	4848275	1,15	46025	1,32	1,15
Păşuni	101723675	24,12	1402750	40,36	1,67
Păduri de foioase	44872300	10,64	6400	0,18	0,02
Păduri de conifere	34700	0,01	0,00	0,00	0,00
Păduri mixte	892475	0,21	29875	0,86	4,06
Vegetaţie arbustivă de tranziţie	7919600	1,88	793500	22,83	12,16
Tarenuri mlăştinoase	135775	0,03	0,00	0,00	0,00
Elevaţie	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
236-300 m	52695600	12,49	71400	2,05	0,16
300-400 m	247529100	58,69	2501650	71,98	1,23
400-500 m	86191650	20,43	808450	23,26	1,14
500-600 m	27697625	6,57	81725	2,35	0,36
600-731 m	7674400	1,82	12050	0,35	0,19
Densitate fragmentare	**Arie(m^2)**	**Pondere(%)**	**Arie procese torenţiale(m^2)**	**Pondere(%)**	**Rata de frecvenţă**
<1 km/kmp	233257775	55,30	601000	17,29	0,31
1-2km/kmp	116565025	27,64	1093825	31,47	1,14
2-3km/kmp	49997850	11,85	572275	16,47	1,39
3-4km/kmp	18966425	4,50	901425	25,94	5,77
>4 km/kmp	3000000	0,71	306850	8,83	12,41

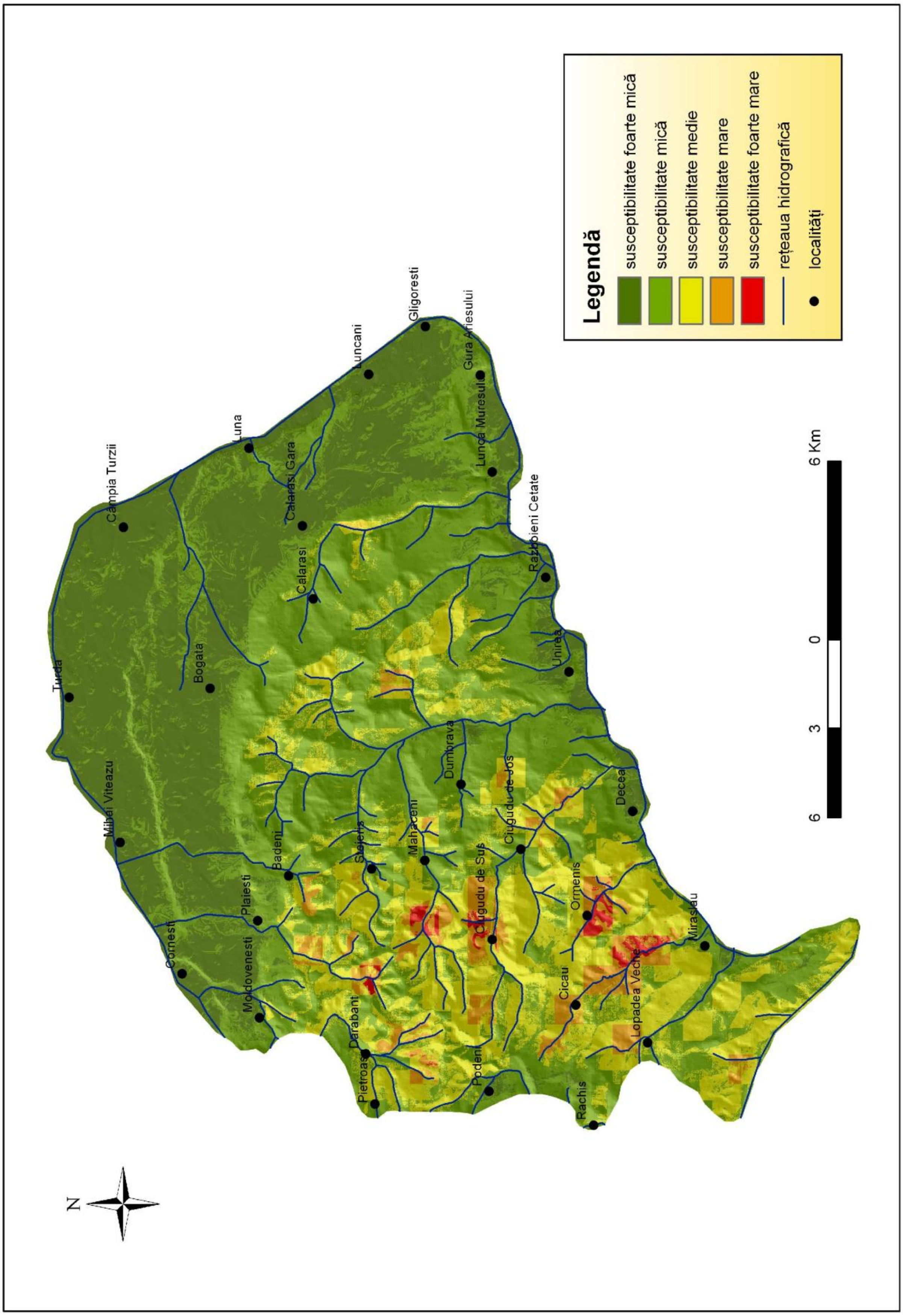

Fig. 103. Măhăceni Tableland – Gully erosion processes susceptibility map for natural terrain

6.6.3. Sheet erosion susceptibility

For the determination of natural terrain vulnerability to sheet erosion processes, we used the U.S.L.E model (Universal Soil Loss Equation), in our country being adapted by ateam led by Mircea Moţoc, who proposed in 1979, the ROMSEM (Romanian Soil Erosion Model), the best version being reconfirmed in 2002 also (Moţoc M, Sevastel M., 2002). This formula is expressed as follows: $ES=K*L^{m}*i^{n}*S*C*Cs$

Where:

Es- sediment quantity generated by sheet erosion as an anual mean (t/ha)

K- climatic agressivety correction coefficient;

L^m – slope length

i- slope gradient

S- soil erodibility factor

C- cover managemenrt factor

Cs- supporting practices factor

Generally, one can consider as mean tolerable sheet erosion number, the value of 3t/ha/year. The values measured here, show that only 3,7% of the total area is subject to >3 t/ha/year erosion. Most part of the studied area (92,2%), shows values of sheet erosion, under 2t/ha/year and on 4% oh the total area, we found values between 2-3t/ha/year. Still, on certain slope sectors, we find high values of sheet erosion within the following catchments: Stejeriş, Bădeni, Mirăslău, Cicău, Ciugud, Aiud, bazinul Unirea, Feldioara (Fig. 105). For the catchments westward from unirea Valley, there are situations of older deforestations from orchards, thus ramaining a territory vulnerable to erosional processes. Eastward from Unirea valley, one can find wide surfaces with a strong sheet erosion, on pastures. Here there is a typical area of over pasturage.

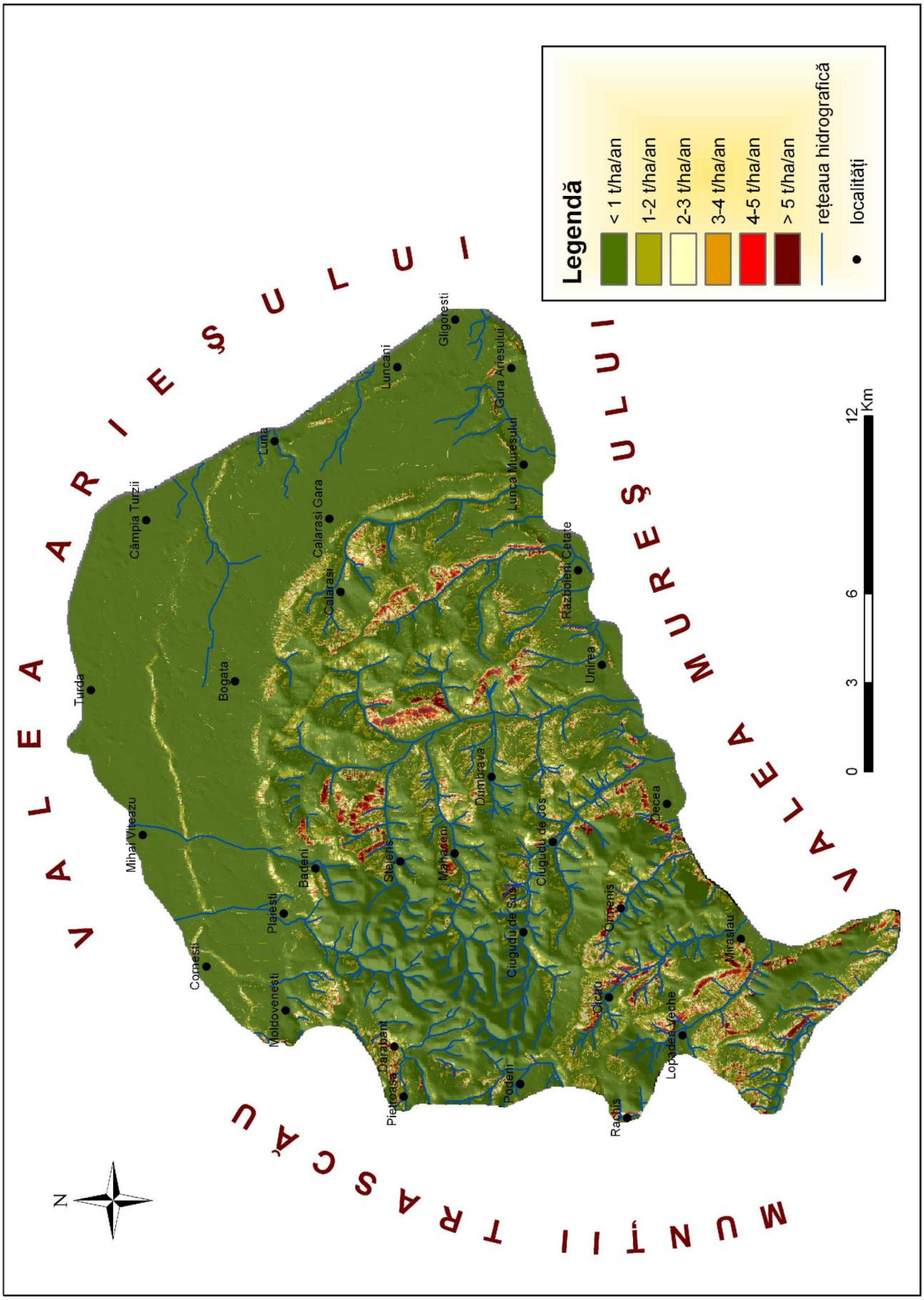

Fig. 105. Măhăceni Tableland – Sheet erosion map on natural terrain using the USLE model

6.6.4. Conclusions

The total susceptibility values were calculated, for all the three processes altogether, they receiving a new redistribution in five susceptibility classes (Fig. 106).

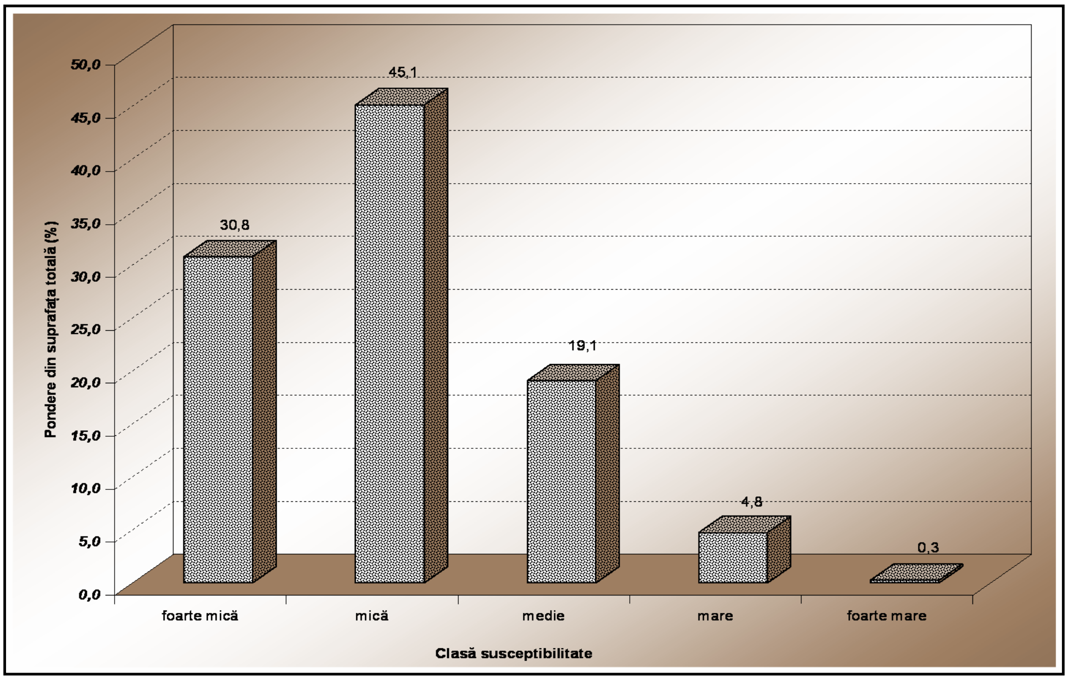

Fig. 106. Weighted classes for actual degradation processes' susceptibility (landslides, gully erosion processes, sheet erosion)

Thus, a new map was constructed, showing the degradation processes susceptibility for natural terrain: landslides, gully erosion processes, sheet erosion (Fig. 108). According to it, out of the total area of 421,7 km² of Măhăceni Tableland, natural terrain with high susceptibility covers21,11 km², representing 5,1%, medium values are found for 19,1% of thge territory, covering 80,45 km² and for 75,9% of the total study area, we found low degradation processes susceptibility values, for320,05 km². After field validations, it has been confirmed that on a regional scale, one can delimit certain areas with a high degree of terrain degradation: Ciugud catchment-the mid-inferior sector, the upper part of Mirăslău catchment, Stejeriş catchment, Măhăceni catchment, the left-side slopes of Unirea Valley, Măcicăşii catchment, the left-side slopes of Feldioara and Aiud valleys.

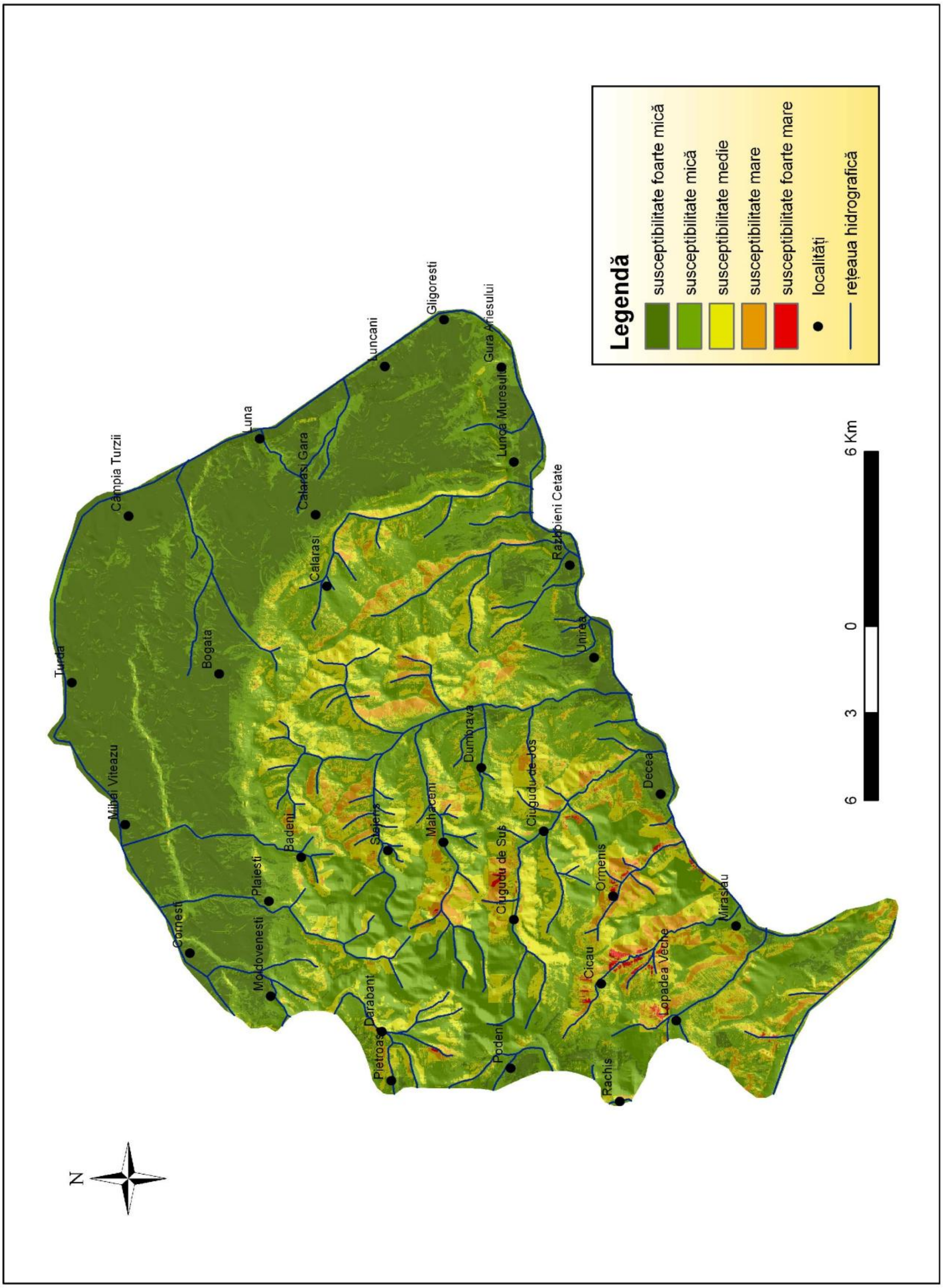

Fig. 108. Măhăceni Tableland - Actual degradation processes susceptibility map (landslides, gully erosion processes, sheet erosion) for natural terrain

7. Reflecting the morphological component on the territorial system of Măhăceni Tableland within the context of sustainable development

The practical part of this study represents an approach to the morphological characteristics of Măhăceni Plateau in the territorial system, referring to the social component, by virtue of the relationship between natural and social system of the studied area, in the context of sustainable development. In this regard, we have studied the human impact on the morphological component of the current modeling and impact on the territorial system of Măhăceni Plateau

7.1. Geographic landscape and sustainable development-conceptual framing

In the modern sense, the interdisciplinary character requires that geomorphology slides from its former knowledge management role to an explanatory one, with the purpose of forecasting processes and geographical phenomena. As a result, terms like: ecosystem, geographical environment, geosystem, landscape appear in the geographical literature, establishing on the one hand, the relationship of geography and geomorphology with other sciences and on the other hand, setting the boundary between the object of study and the research methodology.

The geographical landscape is a unit of space characterized by the interaction of the abiotic, biotic and anthropogenic factors, with its own structure and physiognomy, perceived and used differently in relation to the mode of perception. The geographical landscape is an element of the synthesis produced by the interaction of all components of the environment, therefore the geographical landscape is reflected by what is visible, tangible and expressed in a territory or geographical area

The concept of *sustainable development* designates all forms and methods of socio-economic development, whose foundation is firstly to ensure a balance between socio-economic systems and elements of the natural capital.

In our country the concept was introduced in the legal system by Marcian Bleahu – acting as a minister, after the Rio Summit in 1992, where he was elected the vice president of the board of the World Conference on Environment and Development. On his return, Professor Bleahu introduced the principle of sustainable development in the governmental program of economic development but also in the Environmental Law.

Evaluating the sustainable development concept in this paper, there are three major levels: sustainable development worldwide, in the EU and in Romania. For the Măhăceni Plateau, this concept was based on a new framework that was found in the scientific geographical literature in what concerns the relationship between the natural environment and the social environment, in terms of sustainable development:

- global warming and its effects;
- territorial planning;
- anticipation, flexibility and society intelligence, so as not to undermine their physical and social foundation;
- dynamic balance of the social system with the environment;
- disaster assistance;
- territorial arrangement;
- thoroughly planning a policy to maintain the balance between the many dynamics affecting rural areas (diversification of jobs, changes in agricultural production, afforestation, tourism, protection of the environment);
- conservation of biological diversity;
- the attempt to implement and institutionalize skills such as *analysis, prediction and risk*

management in the process of territorial monitoring, from the perspective of the interaction between society and the natural environment in the context of sustainable development.

7.2. The geomorphic support of Măhăceni Tableland and its influence in developing the territorial system

7.2.1. The natural support

The geomorphological landscape of the Măhăceni Tableland has evolved based on two major components: the particularities of natural environment and the changes from the anthropogenic action. The territorial system of the area to be studied was developed based on these two major double impact directions: the impact of the natural environment on the social environment and the impact of the social factor on the natural environment.

7.2.2. . The anthropic support of Măhăceni Tableland and the reflection of human actions upon the actual landform dynamics of the area

The anthropogenic factor imposes a particular way of land use, favoring the installation and evolution of current degradation processes. Other activities are linked to transport and travel with carts, the excavation for construction material, military activities and pollution activities.

7.2.2.1. Land use and its influence in initiating and developing of actual degradation processes

Currently, land use in Măhăceni Tableland (Table 26) indicates that the largest share of areas consists of arable land (52.34%), followed by pastures (24.12%).

Tabel 26. Classes of land use in Măhăceni Tableland

Utilizarea terenului	*Suprafaţă(ha)*	*Procent (%)*
Zone construite	4059,26	9,62
Arabil neirigat	22076,76	52,34
Livezi	484,82	1,15
Păşuni	10172,37	24,12
Păduri de foioase	4487,23	10,64
Păduri de conifere	3,47	0,01
Păduri mixte	89,25	0,21
Vegetaţie arbustivă de tranziţie	79,16	1,88
Tarenuri mlăştinoase	13,58	0,03

A feature in terms of land use behavior is the planting of fruit trees. During the 1970s-1980s, a series of consolidations took place (especially in the Stejeris, Măhăceni, Aiud catchments) in order to serve the plantation of fruit trees (apple trees, plum trees). After the 1990s, these orchards were left to decay, no other agrotechnical works were undertaken, many trees were cut, and the slopes rapidly degraded. Currently, these slopes where there used to be orchards are most affected by intense erosion processes: landslides and gully erosion processes. We took into consideration two insightful basins for Măhăceni Tableland: Aiud and Stejeris, where the development of the woodland was observed for a period of 21 years (1984-2005), coordinated with the current distribution and development of slope processes: landslides and surface erosion.

The Aiud valley basin suffered from the 1980s until today a large decrease in the area occupied by woodland: from 346.69 ha in 1984 to 66.4 ha in 2005 (Fig. 110).

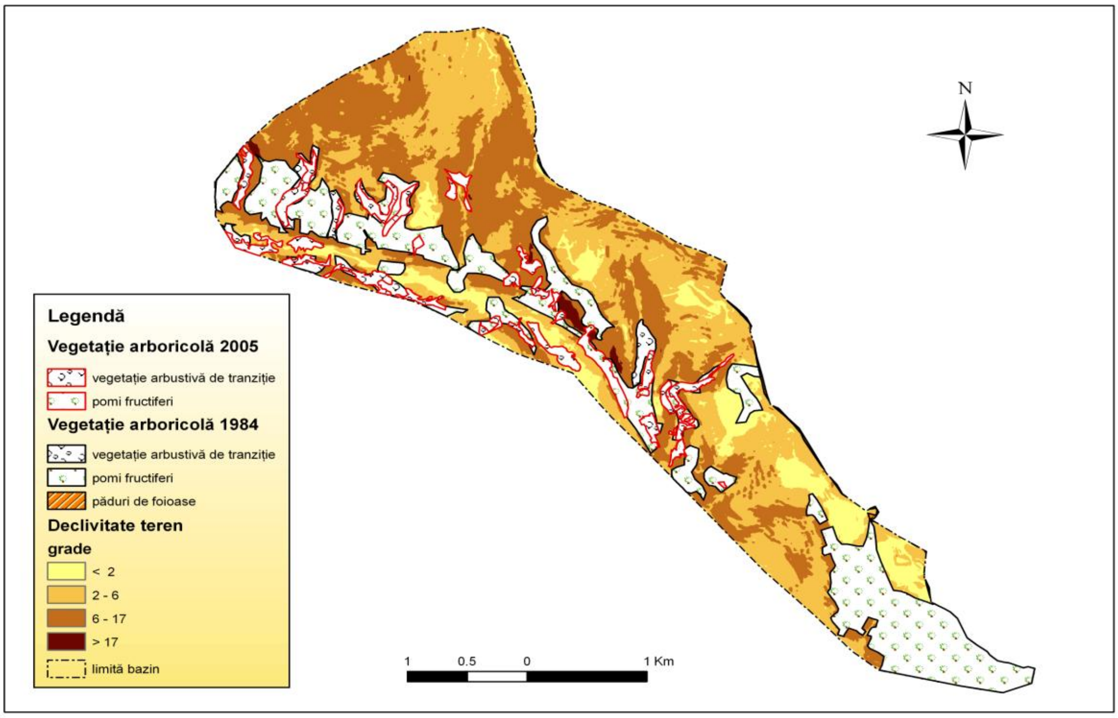

Fig. 110. Aiud catchment - tree coverage in 1984 and 2005

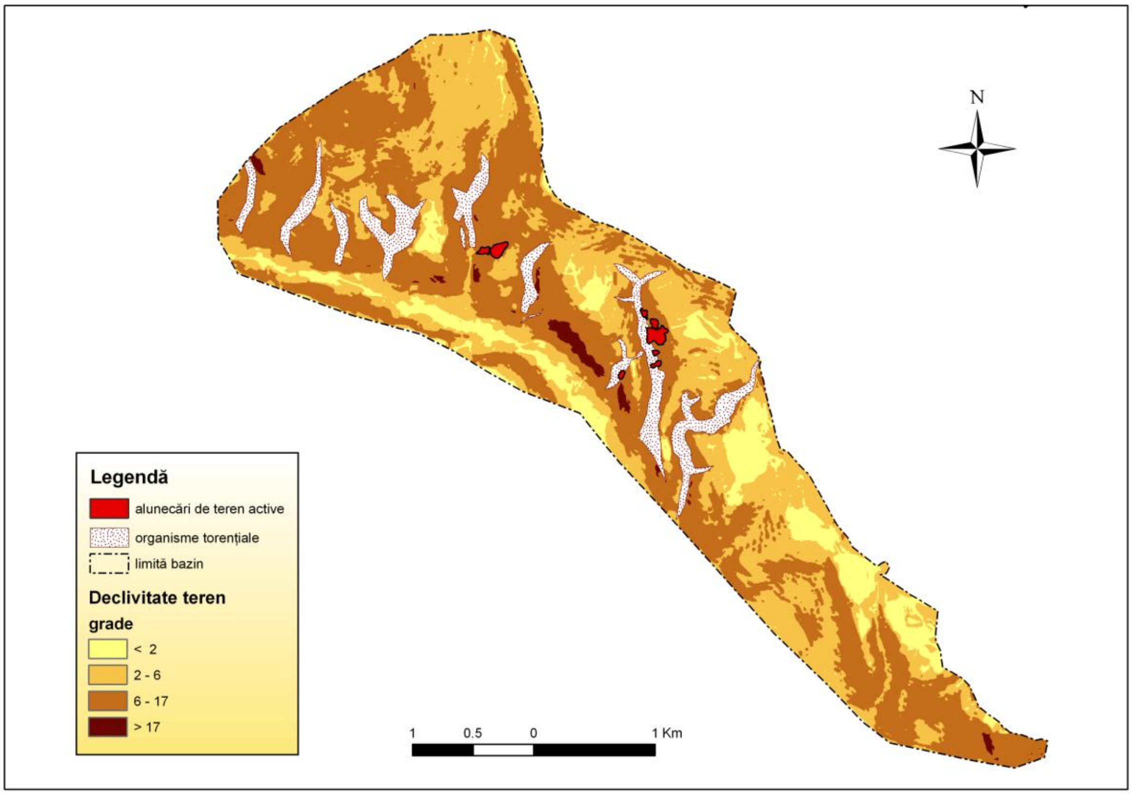

Fig. 111. Aiud catchment - the location of actual slope processes
(gully erosion processes, landslides)

A similar situation, though at a smaller scale, is found in the Stejeris catchment. Here, the surface of of 178.15 ha was covered with fruit trees in 1984, but by 2005 the area fell almost 5 times (Fig. 112).

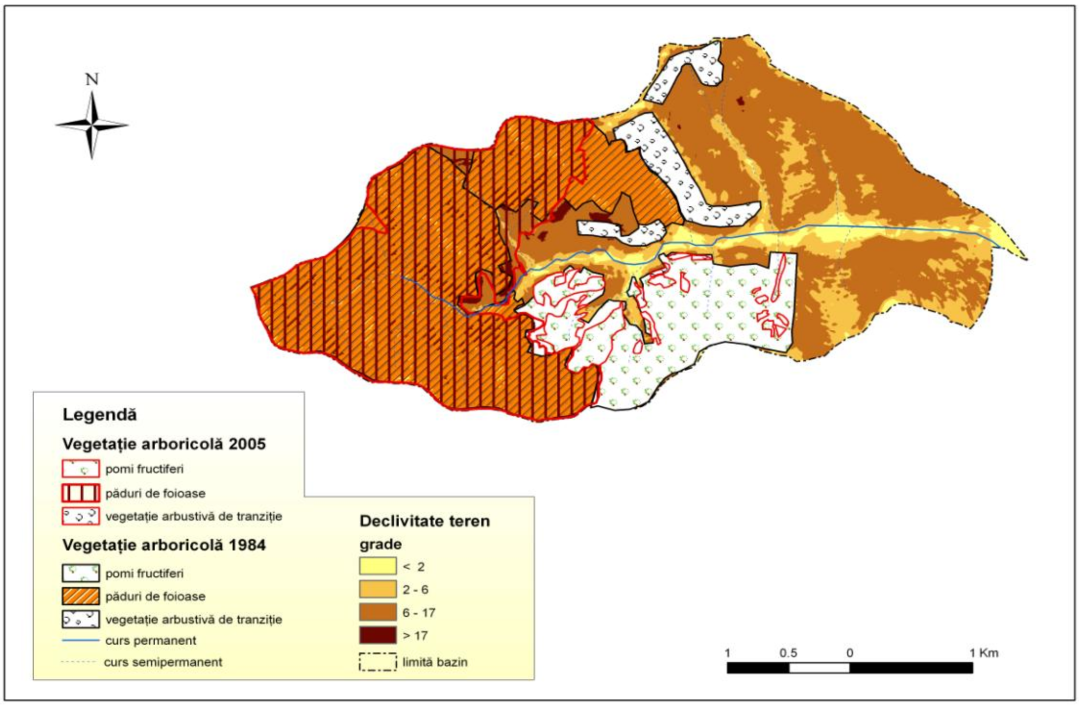

Fig. 112 Stejeriş catchment - woodland coverage in 1984 and 2005

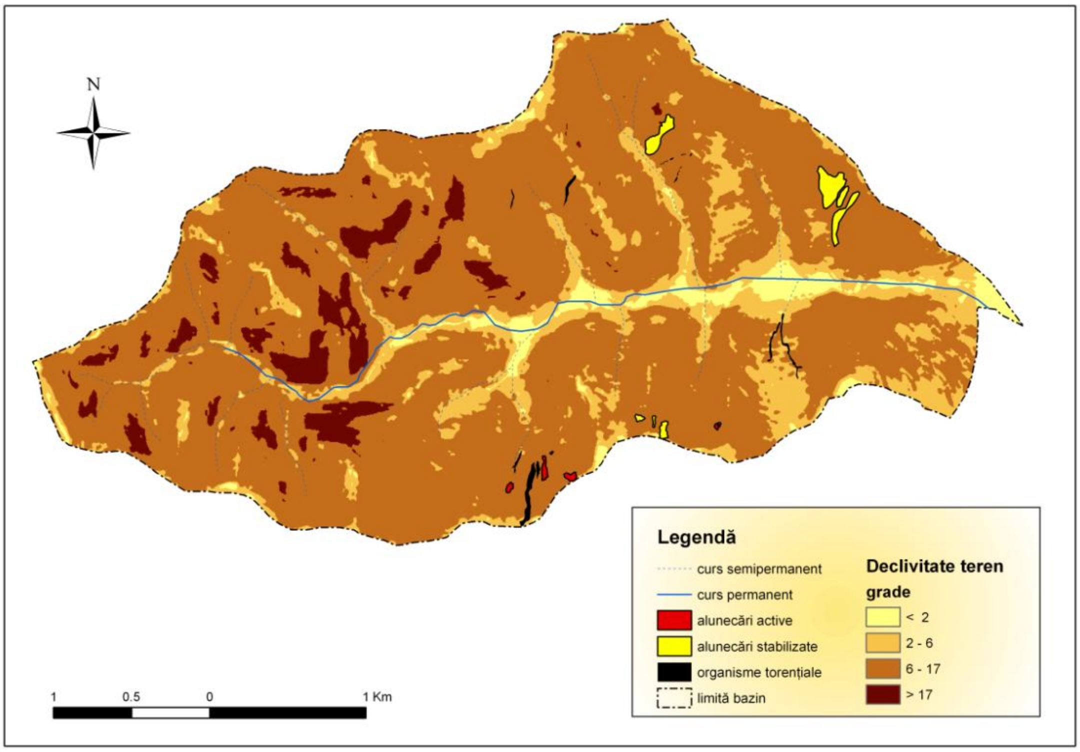

Fig. 113. Stejeriş catchment - current location of erosion processes (ravines, landslides)

Fig. 114. The setting in of actual erosion processes as a result of landuse on the right slopes of Stejeriş catchment

7.3. The impact of actual landform processes on the territorial system of Măhăceni Tableland

Recent changes in the geographical environment – both in the natural systems (global warming, climate change) and anthropogenic (globalization, territorial expansion, etc.) has consequences on how contemporary modeling processes take place (propagation of hazards, disasters, etc.). In this respect a certain relationship is born between the natural system and the anthropogenic system, the emphasis is on studying the processes of modeling in reduced space and for short and medium periods. Therefore the need to divide the applied geomorphology studies that come to support analytical efforts and monitoring territory in the short, medium and long term.

7.3.1. Actual landform processes with a a negative impact on the territorial system of Măhăceni Tableland

The current modeling of the Măhăceni Tableland is strong, as a result of both the natural dynamics and especially as an effect of the human influence. Current modeling processes are active and induce damage, the most important being recorded as a consequence of landslides and torrential processes.

The territorial system elements of the areal of study (roadways, buildings, land) are adversely affected by these processes, which cause damage that should not be neglected, since it refers to small and underdeveloped communities.

7.3.2. The risk issue, the role of natural hazard predictability and mitigation measures

Among the current modeling processes with a potential to inflict damage, landslides represent a major threat. In the Măhăceni Plateau, these processes occupy a total area of 3.33 km ², of which 11% are active landslides and 89% are partially stabilized or stabilized landslides, which can reactivate, during periods of maximum rainfall.

Concentration of these processes in areas with settlements and roads, need assessments and further study in order to determine the possibility of producing damage. The impact of landslides on the territorial system of the Măhăceni Plateau has an impact on human settlements and transport links

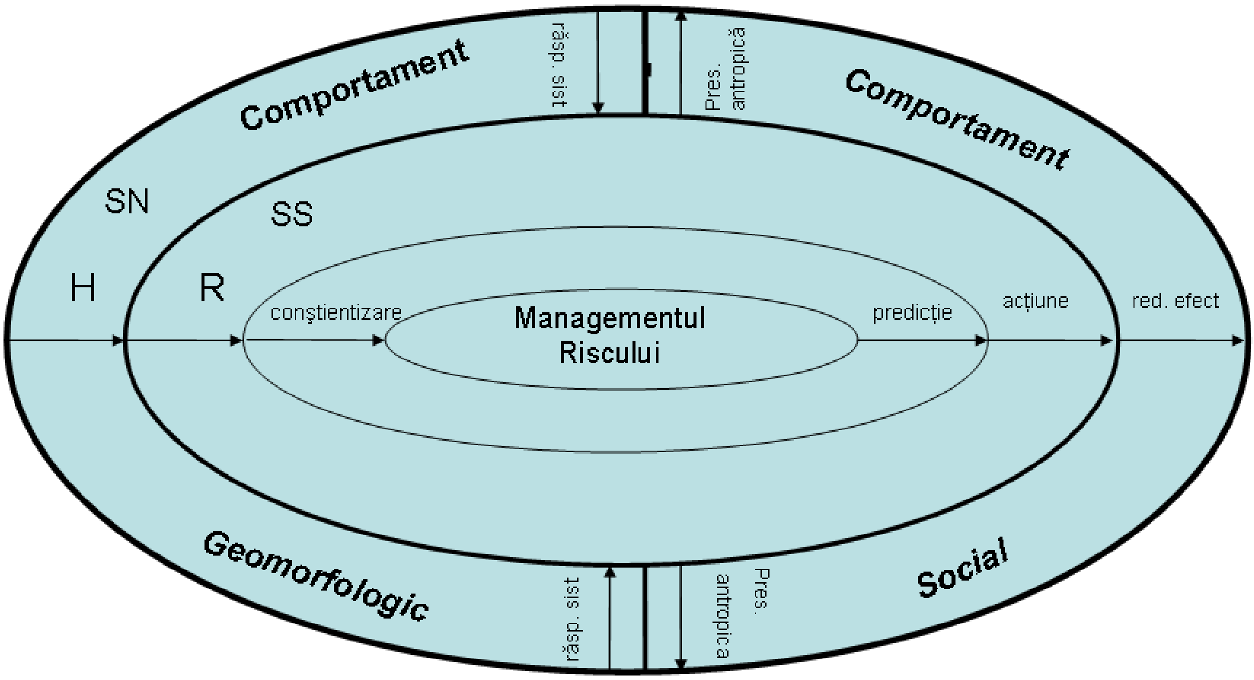

Fig. 122. Risk awarenesss within the relationship: natural system-social system

SN= Natural System; SS= Social System; H= Hazard; R= Risk

7.3.2.1. Landslide risk assessment in Măhăceni Tableland

Risk management can be expressed in terms such as: susceptibility, vulnerability, hazard, risk, disaster. Prediction of landslides as natural hazards, are preceded by obtaining probable information related to the dynamic of the process and its spatial expansion.

The approach of the risk assessment for landslides in the Măhăceni Plateau followed the next steps: evaluation of susceptibility, vulnerability and risk of landslide, the elements considered to be at risk are the settlements and the access roads. This approach represents a prediction model on short and medium term for the dynamics of landslides and their impact on the territorial system of the Măhăceni Plateau.

The first phase was to create a database of landslides (inventory of 324 landslides stabilized / partially-stabilized and active assets using a Magellan GPS explorist 600). Then the data was processed in GIS and then the landslide susceptibility map was built based on eight major factors in triggering landslides (the degree of inclination of the slope, exposition slope, lithology, drainage, slope shape, land use, elevation, distance to rivers) based on the frequency ratio model.

In determining the vulnerability of settlements (buildings) and roads to landslides several major parameters were observed: the distance of the elements at risk from the source area, the damage type, the building structure, the type and intensity of landslides (Fig. 123, 124).

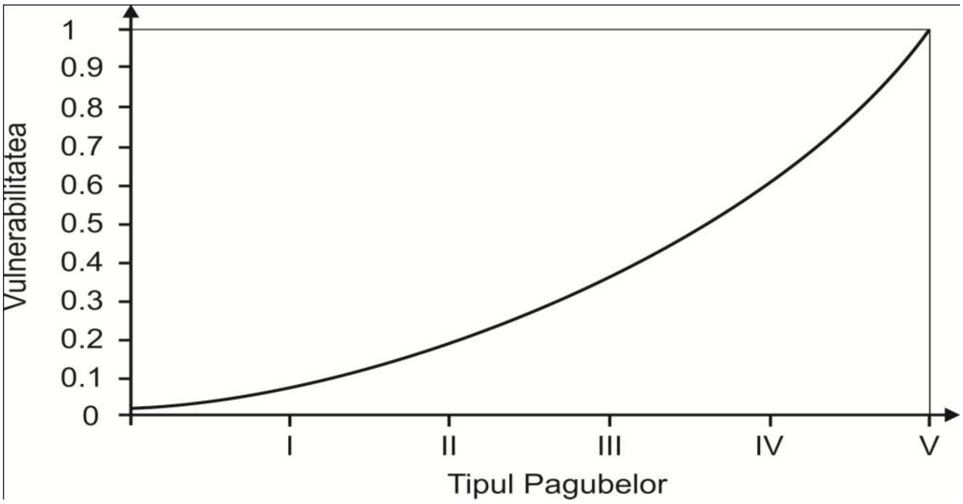

Fig. 123. Landslide vulnerability in Măhăceni Tableland for buildings depending on the type of damage (modified after Leone et. Al., 1996 and Glade, 2003). I – (V = 0.01-0.1) superficial damage (small cracks in the sidewalls), stability is not affected. II – (V = 0.2-0.3): large cracks only in the side walls of the building, stability is not affected, repairs are not urgent. III – (V = 0.4-0.6): strong deformations, large cracks in walls, cracks in the structure of resistance, stability is affected, unusable doors and windows, evacuation is required. IV – (V = 0.7-0.8): Structural breaks (broken side walls, tearing in the walls merge, the foundation breaks), partially destroyed, evacuation required, reconstruction of the damaged parts. V – (V = 0.9-a) partial or total destruction, evacuation required, complete reconstruction.

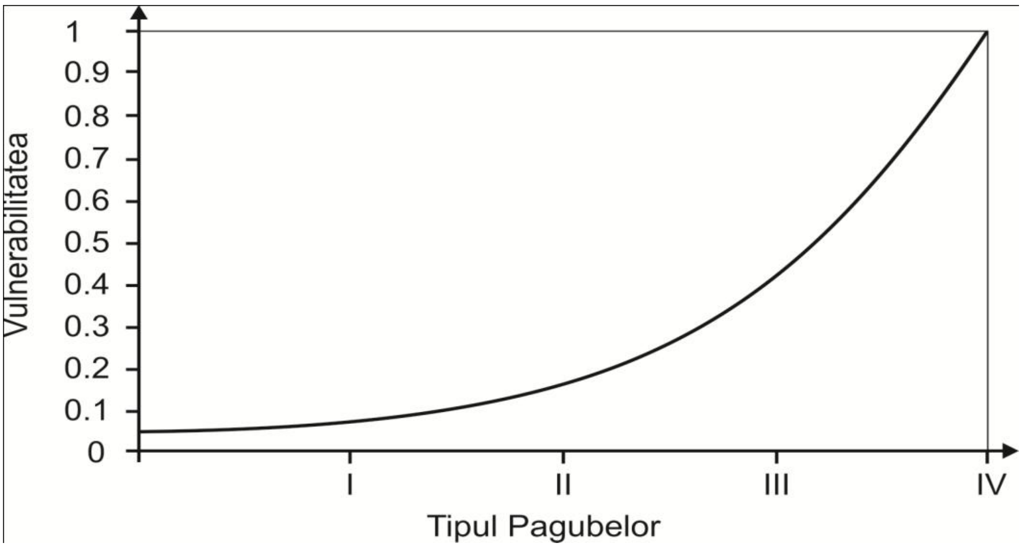

Fig. 124. Landslide Vulnerability for access roads for Măhăceni Tableland, depending on the type of damage (modified by Leone et. Al., 1996 and Glade, 2003). I – (V = 0.05-0.3): superficial damage of the road, II – (V = 0.3-0.6): damage to the roadway, repair requires 10m³ material, III – (V = 0.6-0.8): damage to the roadway, repairs required 100m³ material; IV – (V = 0.8-a) road is destroyed.

The vulnerability values were calculated for landslides taking into consideration the distance to landslides as a factor, considered to be crucial in determining the degree of vulnerability, these values decreasing with augmenting the distance from source area. A threshold of 50 m was established, in this way the degree of vulnerability decreases from very high to low with every 50 m, at the distance of 250 m from the source the impact is considered negligible, because the magnitude of the process is reduced. The vulnerability values for settlements and access roads were calculated according to the type of the damages.

In a final phase, based on the susceptibility and vulnerability values, the risk map for landslides was built in GIS in the Măhăceni Plateau for settlements and access roads (Fig. 125), using the formula: R = H x V (UNISDR, 2004).

In the studied area, approximately 10% (9.99%) represents areas with high landslide risk (Table 30), corresponding to a total area of 42.12 km ^{2}, out of which 35.62 km^2 represents high risk areas and 6.5 km^2 presents very high risk areas to landslides, representing 1.54% out of the total area of Măhăceni Tableland. For 15.98% of the territory we found medium values of landslide risk (67.36 km ^{2}) and 74.04% of the total area indicates low values for landslide risk.

The highest risk values for settlements is found in eight locations: Stejeris, Măhăceni, Dumbrava, Ciugudu de Sus, Ciugudu de Jos, Miraslau, Calarasi, Ormeniş (total population: 1750 inhabitants). Landslides in these areas have so far affected a total of 35 houses (and a cemetery), seven of whom were totally destroyed and removed, and the rest of them have cracks and wall deformities (Table 31) which can be solved, but at a reactivation of the landslides, they can be seriously damaged.

Table 31. Măhăceni Tableland – human settlements with high landslide risk and landslide damage

Loc. afectate	Stejeriş	Măhăceni	Dumbrava	Mirăslău	Călăraşi	Ormeniş
Nr. case afectate	3	11+1 cimitir	10	3	7	1
Nr. case cu crăpături	3	8	8	3	5	1
Nr. case case distruse	-	3	2	-	2	-
Materiale de construcţii folosite	Cărămidă; fundaţie de piatră	Cărămidă; fundaţie de piatră	Cărămidă; fundaţie de piatră	Cărămidă; fundaţie de beton	Cărămidă; fundaţie de beton	Cărămidă ; fundaţie de piatră

Regarding the access roads network, the highest risk in case of landslides is for the European road E81 (on a length of approx. 1.26 km) and two roads which cross from Ciugudu de Sus and Ormeniş (over a length of approximately 1.4 km) – the estimated cost of rehabilitation in case of damage from landslides was estimated at approx. € 360,000 (DRDP Cluj, 2008).

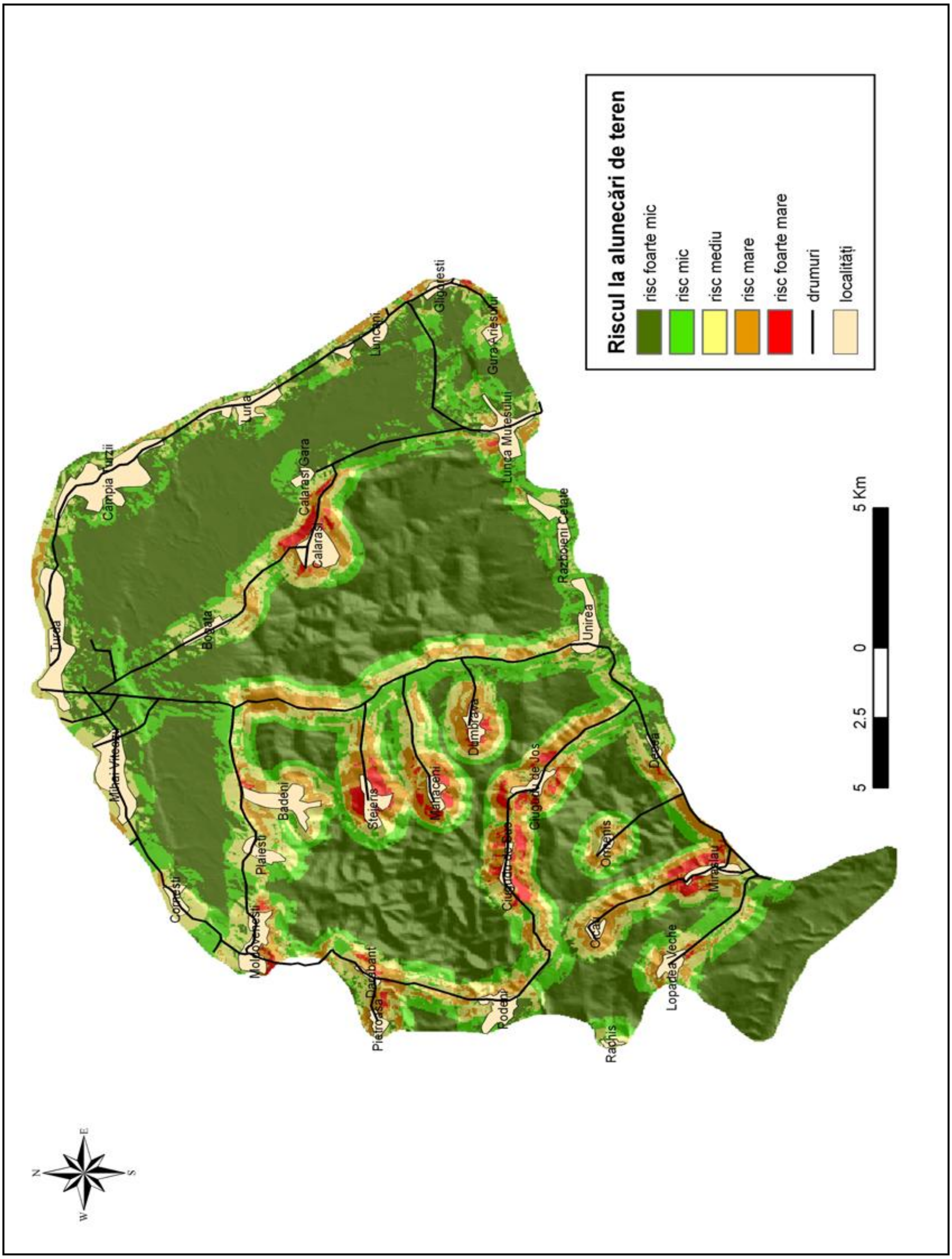

Fig. 125. Măhăceni Tableland – Landslide risk map for human settlements and roads

7.3.2.2. Conclusions

We can observe the lack of adequate information at the level of the community and little interest shown by the population in these hazards and the damage they can cause. Because of this we meet situations such as: the construction of new homes in areas with active landslide and a high vulnerability to landslides, mining of sand in areas with a very high degree of vulnerability leading to destabilization of the slope, which helps in triggering landslides. We can also note the lack of a predictive study or identification of areas with high landslide risk from the authorities.

Fig. 126. Recent landslide (2005-2006) affecting the European road E81

Landslide prediction on short and medium term has the following main goals: reducing the potential chance of human and material losses in case of hazard, reducing repair costs and decreasing the risk, educating and informing the communities regarding these hazards, resulting in a correct behavior of the society (consolidation of the damaged areas and with a high risk for landslides, avoiding exploitation and construction in high risk areas, imposing a mandatory insurance policy for the land in these areas, etc.).

7.3.2.3. Mitigation measures in landslide initiation and development

In order to increase the stability of slopes and fight against the negative effects of landslides, rehabilitation actions are required, as technical solutions on the short, medium and long term. These actions fall into the next categories: mechanical and hydraulic works, works of land leveling and modeling of the sliding land and biological works in order to prevent and fight against landslides.

Tabel 32. Species of forest vegetation that help stabilizing the slopes damaged by landslides in transitional areas of steppe to forest steppe (after Dîrja, M., 2000)

Specie lemnoasă	Nr. Puieți/ha	Procedee de pregătire a terenului predispus la alunecări
În stepă		
Să, Sc, V.t, Lc	6700	Gropi de 40-40-30cm
Să, Sc	5000	Terase cu gărdulețe la 2-3m din ax în ax; gărdulețe rombice; mulcire; pământ vegetal; plantații cu puieți crescute în pungi de polietilenă
În silvostepă		
Sc, Pi.n, Fr, Ju, A.t, Mj, Sg, Lc, Sp	6700	Gropi de 40/40/30cm; terase late de 0.8-1m la distanță de 3m din ax în ax
Pi.n, Fr, Mj, Sp, Lc	5000	Gropi de 40-40-30cm;
Am.n, Fr		
V.t, Să, C.a	5000- 6700	Plantații în despicătură
C.a	6700	Terase cu gărdulețe la 2-3m din ax în ax; gărdulețe rombice; mulcire; pământ vegetal, puieți crescuți în pungi de polietilenă
Mj, V.t, Ca, Sp, Li	3000- 5000	Vetre cu diametrul de 0.5- 1m cu pământ vegetal

Să- Oleaster; Sc- locust; V.t-sour cherry; L.c- Wood Spurge; Pi.n-black pine; Fr-ash; Ju- Field Maple; A t-tartar maple; Mj- Manna Ash; Sg- Common Dogwood; Sp- Smoke bush; L.i-lilac; Sa. A-white willow; Sa. P- Crack Willow; An.n- Black Alder; Cr- common hornbeam; C.r- Glossy Buckthorn; Pl.e- Canadian poplar; Co-dogwood.

Concluzii

The western border of the Transylvanian Depression is an area which still rises different problems concerning the evolution of the Transylvanian Basin in relation to the Carpathians' uplift. As a contact area between the Trascău Mountains and the Transylvanian Depression, Măhăceni Tableland reflects the Miocene-Pliocene changes on the Transylvanian-western border, as a controversial territory which has been very poorly studied so far. The present paper follows the main features of the morphogenetic system of Măhăceni Tableland, thus offering a regional model towards the knowledge of the marginal Carpathian structures from the western border of the Transylvanian Depression.

The morphogenetic system of Măhăceni Tableland follows the complexity of this contact area, where the geotectonic factor has the great influence as the developing and evolution support for actual landform dynamics.

Contemporary landform processes show an accelerated dynamic and they do not occur remotely, but they associate, their evolution being favorised by both natural and anthropic conditions.

Actual landform morphodynamic in Măhăceni Tableland, reflects upon the territorial system, mostly through degradation processes on natural terrain- especially landslides- which also present a damaging potential for human settlements and access road network. A problem of analizing and prediction on natural hazards arises with the goal of reducing damage and combat against erosion and degradation for natural terrain. The present paper is a study of applied regional geomorphology.

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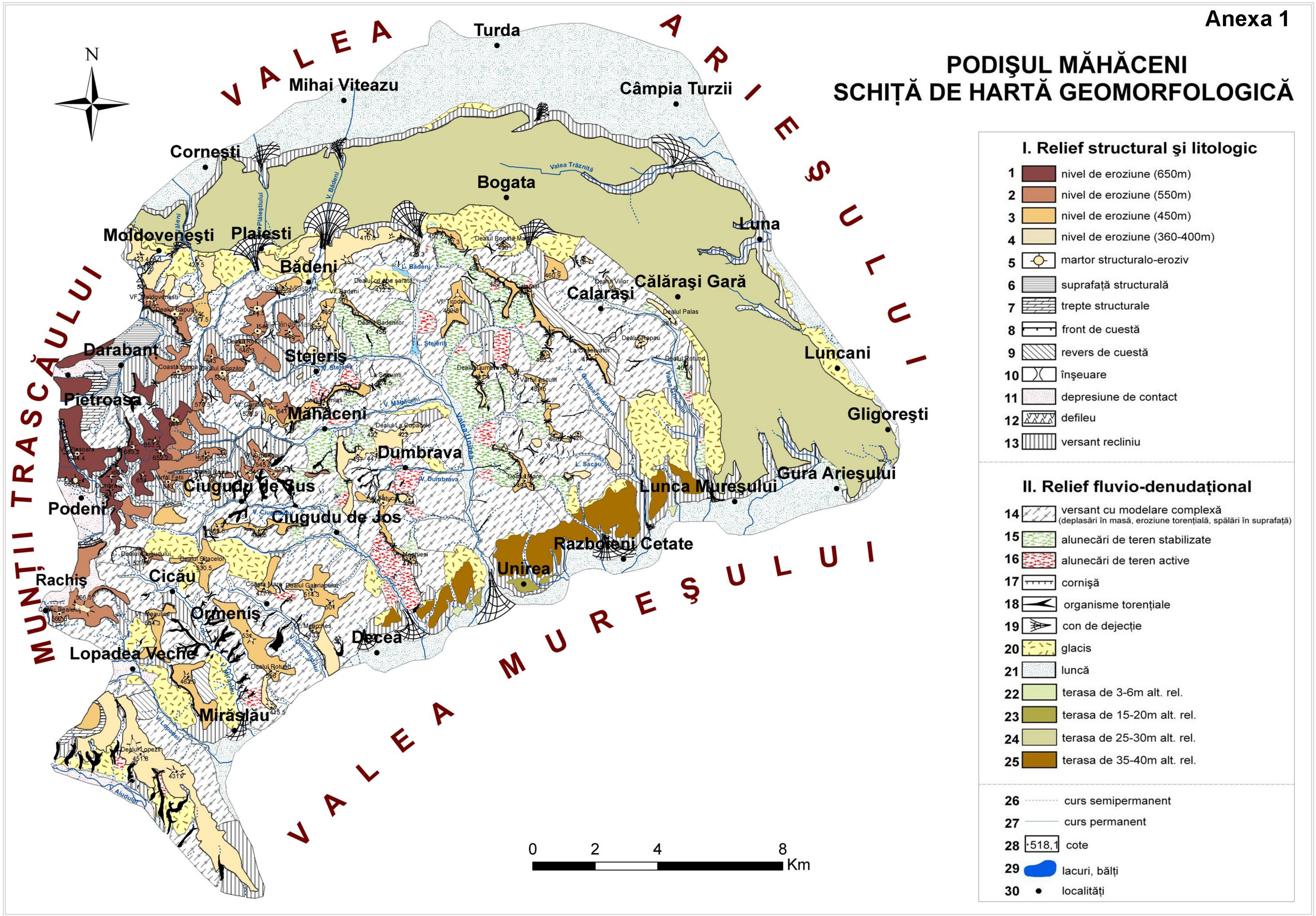
Anexa 1
PODIŞUL MĂHĂCENI
SCHIŢĂ DE HARTĂ GEOMORFOLOGICĂ
I. Relief structural şi litologic
1 nivel de eroziune (650m)
2 nivel de eroziune (550m)
3 nivel de eroziune (450m)
4 nivel de eroziune (360-400m)
5 martor structuralo-eroziv
6 suprafaţă structurală
7 trepte structurale
8 front de cuestă
9 revers de cuestă
10 înşeuare
11 depresiune de contact
12 defileu
13 versant recliniu
II. Relief fluvio-denudaţional
14 versant cu modelare complexă (deplasări în masă, eroziune torenţială, spălări în suprafaţă)
15 alunecări de teren stabilizate
16 alunecări de teren active
17 cornişă
18 organisme torenţiale
19 con de dejecţie
20 glacis
21 luncă
22 terasa de 3-6m alt. rel.
23 terasa de 15-20m alt. rel.
24 terasa de 25-30m alt. rel.
25 terasa de 35-40m alt. rel.
26 curs semipermanent
27 curs permanent
28 518,1 cote
29 lacuri, bălţi
30 localităţi
N
0 2 4 8 Km
VALEA ARIEŞULUI
VALEA MUREŞULUI
MUNŢII TRASCĂULUI
Turda
Mihai Viteazu
Câmpia Turzii
Corneşti
Bogata
Moldoveneşti
Plaieşti
Luna
Badeni
Călăraşi Gară
Calaraşi
Darabant
Stejeriş
Luncani
Pietroasa
Mahaceni
Gligoreşti
Dumbrava
Gura Arieşului
Ciugudu de Sus
Lunca Mureşului
Podeni
Ciugudu de Jos
Razboieni Cetate
Unirea
Rachiş
Cicău
Ormeniş
Decea
Lopadea Veche
Mirăslău
Valea Trăznita