Transylvanian Rural Areas Vulnerability to Contemporary Geomorphologic Processes

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Introduction

The vulnerability comes from recognizing the fact that every geographical system possesses a different susceptibility to record specific damage, according to the risk taken. It is closely related to the change resistance and the capacity to adapt to new conditions and forms. The efficiency to the risk adaptation raises the level of resilience of the potentially affected community by the geomorphologic process. The loss susceptibility is correlated to sensitivity, resilience and fragility of the geographic system disturbed by the extreme phenomena, and the global answer to these variables is vulnerability.

The vulnerability of a rural geographic system, no matter its size, can be defined as its capacity to be affected by a hazard and its resilience indicates the system's inherent tendency to expose itself to conversions and to regain the hazard affected functions.

The vulnerability of the Transylvanian rural area, in terms of the geomorphic risk function, highlights the exposal degree of the rural communities to the action of contemporary geomorphic processes: gaping, torrential, mass movement processes. Risk exposure or the vulnerability of the rural socio-system, indirectly expresses the adaptation efficiency, the resilience degree of the affected community.

An evaluation at the end of the 20th century and at the second millennium would surprise some definitory aspects of the environmental politics and implicitly the causes that stay beyond the natural risks and hazards: the accelerated exploitation of the soil and subsoil resources, desertification, malnutrition, and epidemic.

The United Nations Program for Environment (UNEP) has launched advertisements for the end of the second Millennium and start of the third Millennium about the consequences of the ecological management.

The last decades were identified with an accelerated decrease of the soil and subsoil resources, due to intense deforestations, natural and anthropic desertification, accelerated erosion of the soil, the exemption of some species of plants and animals, the appearance of new waves of viral epidemic and the intensification of telluric activity.

ONU statistics said that, at the end of the second Millennium, the year 2000, the last three decades had marked the decrease of natural resources of Terra in the largest part of the world (especially for the countries in progress of development) under the power of the financial pressure and political-military power of the industrialized and technologic countries, reunited in large economic, multinational groups. Approximately 900.000 sq km of forests have been deforested (area equivalent with the surface of Venezuela), while almost 25% of the mammals species and 10% of the birds species are heading for perdition.

The erosion of the soils and the deforestation annually cause losses of about 42 billion USA dollars, while for the programs of stopping the soil erosion are being allocated only 2,4 billion USA dollars.

The hydro-erosion is more incisive than the natural regeneration of the soils, fact that leads to the decrease of the agricultural productivity, through the elimination form the soil of some mineral compounds (nitrogen, phosphorus and potassium).

The losses of nutrients are being added to the hydro erosion, aspect set by the world statistics through four tones of soil per hectare of agricultural field in Canada; 10,4 tones per agricultural hectare in the United States; 16,4 tones per agricultural hectare in Portugal; 33,1 tones per agricultural hectare in Spain and 26,7 tones per agricultural hectare in Romania.

The desertification threatens the life of at least one billion people. Almost ⅔ of the surfaces of the dry arable fields are degraded, respectively 3,5 billion hectares. The deserts advance continuously due to the bad actions of the man: the destruction of the forests, the excessive consumption of the underground water, the monocultures (on the basis of some enormous anthropic pressures) cause vegetal diseases, overgrazing, chemical, organic and radioactive contamination of the waters and soil. These "aggressive" politics over the environment have lead to the identification of some desert areas, of anthropic origin, the summed up make over 9 million sq km (UNEP, 2000).

On ONU official statistics, the repercussions of the global warming of Terra are in every extreme phenomenon, catastrophe or natural risk: tropical cyclones, tsunami waves, mud torrents, drought, floods, and spontaneous fires.

The reaction of the population to the manifestation of these processes and risk phenomena is very different, reported to their degree of preparation, but according to the technological power and the capacity of population to defend itself. On average, a situation of natural risk provokes 23 deaths in rich countries, 1.052 deaths in the poor ones and 145 in those with an medium PIB.

The dysfunctions of the terrestrial space are perceived in the context of climatic global changes. The time between the beginning of the event and the information given to the people is very short, due to the globalization of the information and the integrated monitoring of Terra through the satellite network.

The new spatio-temporal relations between persons, and the human communities were generated by the revolution in the technology of transports and communication. This technology has affected the representations, the feelings, the emotions, the daily material or non-material distances between people, between people and their activities, between people and their birth places, etc. The man has anticipated the "revolution of communication" at infinitely large distances, but is helpless in forecasting the extreme events, catastrophes, hazards and risks, invoking the probability of the appearance of the extreme event.

In *geography,* the risks (covered by a rich literature) are fragmented on risk and place categories without insisting upon the association of those two notions: risk and territory, respectively surprising the spatialisation of the risk and determining the conditions of its appearance in a certain space or territory, in a certain spatio-temporal sequence and cartographical representation (through the risk maps) the proportion of the phenomena and processes that sustain "the crisis status" within a geo-system or socio-system.

The complex manifestation of the risks is an exercise for the management or administration of the crisis or risk status, often highlighting the presence of other risk situations, unnoticed before.

Approaching risks through their spatialisation would represent a possibility for a better understanding of the causes of their generation or resistance opposed by the environment in the manifestation of some geomorphic, climatic, hydrologic, pedologic, and biotic processes.

The spatialisation of the "risk" imposes on one hand its identification and consideration, and on the other hand the projection and representation of the components. Many authors differentiate the local risks (site risks) and the risks associated to transports and transfers (transport risks), in the background of the major risks (Glatron, 1996). Others mention the existence of "diffuse risks" and "punctual risks", specifying that risks can diffusely affect some spaces or, on the contrary, to be precisely located, with a punctual action (the collapse of the ceiling of a salt mine).

The presence of the areas with territorial dysfunctions, social and economic, caused or conditioned by geomorphic processes, is generally represented for geography researchers and especially for geomorphology researchers as a "field" of privileged studies. They have tried to identify the mechanisms and the causes of the production of the hazard, to monitor the evolution of the processes or process, to extent the area of the impact and to mind the administrative authority over the effects and social impact.

The lithology- premise of the vulnerability and geomorphologic risk factor

The functional integration of *the diapirical areas and domes* in the morphology of the Transylvania Depression supposes, even from the beginning of the analysis, the report of these units to the regional morphodinamic context of the evolution of the Transylvanian intra-Carpathian space, the argumentation of the tectonic role of revolving plates of the Transylvanian-Pannonic micro-plate, especially its *neotectonic mobility* and defining some tectonic and neotectonic relations, geo-morphologic, morph-climatic, morpho-hydrographical and biopedographic, with the Carpathian mountain frame (figure 1).

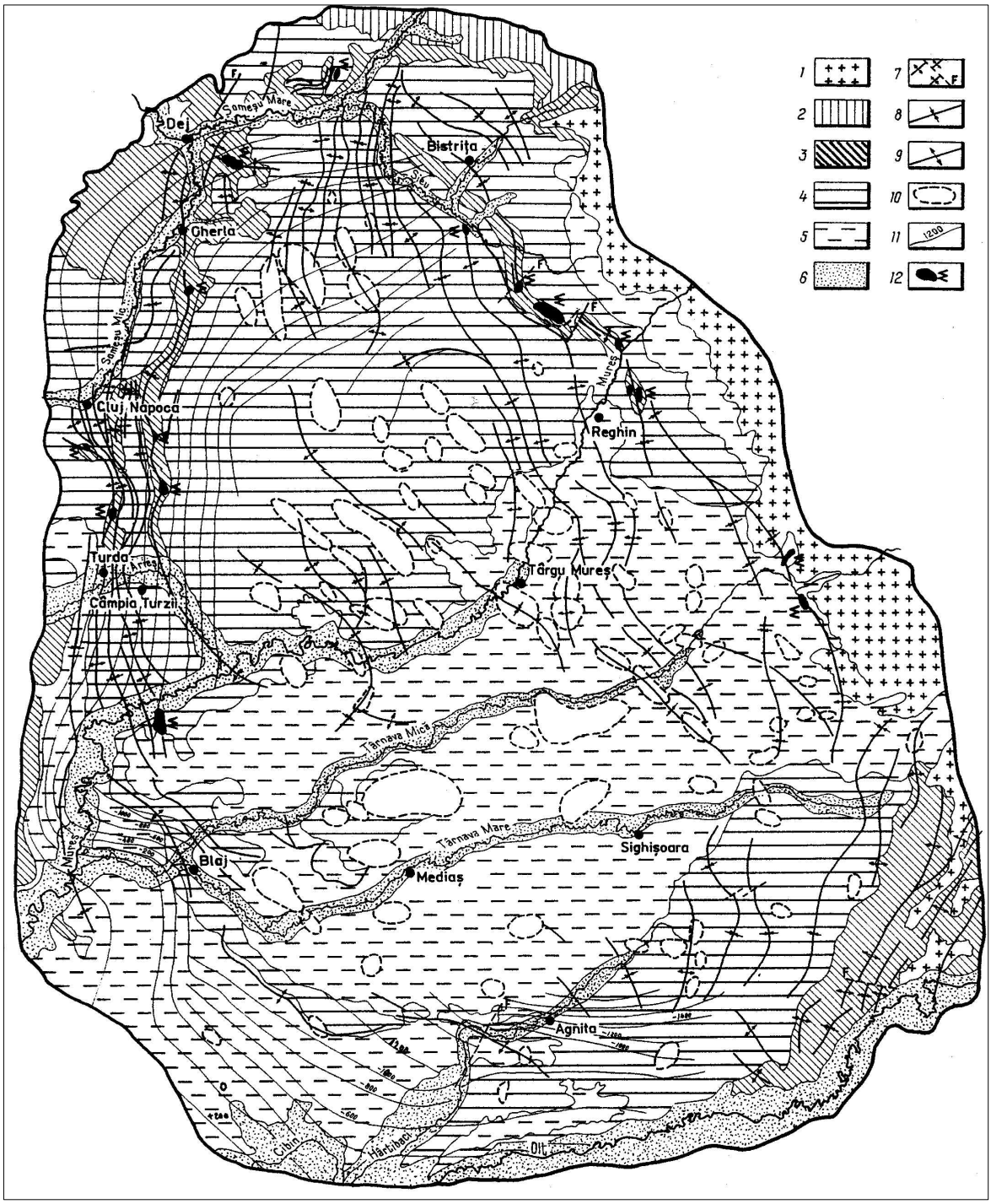

Figure 1. The tectono-geological map of the Transylvania Depression: *1. Agglomerate plateau; 2. Helvetian deposit; 3. Badenian deposit; 4. Sarmatian deposit (Vh+bs$_1$); 5. Pannonian deposit; 6. Quaternary deposit; 7. Anticlines fault and synclines; 8. Diapir synecline; 9. Diapir anticline; 10. Dome and brahyanticlines; 11. Isobaths of Dej volcanic tuff; 12. Salt massifs.*

The action of the tectonic, geologic and physic-geographic factors, has determined the establishment of a structural edifice that is marked by a pale geographic evolution common with the Carpathian space. The tectonic "game" of the neighbouring mountain (uplifts or settlements) have stimulated or slowed the process of genetic settlement or erosion, conditioning the regional inequality of the deposits and the differentiated character of the settlements. The orientation of the diapirical cockles, domes, and brachiantyclinals in the area of the Transylvanian Depression, according to the geophysical prospects, is the consequence of the movement of the Transylvanian microplate. The badenian deposits situated above the salt stratum show a sedimentation regime of great deepness (offshore) with a pelitical and pelitico-psamitical litofacies, developing an increase of the percentage of the sand from North to South. The improvement of the mechanisms and processes of modulation is offered by *the matrix of the Pleistocene-Holocene shaping* of the Neocene "feeling" of the Transylvanian Depression that is put under the incidence of climatic oscillations and the manifestations of the neotectonicity, in the general effort to improve the domelike structure, brachianiclynals and diapirical cockles.

Vulnerability and risk in the Transylvanian rural territorial planning

The localization of risk appears as a highly important element in *territorial planning* and most of all in argumenting the strategies of sustainable development of a territory (area, region). *The geomorphic risk* is indissolubly connected to the *vulnerability of the geomorphic systems* at a certain time of the natural or anthropic impact.

The vulnerability of a geomorphologic system, no matter its nature or dimension is defined through the capacity of this one to be affected by hazard. Accepting this postulate, *the vulnerability* of a system supposes potential dysfunctions inside, that are in a close relation with the resistance to the change of the system, respectively to its *sensitivity* and *capacity to adapt* to the new conditions of environment, according to the regional and local transformations. *The resilience of the geomorphologic system* appears on this basis of the adaptation, and supposes that the capacity of the systems should be capable to cancel the perturbations created, and coming back to a way of manifestation similar to the one before the perturbatory events (hazard).

The activities of territorial planning must be conceived on the basis of the durable development and sustainability of the terrain paradigms. The chosen strategies for reaching the goals, on *long time* (guaranteed protection), on *medium time* (adopting some flexible methods of guaranteeing investments) and on *short time* (without guaranteeing the investments), together with *the assurance of the risks,* be it natural or associated to the human communities, they have to prove the efficiency of the territorial planning activities.

This supposes the analysis of the resilience of socio-systems and geo-systems, respectively of the capacity of the society (human community) to surmount and reconstruct itself after an event (risk) or of the geosystems to go back to the equilibrium state (graded) after an extreme event (hazard, risk).

The human communities must be aware of the dangerous phenomena, processes and to establish programs in order to commonly react to the risk, based on education about risk and building a society with risk (respectively co-living with the risk).

The changes that came in *the rural Transylvanian space* after 1990 are conditioned by the right of propriety over the land and the small possibilities to agriculturally exploit it, due to the absence of a capital. By its excellence, the monastic Transylvanian space is not a space with great agricultural productivity. The anthropic intervention in the rural Transylvanian space can be expressed through actions with contradictory character: some aggressivity controlled by *the pre Decembrists cincinal plans* and a subliminal exploitation by the "post Decembrists" farmers. These aspects are territorial expressed by the intensity of the contemporary geomorphologic processes: pluvio-denudation, flows, ravinetion, settlement, terrain slides, creep.

The applications realized during the project "*The plan of arrangement and development of the Periurban of the City of Bistrița"* have revealed the contradiction between the aspirations of the periurban and urban areas of Bistrița. The ageing of the population, the rural exodus

towards the urban place, the migration to the European space caused the dysfunctions that appeared in the geographic space of Bistrița. The abandonment of the agricultural fields, due to the impossibility of exploiting them, the absence of morpho-technical means for exploiting, or the absence of some financial funds to be able to assure the payment of the services, has lead to some new relations between valley and cliff. The agricultural fields not worked for many years have transformed into areas of retaining humidity, building up sectors of high humidity between the cliff and the meadow, but also decreasing the actions of the torrential organisms or of the instability of the previous activated landslides. The orchards from Dumitra, Livezile, Unirea, Şieu-Măgheruş, Viişoara, Cepari, Budacu de Jos, Ghinda, represent the examples of necessity of rehabilitation towards the agricultural abandonment.

The evaluation of the anthropic implication in the contemporary morpho-dinamics in this area is reflected in the way of using the territory and the territorial restriction imposed by the presence of the diapirys, through the geo-morphologic processes it sustains, respectively the map of terrain readability (figure 2).

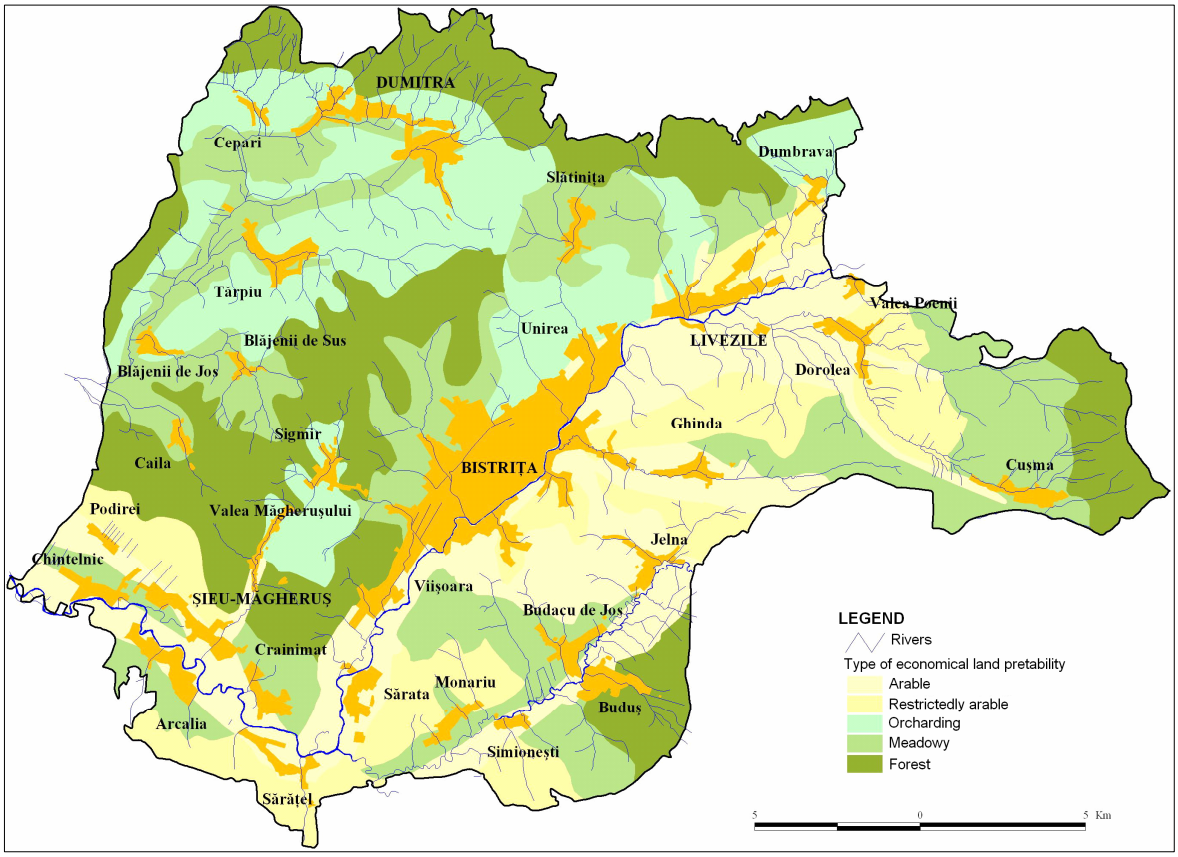

Figure 2. The map of the use of the territory (PATZ - Bistrița, 2005).

The forest fond departs in quantity the administrative components of the periurban territory: Bistrița City (3.657 ha, respectively a degree of forestation of 25,1%), the villages Livezile (2.745 ha, respectively 25,1%), Dumitra (18,6%) and Şieu-Măgheruş (1.297 ha, respectively 21,7%) Budacu de Jos (854 ha, respectively 14,1%) and Şintereag (903 ha, respectively 12,8%).

The agricultural pressure was replaced by the edilitary one. The population exodus to the communitarian European area finds its spatial identity in the new dimension of the rural.

The constructions from the 3rd millennium are taking the experience of the immigration places, respectively “houses with olane”, with almost flat roof specific to the areas without snow, in Sub Carpathian and Carpathian regions with average precipitations of 750-1.080 mm and a duration of the average snow batch of 50-90 cm of 60-80 days a year. The marketing and territorial management dysfunctions are being reflected in the vulnerability of the new rural space created.

The salt areas represent a potential for tourism that is under evaluated and improperly turned into account. The salt mines have some special conditions due to the aerosols, making them turned into health resorts for treating asthma and chronic bronchitis. The constant quite low temperature of the air is a very active element in the process of adaptation-acclimatization of the organism. The presence of the salt aerosols as solid particles, the positive air ions, the absence of allergens in the aerial salt mines and the lack of air polluters and pathogen germens give the salt mines the opportunity to offer the best conditions for speo-therapy and climate-therapy.

The treatments are now being made in good conditions at Praid, where there is also specialized assistance in breathing diseases and are open to public (for visiting and treatment). Associated to the curative treatment as speleotherapy and climate-therapy the salt mines are associating in the diapirical cockles and balneal tourism (Ursu Lake, Aluniş Lake, Tăul Negru Lake etc, in Sovata, using the saprogenic mud and the heliothermy phenomenon, specific to the salt lakes with pluvial and fluvial alimentation.

The vulnerability of the peri-urban area of Bistrița to the contemporary geomorphic processes. Methodology and results

The factorial analysis led to the identification of the unproductive areas with recent landslips, muddy flows, collapse, crumbling. By comparing them with the productive areas (grazing fields, hay fields, forests, orchards) the vulnerable areas could be delimitated (Livezile 6,7 ha; Cuşma 2,7 ha; Blăjeni 1,3 ha).

The next stage consisted in identifying the forest areas, affected by geomorphologic contemporaneous processes and their reference to the productive areas (Bistrişa, Cuşma Blăjeni); the identification of the agricultural areas with secondary hydrical processes conditioned by the contemporary morpho-dynamic: areas excessively moistured due to the slow drainage caused by the vegetation: Dumitra (7,8 ha/3,77%), Cepari (1,80 ha/1,76%), Tărpiu (3,30 ha/2,55%). The final stage has been marked by the drawing out of the balance territorial which describes the territorial dysfunctions induced by the geomorphologic processes in the periurban area of Bistrita. On the basis of this balance we elaborated the map of the vulnerability on this territory and we established the measures for preventing the risk situations caused by the contemporary geomorphologic processes.

The objectives of territorial equipping derived from *the SWOT analysis of Bistrița* countersigned:

- the stabilization of the slopes affected by geomorphologic contemporary processes determined by the natural precipitations;
- the improvement of the natural drainage and the agro-pedo-ameliorating works: Sigmir, Valea Jelnei, Valea Budacului);
- the capture of the slope springs (Dealul Ghinzii, Dealul Cocoşului, Bazinul Dorolea);
- the restoring of the abandoned fruit growing surfaces;
- the expulsion of the natural causes which leads to the acceleration of the pouring torrential erosion;
- the saving of the soil with graminaceae in order to unsettle the torrential flow; the expulsion of the anthropic causes that lead to: the acceleration of the torrential erosion and the presence of the settlement processes;
- the drawing up of the map of the environmental risk and a plan of measures in order to improve the hot spots (*the SWOT analysis*) of the periurban area through the regaining into the economic circuit and into the terrains with geomorphic restrictions; the drawing up of a map to indicate the natural risks and the protection measures.

The achievement of the vulnerability maps

The instability of the geomorphologic systems is considered to be a function of their sensitivity, respectively the answer of the inner changes like: meteorization, slope, geochemism or external changes like: precipitations, thermic oscillations, mechanic actions, anthropic impact,

but also an attribute of the fragile relations between the components of the geomorphologic system.

The potential vulnerability amplified by hazard is going to express the proportion of the geomorphologic risk, respectively the losses of human lives and material and cultural goods:

$$R = V \times A$$

R – geomorphologic risk;
V – vulnerability;
A – hazard (fr. Aléa).

Drawing up a report on the vulnerability of a morpho-geosystem, on its sensitivity, on the measure of the answer given to the impulse, we achieve a regionalisation of the vulnerability regarding a certain process (sliding, settlement).

The evaluation of the progress of the periurban in Bistrița and its hierarchic evolution supposed the next steps: the inventory of the factors and conditions that define the vulnerability of the geomorphologic systems: lithologic, tectonic, climatic, hydrologic, biotic and anthropic; the delimitation of the areas, zones, regions with specific vulnerability (ravinetion, torrential, landslides, settlement, creep, mud flows, land flows, rocks and snow avalanches); the hierarchy of the vulnerability of the areas according to the frequency, intensity, and importance of the process (phenomenon, event) and the degree of activity (active, passive, reactive); the construction of the vulnerability map and its legend.

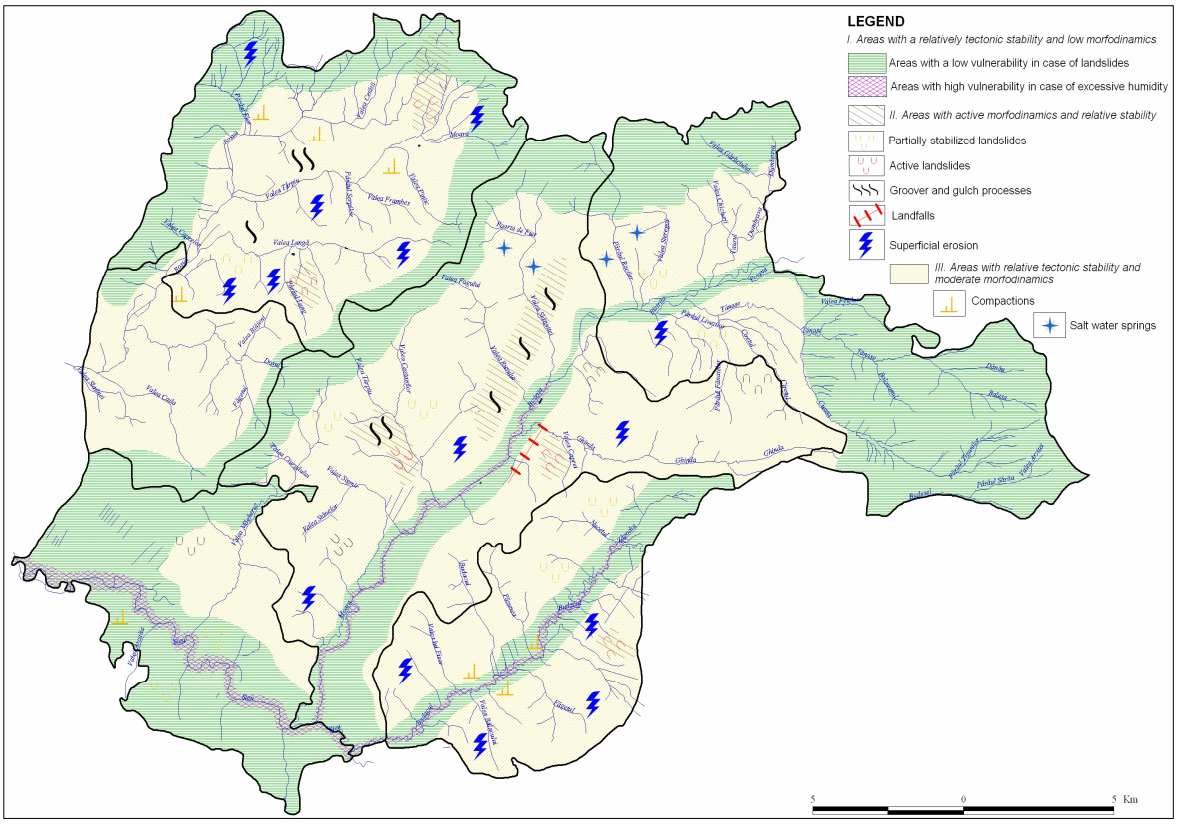

Figure 3. Vulnerability map (PATZ - Bistrița, 2005).

The activities of assessment regarding the conditions that define the vulnerability or the instability of geo-morphosystems have followed a regional, geomorphologic study: the marking of the area and the spatiality approaches to the close areas, the identification of the specific parameters of the area and their integration in the general approach of long lasting development of the region.

The basic idea of this kind of studies is that of preventing and fighting against anthropic and natural risk. The geomorphology researcher is the one who must identify the unstable areas from a morphodynamic point of view, which could produce such risk phenomena.

The identification of the unstable morphodynamic areas imposed the spreading out of the following activities: the analysis and the interpretation of the photos taken from plane, the morphometrical and morphological analysis of the relief on topographical maps (Gauss for Romania) at a scale of 25.000 and 50.000; the analysis of geological maps and stratigraphic columns; the use of thematic surveys at a institutional level (town Mayors, woodsy centres, cadastral offices, civil defence, water fuels and local transport).

A synthesis of these activities has been materialised into the map of the vulnerability of the territory (figure 3).

It is reported to every process capable of making the territory instable (and especially in geomorphologic terms the instability of the cliff), respectively the vulnerability of the territory to processes of linear erosion (fluvio-torrential); the vulnerability of the territory to processes of: sliding, settlement, collapse, solifluxion and creep, flowing etc.

In the process of territorial planning, the morphometrical and morphological analysis of the terrain is directed to the security of the constructions, the productivity of agriculture, the shaping of the areas with no or minor risk in the projection of constructions; the delimitation of the areas with subsoil resources of a national importance, the area of seismic impact; the areas of tectono-erosion etc.

The legend of vulnerability map is going to reflect the gradually increase of the dangerous phenomena from a small vulnerability to a medium and an extremely huge vulnerability.

The projection of the territorial dysfunction on the map of vulnerability reflects a wide perception of the public towards the aggressiveness of the contemporary geomorphologic processes and performs a civic attitude for protecting the rural and its cultural and natural values.

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