Babes Bolyai University Cluj Napoca

Doctorate School of Geography

Doctorate Thesis

Risks associated to geomorphological processes in Cluj metropolitan area

Doctorate thesis leader,

Prof. Univ. Dr. Ioan-Aurel IRIMUŞ

Doctorate student,

Ion Danci

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Introduction

The need and importance of studying the phenomena and processes of risk arises from the impact that events and / or natural phenomena have on humans and on its socio-economic activities (agriculture, tourism facilities, construction, communication paths, and so on). The concept of risk includes several components: the thing that can happen (phenomenon), its environmental context, disaster, consequences it can produce, relative uncertainty of the event itself.

To understand the concept of risk, it's necessary the analysis of terms commonly used in explaining risk (hazard, sensitivity, resilience, fragility, vulnerability, hazard, exposed value, etc..), Development of concepts and definitions to assess and quantify risk. Nationally since the early 70s there were concerns in the field studying geomorphological phenomena causing risk, maps were made with the territorial spread of landslides in Romania, taking into account the geomorphologic factor as the main factor producing landslides . Currently in Romania, Decision no. 447/2003, regarding the development and content of risk maps naturally to landslides, presents the overall sequence of operations for the preparation of risk maps naturally to landslides and content.

Urban development in the form of expansion of the space environment and its evolution with integrated within its suburban settlements (or suburban, suburban, regional, etc..) it's best known in developed countries, is characteristic of a new phase of urban development, further stages of concentration of population and forming the present city suburbs. Experts have called this new socio-spatial reality as metropolitan areas, metropolitan areas, or in the case of very large, as urban areas.

Many of strategic urban planning issues at European level can not be treated directly than at metropolitan areas to facilitate the development of production, exchange and consumption of goods so as to avoid obstacles due to the excessive localism and centralism in national level.

Identification and location of geomorphological processes plays an important role in shaping, designing, developing and implementing local development strategies, regional and national. Once identified geomorphological processes can proceed to achieve the necessary risk maps in urban studies and planning, from which it will draw the expansion of settlements, the location of economic, (prohibitions, conditions), real estate investment, transport networks, and so on

CAP. I Cluj Metropolitan Area

1. Study argumentation

Development of metropolitan areas facilitates integrated land use planning at the regional level and by this to diminish the disparities between the center and surrounding area, caused dispersion in the demographic, social and economic structure, imbalances related to transportation, infrastructure financing, reserves residential and commercial space, removing or reducing such disparities will lead to improved quality of life.

Existing studies in the administrative territorial units, or those foreseen in the PUG's of these administrative-territorial units, with some exceptions, are insufficient, unclear and difficult to implement by the public authorities.

Uncontrolled expansion of real estate held in 2006-2009 led to exercise additional pressure on land, all major real estate investments were made without any risk studies or impact assessments, or if those exist there are not taken into account in the issue of building permits. This estate expansion has led to new investments in infrastructure, communications path, network utilities, etc., of course without conducting risk studies, or to take into account existing ones.

Another motivating aspect in the choice of the research theme is to try, through this study, to aware the local authorityes to develop risk studies, well documented to be included in the documentation of spatial and urban planning.

2. General and specific objectives of the study

The main objective of this thesis entitled "The risks associated to the geomorphological processes within Cluj metropolitan area" is to identify contemporary geomorphological processes wich associates risk, identify, locate and delineate areas exposed to the hazard, to geomorphological risks , analysis of elements at risk and mapping vulnerability, preparing maps of the geomorphologic risk, wich subsequently helps to quantify the geomorphological risk and establish strategies and measures to prevent and mitigate the effects of geomorphological processes generating risk.

Specific Objectives

- define notions of risk and risk geomorphologic
- content analysis research approach and methodology of geomorphologic risk metropolitan area Clujana
- delineation and description of Cluj metropolitan area in terms of physical-geographical conditions and socioeconomic

- highlighting the relationship between the physical-geographical and geomorphological processes generating risk
- graphical representation of the morphometric characteristics of the land
- vulnerability assessment through relationships, interactions between elements at risk
- informing the authorities, investors and the general public on risk areas
- identification of new land required for real estate development, unexposed to risk

3.Chronological highlights of geographical studies in Cluj metropolitan area.

International risk research

Geomorphological risk study was spurred whith the production of ZERMOS maps and appliance of the method Champenoise Amat-Chantoux, (1979), Chazan, (1974), Carrara (1977, 1983); Calcagni, Palmemtola, Pennetta, (1982), Mejia-Navaro , (1994), Alexander (1993, 2005), Smith (1996), Guzzetti, F., (2005), Fall, M,. Azzam, R., Noubactep, C., (2006), Dai FC, Lee CF, (2006), Aykut A. et al., (2007), demonstrates that geomorphological risk research and develop of risk maps represent permanent concern to the geomorphologs. Researchers like Crozier, (2005, 2010), Dauphine, (2001), Cutter (2001), Thywissen, (2001), Irasema Alcantara-Ayala (2002) Giacomeli, P., Sterlacchini, S., Mattia De Amicis, (2003), Guzzetti, F., (2005, 2006), Crozier, MJ, Glade. T., (2005), Thywissen, Katharina (2006), Lee, S., et al. (2004, 2006, 2007), Fell, et al. (2008), Yilmaz, Isik., (2009), and so on, are among the researchers who played a major role in the study of natural hazards.

Risk research in Romania

Romanian geographical and geomorphological school expressed concerns in the field of geomorphological risks and hazards (Morariu, 1960, 1968), Cotet, (1978), Ielenicz, (1986), Smith, (1981), Zavoianu, Dragomirescu (1994), Mac (1991, 2002, 2003), Grecu, (1997, 2003, 2004), Surdeanu, (1998, 2002, 2007, 2008), Blăteanu, (2001, 2010), Armas, (2001, 2006, 2007), Sorocovschi (2001, 2003, 2005, 2007), Petrea (2002, 2003), Irimuș, (1991, 2002, 2005, 2006, 2007, 2008, 2010), Posea, 2003, Rădoane, (2003, 2007, 2010), Osaci -Costache, (2003), Philip (2009), Neagu (2012), and so on, are some of the researchers who contributed to the development of some models of assessment and vulnerability of the land mapping to identify perimeters likely to trigger hazards or geomorphological hazards, the development of monitoring programs and projects for areas vulnerable, to experimentation with techniques and methodologies for investigating geomorphological risks.

Studies regarding risk in the metropolitan area of Cluj

Geomorphological risks studies and related fields within the metropolitan area of Cluj, were undertaken by researchers in particulary belonging geomorphological school in Cluj, among which, Maxim, I. AL. (1960), Morariu. T., Mac, I., (1969), Ciupagea, D., (1970), Belozerov, V. (1972), Mac, I., Irimuş, IA, (1991), Crisan, I., Zemianschi, S ., Cacoveanu, H., (1994) Pop, G., (2001), Surdeanu, V. Goţiu, D., Russian, I., Cretu, A., (2006), Bilasco, Del.., Horvath, Csaba ., Cocean, P., Sorocovschi, V., Oncu, M., (2009), Irimuş, IA, Petrie, D., Rusu, I., Corpadea, A., (2010), Covaciu, F, I ., (2010), Poszet, S., (2011), etc.

4. Content and limits of the metropolitan area

All studies and projects aimed at developing a region must take into account the physical - geographical and human factors. No plan for territory maintenance, or an integrated development plan, as our case is, are not done (or should not be done) without preparing studies on natural hazards. Risks involve hazard and vulnerability.For the hazard research is necessary to analyze in detail of the land from the physical-geographical perspective and for vulnerability analysis is necessary an socio-economic analysis of the elements at risk (population, infrastuctură, etc.).

The content of metropolitan area notion in the international literature

A metropolitan region covers an area containing a number of autonomous administrative units, focusing both on metropolitan independence and business coordination within the metropolitan area (1993, The World Conference, Tokyo). The term of metropolitan area, or region, area, conurbations or large urban areas, is defined as "a continuous urban area with large dimensions witch work as a single multifunctional region".

Richard Forstall, Richard Greene and James Pick (http://ro.wikipedia.org/) tried to give a coherent definition of the concept of metropolitan area with their study , like this they define metropolitan area as "an urban center, with surrounding areas, which follows two principles, (1) only 35% of the population are employed in agriculture or fishing, and (2) over 20% of the labor market travels in the urban center.

The content of metropolitan area notion, in romanian literature

Although it did not specifically referred to metropolitan areas more researchers have addressed some issues of territorial planning, territory organization planning, spatial planning, concerns witch are related to the idea of "metropolitan area". Of these authors mention Dorel Abraham (1991), John Ianoş, (1987.1994, 2004), Cucu Basil (1997), Cocean, (2007, 2009), Benedek (2001, 2002, 2004), Deaf Basil (2003, 2005), Spânu Radu Calin (2000, 2002, 2004), Daniela Antonescu (2003), Dan John Mănăstireanu, (2010), etc.

Iordan I., (2003) defines the metropolitan area as "territory and its villages located around large cities, which have links with the city in one or more fields of activity, permanent or temporary, providing a wide range of influences"

Metropolitan areas are made in order to develop economically certain settlements , so you can easily access european funds. Basically the settlements were associated in an metropolitan zone (area) can benefit from European funds witch are more consistent.

CAP. II Research Methodology

Research methodology and terminology issues are of particular importance in the study of the risks by technical-scientific terms and by harmonizing current legislation with terms, concepts and research methodologies. Risk study is systemicly organized as a discipline, appeared in the last years due to legislative requirements, more stringent, adopted in terms of occupational hygiene, environment pollution, etc environmental protection in general.

2.1. Materials and work hypotheses

For objective scientific approach was consulted topography, geology and geomorphology, hydro-climatic data, and for the extraction, building and graphical analysis was used ArcGIS 9.3 software with its applications.

2.2. Agreed research methodology

Research methodology and development of the work consists of several stages: consultation bibliography, research planning documentation, documentations of mapps, topography, consulting maps, orthophotoplans (including satelite images) identifying contemporary geomorphological processes, field research for measurements and observations of geomorphological processes, etc..

In our scientific approach these research activities will be phased as following:

- preliminary stage of the data collection, bibliografy studies, analysis of the hazard concepts, vulnerability, risk, metropolitan area
- analysis of territory, in terms of the physico-geographical caracteries, structure of metropolitan area, network of settlements, population, etc.
- identify geomorphological processes, classification and inventory of them, morphometric and morphographical analysis
- slopes susceptibility analysis to geomorphological processes
- hazard analysis
- vulnerability assessment by analyzing elements at risk

- identify areas at geomorphologyc risk (buffer zones), establishing the level of risk
- risk management, methods, strategies
- legislation on geomorphological hazards

Agreed criteria in establishing and defining metropolitan area of Cluj. Cluj metropolitan area was established by Decision no. 415/2008 of Cluj Napoca City Hall and on the decisions of the local councils of communes Aiton, Apahida, Baciu, Bonţida, Borsa , Caianu, Chinteni, Ciurila, Cojocna, Feleacu, Floresti Gârbău, Gilău, Jucu, Petreştii de Jos, Tureni, Vultureni, witch are part of the metropolitan area. These administrative units fall within a radius of 30 km around the city of Cluj-Napoca, the optimal distance for the development of peri-urban area.

Identification of geomorphological processes in Cluj metropolitan area was done by consulting bibilografy and existing risk studies, the orthophotoplans (2002, 2009), the 1:25000 scale maps, as well as the internet site google earth using ArcGIS 9.3 software and observations field.

To determine surface erosion I've used the USLE (Universal Soil Loss Equation) model, adapted after the version ROMSEM (Moţoc M, Sevastel M., 2002), a method which we consider appropriate in our case.

Research and evaluation methodology for natural hazards provides information about the probable location and severity of dangerous natural phenomena, likely to behave in a certain time in a certain place.

Legislation in Romania, according to Decision no. 447/2003 are set out detailed rules on how to design and the content maps of natural risk to landslides, showing the overall sequence of operations of preparation of risk maps naturally to landslides and content.

A much simpler method of hazard analysis and preparation of hazard map is that of considering the geomorphological processes affected area of the total area considered.
Research methodology of the elements at risk and vulnerability are numerous, offering a wide range of possibilities for evaluation.

A simple approach in the study of vulnerability is linking vulnerability with a single parameter (eg population density of the area at risk, Fell, 1994). Of course this method has a high degree of approximation reflected in the quality of results, but taking into account as many parameters to reduce the degree of approximation. This simple method is suitable for determining the degree of vulnerability to large areas of land,situation in which we find ourselves in our scientific approach.

Another way to assess vulnerability is to analyze the elements at risk, Giacomeli, P., Sterlacchini, S., Mattia De Amicis, (2003), this method expresses the monetary value of the items at risk.

Research methodology of the risk. Risk research involves identifying potential hazards and vulnerability assessment, based on physical and human elements of socio-cultural dimensions.

Risk research methodology involves three steps: identification, analysis and risk prioritization. (Irimuş, 2007).

Risk identification is the most important step in researching and assessing risks. Identification of geomorphology risk areas concerns the delimitation of areas to be considered more fragile in comparison to others in their neighborhood who were never affected by such processes.

Risk analysis estimates the probabilities and expected consequences for an identified risks or exposures and effects. Consequences will vary depending on the magnitude of the event and the vulnerability of affected items.

Risk ranking can be achieved according to age, intensity of linear erosion processes, mass volume displaced, frequency or cyclicity of processes and geomorphological hazards, impact costs / development, relationship demand-request in the realestate politics or agrotourism policies, but also according to the forecast achieved, regarding the reactivation of some processes or their continuity .

Another simple method for research and risk analysis that after identification, digitization, geomorphological processes and geomorphological processes mapping, to see the influence of these processes on socio-economic components, we will use the extension "buffer zone" of the software components ArcGIS 9.3, to simulate the space manifestacion area and socio-economic objectives likely to be affected (farmland, infrastructure elements),in case of expansion of these processes.

CAP. III Content of the hazard notions, vulnerability , risk , metropolitan area

3.1. The concept of hazard

Analysis of commonly used terms (hazard, risk, sensitivity, resilience, fragility, vulnerability, hazard, exposed value), with respect to extreme events is based on established definitions and quoted by most authors, aiming their critical evaluation and formulation of arguments on which could be intergarte in a logical scientific representations. (Mac, Petrea, 2002)

3.1.1. The definition of hazard

Hazard (term derived from the Arabic word az-zahr = dice game) is defined in the Explanatory Dictionary of the Romanian Language, like "circumstance or combination of circumstances (favorable or unfavorable) whose cause remains generally unknown." As we see in the above definition the emphasis is on randomness and unpredictability in the occurrence hazard. (Zavoianu, Dragomirescu, 1994 cited by Irimuş, 2007)

3.1.2. Notions and elements connected to the concept of hazard

From the analysis of the definitions given to the term hazard, we can identify concepts and elements related to this concept. As mentioned in the definitions of hazards, they involve a number of concepts which are generally the defining attributes of the concept of "hazard", their presentation helps to better understand the definitions given to the concept of hazard.

3.1.3. Hazard Classification

Hazards can be classified according to different criteria: origin, mode of expression, frequency, damage caused, the degree of potential harm, etc.. Also in these types it's required a nuanced analysis and classification of hazards that are part of the same genetic tipe based on strict elements such as, how it manifests, the impact on the physical frame (at the level of components or assembly), impact against humans, damage that could be recorded, etc.. An important classification is that after origin, which divides hazards into two categories, natural hazards and man-made hazards (due to human intervention). If in the case of the anthrophic human influence is evident (directly or indirectly), the term natural does not exclude human presence, on the contrary,it implies it. Quality of hazard it's not given by causing damage, but of the probability of their occurrence. This could be considered the characteristic that distinguishes the extreme natural phenomenon of the hazard. (Surdeanu, Goţiu, 2008).

Geomorphological hazard is defined (Gares et al., 1994) as "a threat or a series of threats to the human community, resulting in instability of the earth's surface features even while the causes of this instability are other (ex. Endogenous: earthquakes; exogenous: marine, climatic, anthropogenic, etc.). ".

3.1.4. Hazard Perception

Perception plays an important role in human existence. The senses are first to receives information from the outside which was later processed by the thinking process. Processing depends on a number of factors extrinsic or intrinsic, which have either a restrictive character or favorable one (degree of training and development of human society, the political world attitude, personality of the subject). Contemporary society's attitude is very important in the perception of hazards related to the danger that lies in them. It is necessary to do some material and human efforts to prevent and reduction of the hazards effects, otherwise, no actions or decisions inconsistent with the facts can lead to amplification effects.

3.2. The concept of vulnerability

The concept of vulnerability is used very differently across literature. There are three study currents in defining vulnerability.

The first trend focuses on the exposure to biophysical hazards, hazardous conditions, human occupancy of hazardous areas, the degree of loss due to hazardous events and the analysis of the characteristics and the impact of this hazardous events (Alexander, 1993).

The second trend is showed in the social context of threats and it concerns the community's capacity to cope with vulnerability and resilience.

The third trend combines both the approach of vulnerability as a danger, and a social reaction and the action to possible events (Weichselgartner, 2001), currently third trend gains in importance in recent years.

Romanian legislation by HG 447/10.04.2003 for the approval of the methodological norms regarding the drafting and content of natural risk maps to landslides and floods, defines vulnerability as "the degree of loss from 0 to 100% resulting in a phenomenon likely to produce human and material losses."

Vulnerability is defined by the dictionary IDNDR (1992) as "the degree of loss (from 1% to 100%) resulting from a phenomenon potentiality to cause casualties and property damage." Vulnerability highlights the degree to which man and his assets are exposed to the various hazards, indicating that the damage could produce a certain hazard.

3.2.3. Basic notions in vulnerability study

Resilience is the ability of the geosystem to maintain the structural and functional integrity in disturbance conditions like the speed of returning to equilibrium conditions by assimilating changes (quantitative, qualitative) induced by disturbances. (Mac, Peter, 2002). Resilience means the extent to which a system has the ability to recover from a hazard manifestation thus negating the turbulences produced by the manifestation of the phenomenon.

Sensitivity can be defined as the measure (speed or proportion) that changes the geosystem or a component of this in conjunction with a stress factor whose magnitude is determined (Mac, Peter, 2002).

Fragility is a measure resulting of the sensitivity of a system correlated with it's resilience in response to some type of disturbance and the size of it. (Mac, Petrea, 2002).

In other words fragility involves the system capacity to revert to a previous manifestation similar to the previous disruptive event.

Susceptibility to loss is a function of fragility, resilience and sensitivity of a system (Mac, Peter, 2002) relationship is directly proportional.

The value displayed refers to the element that must withstand the event and can be expressed by the number of human presence, the value of a property, by production activities, natural resources exposed by a particular hazard. (Sorocovschi, 2003)

3.3. Concept of Risk

Risk can not exist outside human networking with some events that can not be controlled, involving the initiative and the ability of choice of humans . It can be expressed as product of the probability of an event with a high potential for damaging the interests of the human community and the extent of the consequences arising from its production. Complexity of a system, a risk, or a disaster is primarily linked to the large number of factors, components and impacts. The risk is quantified through imminent or caused damage, but it always involves the notion of probability of occurrence. (Sorocovschi, 2003).

HG 447/10.04.2003 for approving the methodological norms regarding the elaboration and content of natural risk maps to landslides and floods, defines risk as "mathematical likelihood estimation of casualties and material damages over a refered period (future) and in a given area for a particular type of disaster. "In case of the geomorphological processes the risk represents material damage and potential human losses caused by the occurrence of these phenomena.

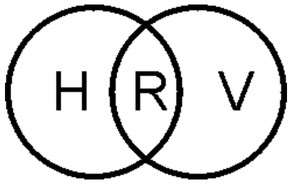
Risk is defined as the probability of human exposure or his property to the action of a specific hazard. The risk represents the probable level of casualties, number of injuries, damage to property and economic activities, of some natural phenomenon or group of phenomena in a certain place and a certain time (Bălteanu, Raduta, 2001).

Risk is a concept that expresses the probability of harmful consequences or losses (lives, injuries, affecting environmental components) resulting from interactions between natural and anthropogenic hazards and vulnerability. It is important to note that risks can not exist outside the human component. The risk is linked to human presence in the territory, able to realize the causes and consequences of random phenomena. In the absence of human community there would only be hazard not risk, regardless of size and consequences of extreme events on the landscape. (Armas, 2007).

Conventionally, risk is expressed by the formula:

$$R = H \times V$$

Risk is at the intersection of hazard and vulnerability (Cutter, 2001).



Causal relationship between hazard (H), risk (R) and vulnerability (V)

3.3.1. Risk Classification

Risks are classified by source, genesis, (generated by natural phenomena caused by human activity) after effects (primary and secondary) after their temporal manifestation (episodic, permanent) by the amount of damages, etc..

Geomorphological risk

Geomorphological risks arise from the instability features of the earth's surface (Gares, et al., 1994). They show a difference from other types of risk because they require, often, a gradual change which may leave room for successive adjustments of the human community. Land areas most exposed to geomorphologic risk are slopes that support accelerated manifestation of gravitational processes (rolling, landslides, subsidence, landslides, mudflows, and so on,).

CAP. IV The natural resources of the metropolitan area of Cluj - premise in generating geomorphological hazards

4.1. Elements of spacing.

Cluj county,in which is framed the metropolitan area , administrative and territorial unit of Romania from Transylvania, part of the North-Western Development Region (Northern Transylvania), located between parallels 47 º 28 '44 "and 46 º 24' 47" northern latitude and 23 ° 39 '22 "and 24 º 13'46" eastern longitude, at the contact of three natural representative units, Apuseni Mountains, Somes Plateau and Transylvanian Plain.

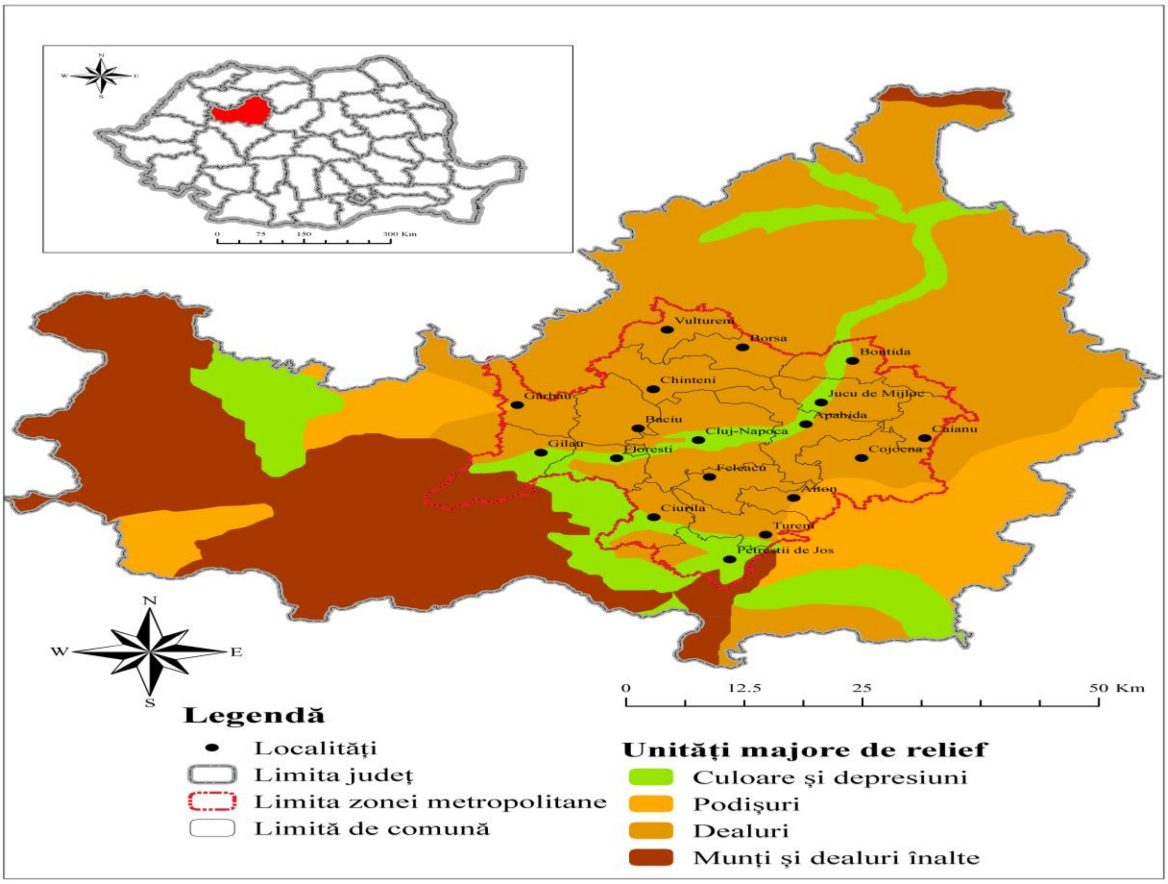


Fig. 1. The metropolitan area of Cluj – Fitting in the territory

Although we do not fully agree with the constitution and current limits of Cluj metropolitan area in our scientific approach we take into account these limitations, conforming to our legislation because is the only way this study will be able to find a practical application .

4.2. Geology.

Of an geological point of view, Cluj metropolitan area is stretching across two major structural units: the crystalline-mesozoic of the carpat orogen and formations belonging to the Transylvanian Basin. (Ciupagea, 1970).

Crystalline-Mesozoic area consists of crystalline rocks, dolomite and granite (Massif Gilău-Muntele Mare) banatitic eruptive type (mainly dacites, rhyolites and andesites) and some areas of mesozoic limestones (Trascau northern extension to the Hăjdate –Tureni area).

4.3. The morphology of Cluj metropolitan area

The landscape of the metropolitan area looks like a amphitheater, which descends from the west, southwest, trough northeast, east, from the mountain area, Somes Plateau (Cluj and Dej Hills) to the Transylvanian Plain limit between these two landscape units is given by Somes small corridor in north, to Cluj-Napoca, Zapodie valley, the eastern part of the massif Feleac, Racilor Valley to the lower corridor of Aries. Metropolitan area territory is overlapping in the north over Cluj and Dej Hills, located in southern Somes Plateau (to be precise the Hills Cluj), between Somes Mic corridor, in south and east, the interfluve between Borsa and Lonea valley (Ucigasului hill, 527, 6 m, Benifea hill) and in the northwest Stogurilor hill. West limit is given by Crâcinoasei Hill, Buzasului Hill, Dambului Hill (627 m) and Pietri Hill (685 m) continuing to Somes Mic corridor.

CAP. V Human Settlements and population - elements exposed to geomorphologic risk

Formation of Cluj metropolitan area was done by Decision no. 415/2008, by the Local Cluj-Napoca Council and based on the decisions of the local councils of the member municipalities, the new structure is called the "Intercommunity Development Association - Cluj Metropolitan Area" and includes Cluj-Napoca, villages, Aiton, Apahida, Baciu , Bonţida Borsa, Caianu, Chinteni, Ciurila, Cojocna, Feleacu, Floresti, Gârbău, Gilău, Jucu, Petreştii de Jos, Tureni, and Vultureni.

Cluj metropolitan area partnership was formed under a common goal of sustainable development. "Sustainable development meets the requirements of the present without compromising the ability of future generations to meet their own needs" (www.mmediu.ro).

Administrative structure.

The metropolitan area includes the city of Cluj-Napoca and these administrative units (communes): Aiton, Apahida, Baciu, Bonţida,Borsa, Caianu, Chinteni, Ciurila, Cojocna, Feleac, Floresti Gârbău, Gilău, Jucu, Petreşti de Jos, Tureni and Vultureni with associated settlements included in the administrative territory. These villages fall within a radius of 30 km around the city of Cluj-Napoca, distance (set by law), optimal, considered by the legislature to develop suburban area.

Population.

Metropolitan area total population in 2008 was 379,705 inhabitants (Department of Statistics, 01.01.2008). According to the census of 2011, the total population of the metropolitan area is 398 275 inhabitants (www. recensamantromania.ro / presa / communicate-de-presa), Cluj Napoca focuses 81% of the population.

CAP. VI Contemporary geomorphological processes in the metropolitan area of Cluj

Geomorphological processes are all processes generated by internal or external agents and lead to change (modeling) terrestrial landscape. The terminology used currently includes a very wide range of terms that differ from one researcher to another. For geomorphological processes that contribute to shaping slopes there are used several well-known terms such as slope processes, land degradation or diluvial processes, the landscape created is known under the name of deluvial relief.

6.1. Contemporary geomorphological processes in metropolitan area of Cluj

Erosion area. Special geological conditions, relief, climate, hydrography, vegetation and anthropogenic intervention in the metropolitan area of Cluj, led to the existence of some conditions of expression of the erosion process . Soils are the most affected by this process, large amounts of material derived mainly from fertile horizont being transported to the base of the mountain.

Landslides are the most important geomorphological processes in this class causing damage both to farmland, infrastructure and human settlements. Landslides are geodynamic processes with a large distribution, with different and specific production conditions. Genesis, dynamics and types of landslides are the result of interference and conditionality of structural elements, petrographic and morphological of the forms and deposits affected.

Linear erosion. By way of expression, it creates at the level of the mountain a series of landforms, through which it’s drain surplus water from precipitation. Through their collaboration on the surface of a slope, linear erosion forms (gutters, ravines, streams), compose the formation of rainfall modeling (Mac, 1980 b).

6.2. Identification of geomorphological processes

Geomorphological processes derive from the complexity of the earth's surface and the relations between natural and anthropogenic factors. At the level of Cluj metropolitan area most common geomorphological processes are landslides (present in most towns of Cluj metropolitan area), followed by torrents, ravines, areas affected by erosion.

Throughout the metropolitan area were identified and mapped (digitizing using ArcGIS 9.3 software, of the orthophotoplans) 686 areas with geomorphologic processes associated to geomorphological risk, of which approximately 300 landslides, 73 ravines, 145 streams, 123 areas with complex geomorphologic processes (landslides, torrential etc.,), 45 areas with increased surface erosion.

Identification, mapping and research of geomorphological processes will take into account the specific units of landscapes on which overlaps the metropolitan area of Cluj: the plains (Transylvania Plain), hilly unit (Cluj and Dej Hills, Feleac) mountain units (Mount Gilău), with geomorphological processes specific to each landscape unit.

Fig. 2. Landslide, northern side, Feleac

6.3. Reasons that trigger off the geomorphological processes

Geomorphological processes occur as a result of the changes, sudden or slow, of the compositional structure, hydrology or vegetation on a slope. These changes may be natural or man-made and lead to the materials instability on slopes. Landslide occurs when the cohesion strength of the material constituting the slope is overcome by the force applied on the slope. Strength of materials on the slope may be subjected by increased water content caused by torrential rains, raising the groundwater level, slope angle increased by construction, excavation, collapse or damage to slope material by natural processes or underground drainage etc.. Surdeanu, (1998), considers that all these causes can be grouped into natural and anthropogenic causes.

Fig. 3. Landslide caused by expansion of the road (southern slope of the hill Chinteni)

6.4. Slopes susceptibility to geomorphological processes

To analyze the susceptibility of slopes to geomorphological processes we perform an analysis of the morphographical and morphometric features of the landscape of Cluj metropolitan area , after which we proceed to assess susceptibility of the slopes to geomorphological processes, establishing relationships between morphographical and morphometric features and susceptibility of the slopes.

In determining susceptibility of the lands to landslides and geomorphological processes it was used the probabilistic model of rate frequency (frequency ratio model - LRM Aykut A. et al., 2007). Frequency rate is the ratio between the percentage of the areas occupied by geomorphological processes on each factor and the percentage of the total area corresponding to each factor.

In general, the prediction of modeling geomorphological processes is necessary to consider that their occurrence is defined by determinant factors and that they appear in similar conditions as the old ones. (Onac, 2010).

To determine the likelihood of geomorphological processes was calculated the rate of their frequency, according to five factors with determining role in the development and distribution of geomorphological processes, slope, orientation of the slope, land use, lithology, depth of fragmentation.

Maps of frequency rate for aggregated classes, namely the frequency rate of the factors were conducted in raster system and then "compiled" using ArcGIS 9.3 software and finally obtained susceptibility map to geomorphological processes.
For susceptibility field mapping was applied the following formula, (Bălteanu, D., Chendeş, V., Sima, M., Enciu. P., 2010).

$$S = [asp\ (15) + lr\ (5) + li\ (35) + sl\ (20) + lu\ (25)] / 100$$

S - the susceptibility
asp - slope orientation
lr – the energy of the landscape (depth fragmentation)
li – lithology
sl – slope
lu – usage of land
To obtain the final susceptibility map was applied the condition that areas with slopes between 0-2 degrees, wetlands, areas with water, etc., are not susceptible to landslides. (Fig. 4)

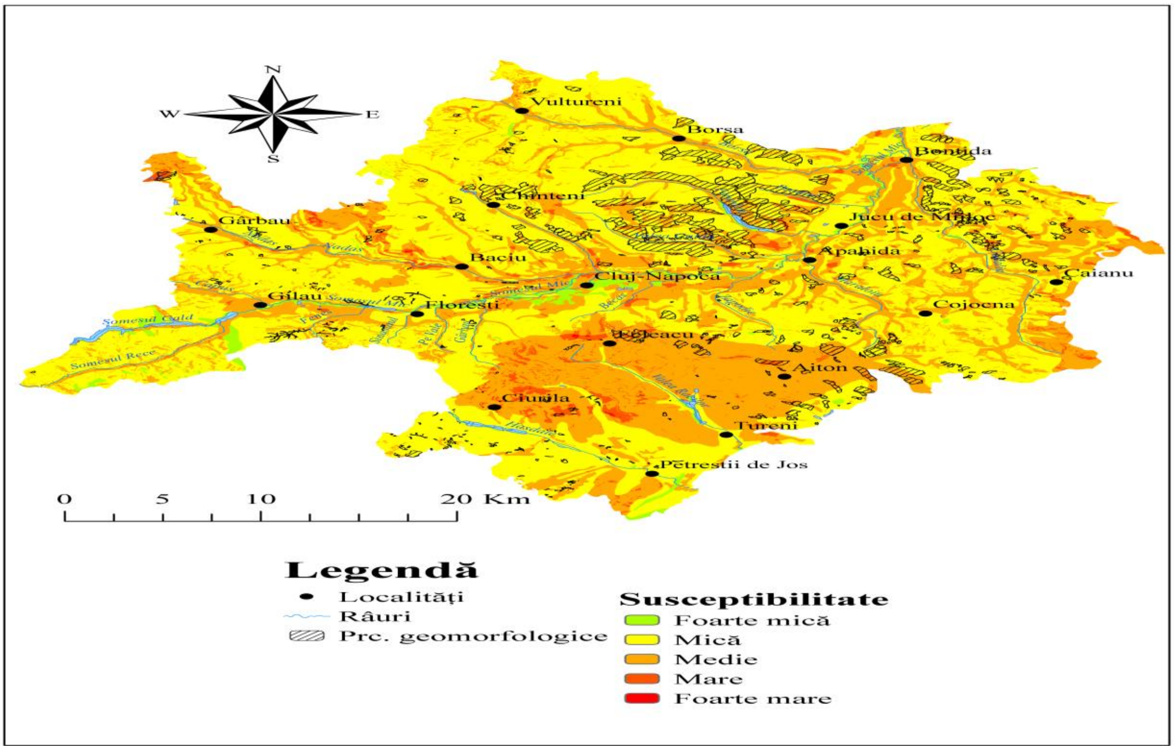


Fig. 4. Metropolitan area of Cluj - Susceptibility to geomorphological processes associated to risk.

In conclusion it can be stated that the analysis of susceptibility to geomorphological processes involve a high degree of uncertainty due to the limitations of the data used and methodological shortcomings. However this method allows a substantial qualitative and quantitative analysis (Guzzeti, et al., 2005), useful to managemet activity of the territory , necessary for public institutions to take measures to reduce the effects of hazards.

6.5 Factorial analysis of susceptibility to surface erosion

Surface erosion is a geomorphological process less visible, but with a high spatial spread. The specific mechanism of this process is particularly active during the manifestation of torrential rains, its effects being observed, indirectly, at an early stage (gradual reduction of soil fertility). Triggering surface erosion causes an intense process of removing the superior segment present in the soil profile (Parichi, M, 2000).

Pedological erosion factor is determined directly by entering in the GIS. This requires conversion of land distribution in digital format from analogue,process followed by awarding coefficients of erosion depending on the genetic type of surface coating (soil or rocks) the degree of erosion and texture, resulting in a spatial representation of the coefficient of the pedo-lithological erosion depending on the soil type of studied territory. This factor is found in Romanian literature in the form of tables. (Moţoc M., Sevastel M., 2002).

$$E = K \cdot Ls \cdot S \cdot C \cdot C_S \qquad (1)$$

Average annual erosion rate for Cluj metropolitan area was calculated according to the formula (1) using geoinformational software ArcGIS 9.3, using mathematical identifier "multiplication". Values of soil erosion obtained, range from 0 to 3 t / ha / year, values over 3 t / ha / year recorded only on islands. Thus respecting intensity classes above, it appears that the Cluj metropolitan area, most of the territory has values of soil erosion between 0 and 2.0 t / ha / year, unappreciated erosion. The small amount of soil eroded is explained mainly by the landscape characteristic to metropolitan area, hilly landscape with small slopes and grassy areas, a large extension of agricultural land mixed with natural vegetation, orchards and forest areas with clusters of well-preserved.

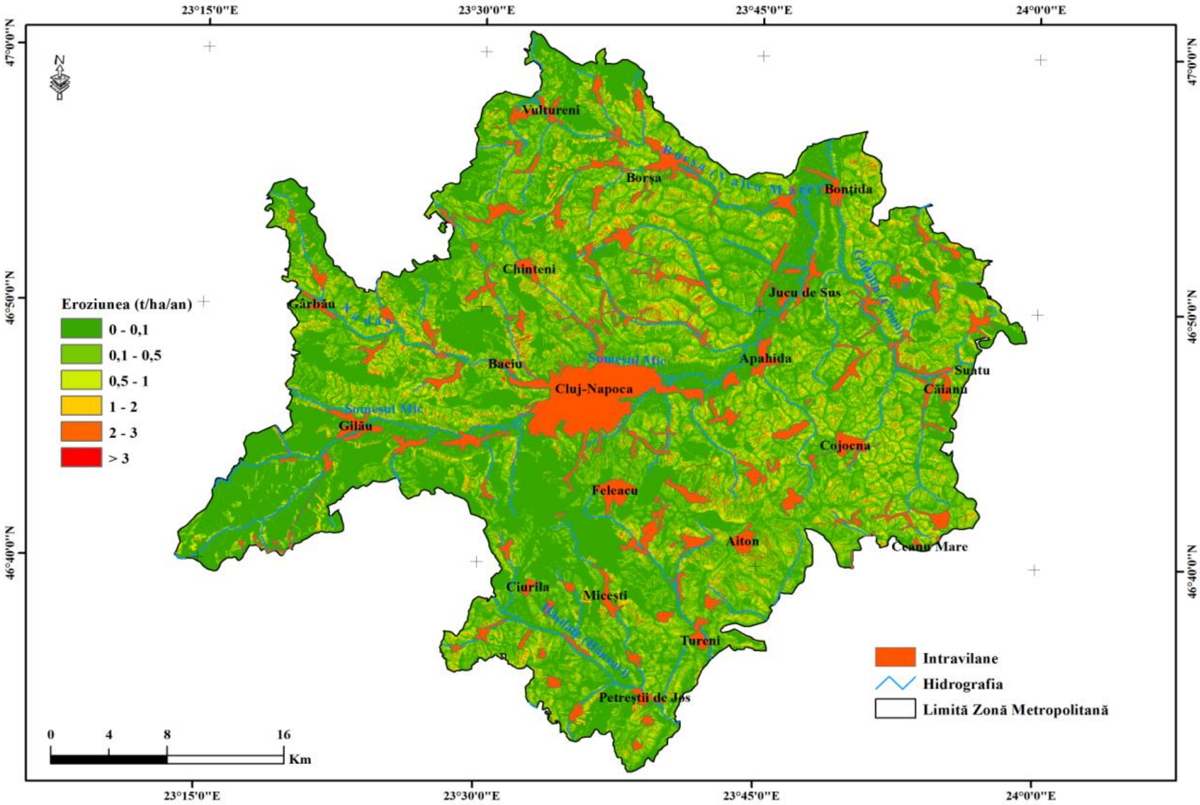


Fig. 5. The rate of soil erosion in Cluj metropolitan area

CAP. VII. Hazards associated with contemporany geomorphological processes in the metropolitan area of Cluj

For a better understanding of hazards and the possibility of practical use of the present study we considered hazard analysis of Cluj's metropolitan area should be performed as the first method, by applying methodological rules set by Government Decision no. 447/10.04.2003 published in Official Gazette no. 305 of May 7, 2003, regarding the development and content of natural risk maps to landslides and floods.

The methodology for developing natural hazard maps for landslide was done, using an integrated information system (GIS) based on computerized databases and digital maps, taken from existing risk studies. We used topographic maps (existing digitized maps, frames, orthophotoplans, (2000, 2009), satelite images, etc.). scale 1:25000, 1:5000, and there was done the topogeaphic recognition of the terrain.

Influence coefficients will be calculated based on influence factors; the lithologic factor, Ka, geomorphological factor, Kb, structural factor, Kc, hydrological and climatic factor, Kd, hydrogeological factor, Ke, seismic factor, Kf, forestry factor, Kg, human factor, Kh. Calculation of these factors is done using spreadsheet according to HG 447/2003.

Environmental hazard ratio K (m) will be determined by the formula:

$$K(m) = \sqrt{\frac{K(a) \times K(b)}{6} \times [K(c) + K(d) + K(e) + K(f) + K(g) + K(h)]}$$

Depending on the values obtained for the study area can be classified as:

• low potential, environmental hazard coefficient values between K (m) = 0.01 - 0.10

• average potential, environmental hazard coefficient values between K (m) = 0.11 - 0.30

• medium-high potential, medium hazard coefficient values between K (m) = 0.31 - 0.50

• high-highly potential, medium hazard coefficient values between K (m) greater than 0.5

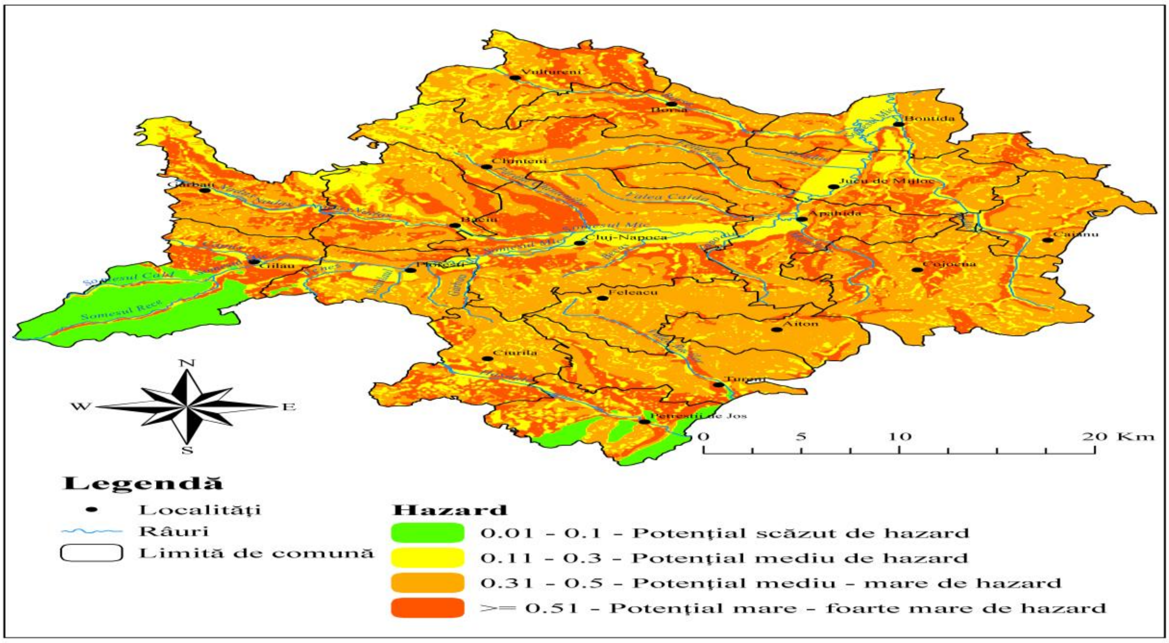


Fig. 6. Factor (Km)

A much simpler method of hazard analysis and preparation of hazard map is that taking into account contemporany area affected by geomorphological proceses , from the total area, for each administrative territorial unit basis. Starting from the premise that as a common land surface is affected by geomorphological processes, the more we believe that it is still exposed to the hazard. This method is preferable to be applied on adiministrativ territorial units.

CAP. VIII. Vulnerability of habitats in the Cluj metropolitan area to the geomorphological hazards

Vulnerability include elements of vulnerability exposed and the factors of vulnerability. Vulerable elements are mainly persons, property, business, etc.., therefore they can be social, cultural, esthetic, or environmental. Vulnerability of these elements varies by factors of vulnerability involving some type of response from the company. These factors are demographic, economic and social. Can be found and work-related factors and the use of soil factors, cultural and historical, institutional and political-administrative, etc. It is difficult to identify and quantify all indicators involved in determining vulnerability. (Surdeanu, Goțiu, 2008).

8.1. Valutation of elements at risk

The specialized literature suggests several methods, qualitative and quantitative to assess the vulnerability of a territory, using various elements at risk.

A simple approach, using primary components, for assessing the vulnerability, is to linking vulnerability with a single parameter (population density of the area at risk, Fell, 1994). Of course this method has a high degree of approximation reflected in the quality of results, but making the right choice of parameters and their numbers counted we obtain good results. Mejia-Garcia Navarre in 1996, cited by Giacomelli et al. (2003), provides an example. Such vulnerability will be expressed by the relation:

$$V = \frac{aD + bU + cL}{a + b + c}$$

D-density population

U - land vulnerability

L - communications networks

a, b, c - the share allocated to each parameter

This simple method is suitable for determining the degree of vulnerability to large areas of land, situation in which we find ourselves in our scientific approach. Using this method was set the vulnerability of Cluj metropolitan area at the level of territorial administrative units. Territorial administrative units are used because enables the possibility for socio-economic data management, demographic, which are used for calculating vulnerability. Thus we adapt this formula and we consider seven elements (primary) at risk geomorphology (population density, housing density, density of the water supply network, sewage, natural gas supplies , density of communication channels ways) , assigning each element a certain weight, depending on the degree of importance, and using ArcGIS 9.3 we establish the vulnerability map in Cluj metropolitan area according to elements exposed to risk considered for each administrative territorial unit.

$$V = \frac{(aD + bCr + cRi + dRii + eRiii + fRiv + gL)}{a + b + c + d + e + f + g}$$

D - population density
Cr - density lines of communication
Ri – water network density
Rii - sewerage network density
Riii-density of natural gas network
Riv- density of the electric network
L - number of housing density
a, b, c, d, e, f, g, - weight to be assigned to each parameter

The weight of each parameter (a, b, c, etc.) will be based on according to the value assigned, population density, communication channels, networks, housing.

After analyzing the results it is observed that territorial administrative units most at risk are those who have good infrastructure and a large population. Of course these communities will be most affected in the event of a hazard, yet also have the ability to recover quickly, just by the high degree of development. Do not forget the interest in these areas as compared, for example, with areas lacking infrastructure where a hazard will cause minimal effects (pastures, orchards) and intervention would not be so prompt, or in some cases inexistent .

Another way to analysis elements at risk is presented by Del Prete et al, (1992). This method expresses the monetary value of the elements at risk.

$$W = [Rm(Mm-Em)]Nab+NedCed+Cstr+Cmorf$$

Where:

W - amount of cost of the various components at risk

Rm - the average income of residents (per month)

Mm - the average age of the deceased

Em - the average age of residents

NAB - total population

Ned - the total number of buildings (dwellings)

Ced - average cost of buildings (dwellings)

CStr - average cost of infrastructure (network)

Cmorf - cost morphological changes

	Rm(Euro)	Mm	Em	Nab	Ned	Ced(Euro)	Cstr(Euro)	Cmorf(Euro)
Aria metropolitană clujeană	345	78,86	39,6	398275	173681	3 473 620 000,0	80 885 264,0	6240800,0

Tabel 1.Value of components exposed to risks

W= [Rm(Mm-Em)]Nab+NedCed+Cstr+Cmorf

W = [345(78,86-39,6)] 398275+173681 x 3473620000 + 80885264 + 6240800

W = $6{,}03307 \times 10^{14}$

W – value for risk expozed elements

Following the calculation made by this method the amount of cost of the components at risk is W = 6.03307×10^{14} (Euro) it represents value of the components at risk throughout the metropolitan area of Cluj. Of course this method is preferable to be applied to areas smaller and compact (localities separately).

CAP. IX Risk in metropolitan area Cluj

Risk research is a difficult process, especially as it involves calculating quantitative evaluation of various quantified indicators (hazard/susceptibility and vulnerability). In this study, quantifying risks, geomorphological was made taking into account the fact that the magnitude of risk depends on geomorphological hazards and human vulnerability elements exposed to risk (population, infrastructure, communications, networking utilities).

Risk is at the intersection of hazard and vulnerability (Cutter, 2001), establishing causal relationships between hazard (H), risk (R) and vulnerability (V). Based on these principles using techniques ArcGis 9.3 (Spatial analyst tools-Map Algebra) was done a quantitative risk assessment. We assessed the risk as the product of the amount of hazard / susceptibility to geomorphological processes and the amount of vulnerability to these processes. Global studies support this methodology of study (Dai, Lee, 2002, Zezere, 2002, Carrara et al, 2001, cited by Goţiu, 2008). This method is also used in the literature in Romania (Philip, 2009).

$$R = \Sigma S / H x \Sigma V$$

R – risk

ΣS / H - sum of hazard / susceptibility (the geomorphological processes)

ΣV - sum of vulnerability (elements at risk)

For a better quality of results and the ability to compare the results we achieve two versions of the risk map. Using the above formula, in the first phase was conducted the risk map, as the final product of hazard and vulnerability, expressed by human elements at risk. Hazard map was prepared using a simple method of analysis were has been considered contemporany geomorphological processes affected area, from the total area for each administrative territorial unit, related to the area affected by geomorphological processes. Representation of the risk in administrative units is supported by the literature in Romania (Grecu, 2003).

The second risk map will be made as the product of the sum of susceptibility to geomorphological processes (landslides, gullies, streams, areas with complex geomorphological processes) and vulnerability territory.

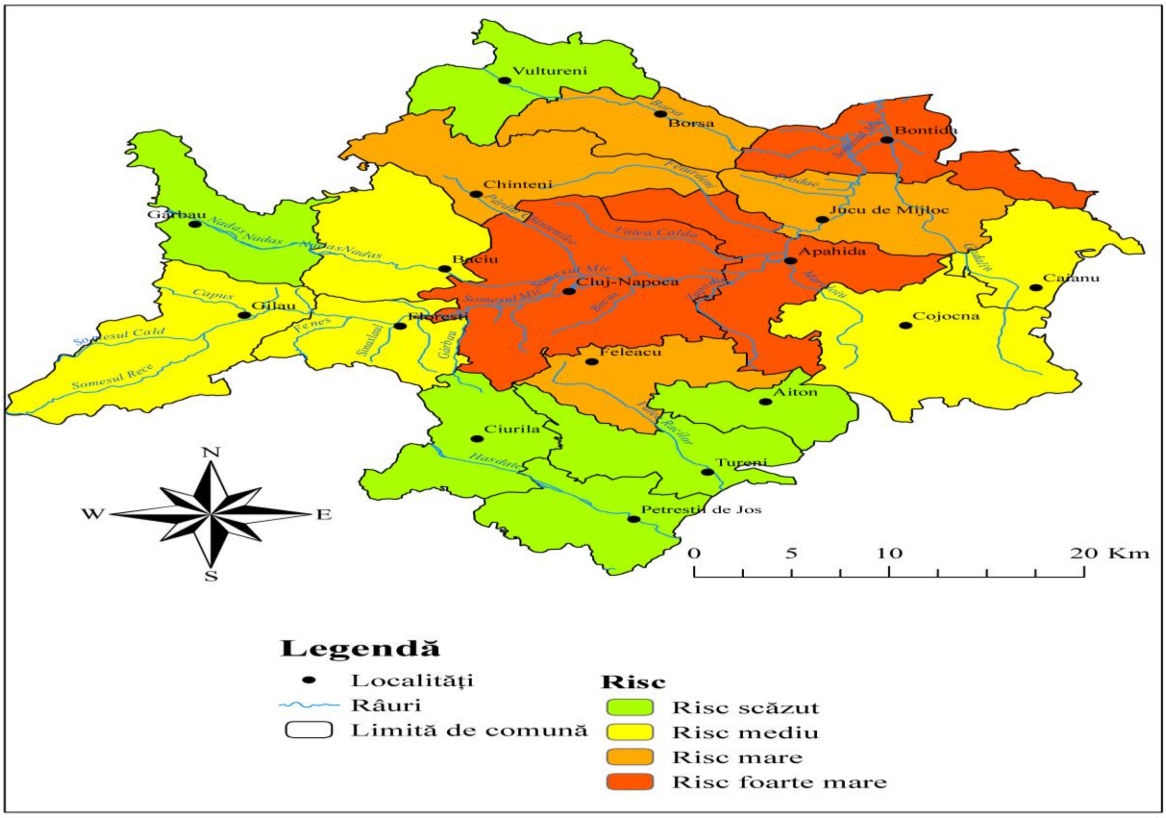


Fig.7.The metropolitan area of Cluj–Map of geomorphologic exposures (hazard-vulnerability).

The calculation for the making of these maps was possible because the data used were in raster format, pixel size was (10x10), so it made a real phenomena sizing.

The second risk map was developed as a product of the sum of total susceptibility to geomorphological processes associating risk and vulnerability of the land, expressed through the elements at risk. (Fig. 52). Analysis of the spatial distribution of values, summary of the results obtained by computer analysis and correlation with field data, reveal that dominate the areas with high susceptibility and high vulnerability to geomorphological processes, namely strong anthrophic areas (overlapping the administrative units Cluj Napoca, Apahida, Feleacu, Bonţida)

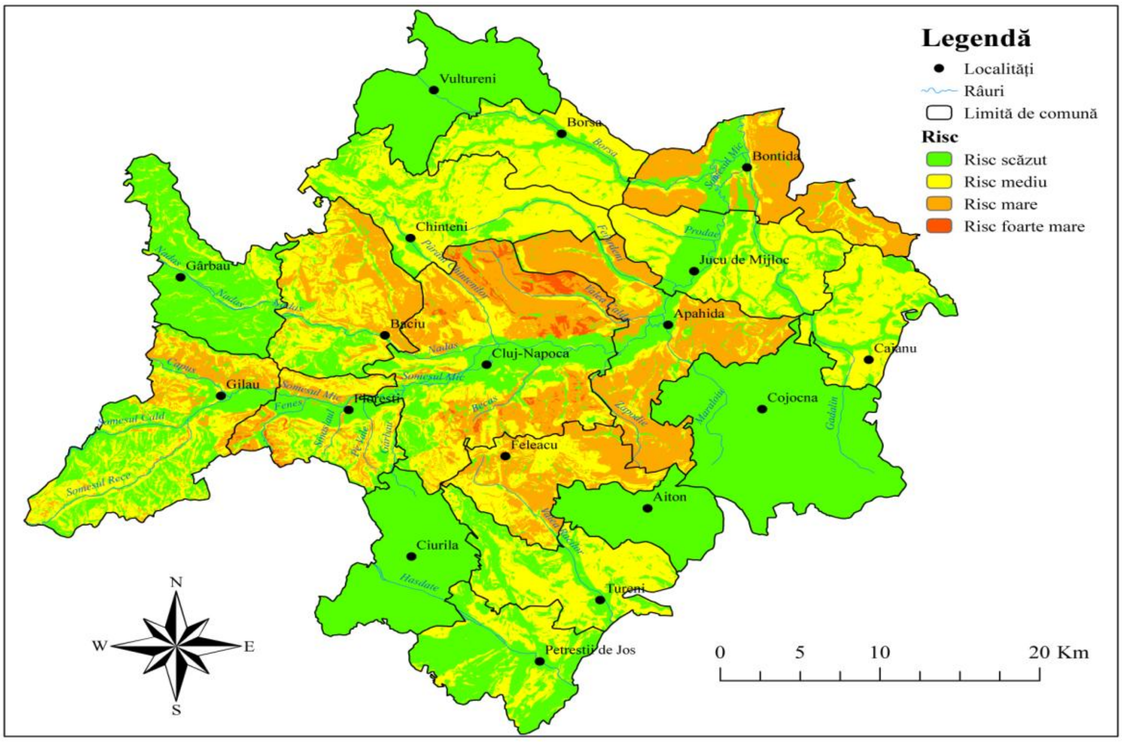


Fig. 8 Aria metropolitană clujeană - *Harta expunerii la risc (susceptibilitate – vulnerabilitate)*

Geomorphological risk assessment

A method of risk analysis and study to see the influence of geomorphological processes on land and socio-economic components, is to use the buffer zones of ArcGIS 9.3 software, which allows a simulation of the spatial manifestation area of geomorphological processes and the perception of the risk.

Buffer zones allow the visualization of vulnerable areas in the immediate vicinity of geomorphological processes. Thus was established a threshold distance of 50 m from the area of geomorphological processes, so the risk decreases from very high to low of 50 to 50 m, so at the distance of 200 m from the area of geomorphological processes impact can be considered negligible.

For a better analysis of the land this analysis was done for each territorial and administrative unit separately (Cluj Napoca and others). We will also make a monetary valuation of the land, housing and utilities and transport infrastructure affected by geomorphological processes.

With the cost of land values and housing we can calculate and predict the value of economic losses caused by geomorphological processes, but we can also calculate the cost of works to stop and prevent these geomorphological processes, because there are situations where the value of land improvement works and stoping the geomorphological processes is higher than the value of the land. Of course this should not be a stop for completing the stabilization of slopes.

CAP. X. Risk Management

Risks management can be defined as all policies, administrative decisions and operational activities that relate to various stages of risk at all levels. (Badila, 2007)

The objective of risk management is to link all elements and actors in disaster management system, to develop tools to minimize disaster based on prevention and intervention strategies, transfer and exchange of knowledge, education and decision-making techniques . Sustainable management of risk involves maintaining and improving environmental quality and quality of life, increasing the responsibility of local authorities and communities, and an integrated fair approach . (Badila, 2007)

10.1. The legislative framework in the field of risk in Romania

For a better understanding of risk management we intend to do an analysis of the legislative concerning natural hazards, under the rules of law, to analyze the main rules laid down in the General Urban Plans of settlements in Cluj metropolitan area. Thus we analyze briefly the main laws governing natural hazards, followed by a punctual analysis of the provisions and measures, in the field of natural hazards, provided the GUP communes.

Current legislation in the field of natural risks, in România, shows the importance and role of risk studies contributing in the development and evolution of any locality, creating the legal framework to study the risk, establishing measures to reduce and combat the effects.

Risk studies are done both for urban and rural areas and identifies areas with natural hazards, establish protective measures. Under the current legislation each Administrative Territorial Unit (ATU) must hold a General Urban Plan (GUP) which according to legislation (law 350/2001, law 50/1991, decision 525/1996, etc.) and Methodological Guide MG 038 - 1999, shall contain regulations on natural hazards risks and implicitly to geomorphologic risks, in each village.

10.2. Elements of disaster management

Disaster management must take into account the stages of a disaster event and includes the following elements: prevention activities, operational management activities (activities that are taken during the eveniment), actions which are taken after the phenomenon (determination of impact disaster on society).

Preventive activities

1. The first activity that we consider necessary for risk management is to identify in detail and geographical demarcation of areas with geomorphological processes which associates the risk of studied territory, in our case Cluj metropolitan area.

2. Their enrollment in plans and urban planning in general and to provide local planning regulations specific risk mitigation measures.

3. Avoiding housing and economic objectives in areas with potential risk by entering into planning documentation (General Urban Plan (GUP) and Urban Local Regulation (URL), the prohibition to build.

4. Making structural measures (work for quickly evacuating water from areas prone to landslides, consolidation, afforestation of degraded lands and watershed rainfall, torrential correction, etc.).

5. Making structural measures (programs and protective measures, public information, communication and education of its population on natural risk)

Operational management activities (which are taken during the event)

1. Warning and/or alarm units and subunits for intervention.

2. Moving on site of the intervention units.

3. Evacuation of wounded and victims, first aid, rescue those under debris, fire, gas leak elimination, evacuation goods, storage and guarding them.

4. Take measures to ensure water supply, electricity, establishing communication systems, maintaining access to the running roads in the affected areas.

Actions to be taken after the hazard

1. Event Evaluation

2. Aid for the immediate needs of the population affected by the disaster and return to normal life

3. Rehabilitation and reconstruction

4. Evaluation of managemend to improve intervention planning for future events in the affected area and elsewhere.

In conclusion we can say that the objective of risk management are those to connect all the institutions involved in disaster management system, develop strategies to intercept and minimize the disaster based on mutual exchange of knowledge and an interdisciplinary approach. Sustainable management of risk involves maintaining and improving environmental quality and quality of life, increasing the responsibility of local authorities and communities, and an integrated fair approach.

Conclusions

The need to study phenomena generating risks in general and particularly geomorphologic risks arising from the need to predict unwanted situations, economic loss or loss of life worse.

Uncontrolled spatial extent, sometimes chaotic building construction, lack of a coherent development of public authorities, the lack of robust risk studies and validation in the field, determines the possibility of generating the default risk phenomena and necessity of studying them. The concept of risk includes several components: the thing that can happen, its environmental context, disaster, consequences it can produce, relative uncertainty of the event itself. Fundamental characteristic of risk is uncertainty, namely that part which distinguishes it from damage or impact.

Research methodology requires a multidisciplinary approach, hence the multitude of definitions for these terms and concepts used in risk research in this regard is necessary to identify a common language to avoid possible confusion in the research approach, developing a unique vocabulary of some definitions and concepts widely accepted because there is a mismatch between the concepts and terms used on the use and meaning of terms used. Translation or definitions of certain languages may cause some ambiguities, creating in some instances a series of misunderstandings that lead ultimately to change the meaning of terms.

Morphographical and morphometric features of the landscape in Cluj metropolitan area, elements of climate, vegetation, excessive rainfall, etc., have contributed to the emergence and development of contemporary geomorphological processes. Large number of the geomorphological processes in Cluj metropolitan area derived from the complex traits Earth's surface.

Research of susceptibility and hazard to geomorphological processes involve a high degree of uncertainty due to the limitations of the data used and methodological shortcomings. However, this analysis is useful in public institutions engaged in the land planning managemet.

Disaster risk assessment is very important, given that hazards interact at different spatial and temporal levels, with development locally, regionally and internationally. In addition to individual study of potential hazards, it is important to understand multidisciplinary and integrated analysis of various processes, given that disasters are often complex.

Vulnerability of an area depends on the hazard, the probability that a phenomenon to manifest a certain intensity and frequency. Vulnerability depends on the number of elements at risk. Some areas will have a less or more degree of vulnerability depending on the elements exposed to a hazard, the probability that an event will take place.

Despite a well-developed legislation after our appreciation, however obvious need for cooperation, information and awareness regarding issues of disaster. Community involvement in solving their problems is very low, solutions, financial and material efforts are required from local or central authorities. Communities are unable to prevent or reduce the impact of disasters, the pre-disaster and post-disaster stages are marked by a lack of management skills and inability to manage resources.

BIBLIOGRAFIE

1. Alexander, D., (1993), *Natural Disaster*, p. 632, (http://books.google.ro/books)
2. Alexander, D., (2005), *Vulnerability to landslides, in Landslide Hazards and Risk*, Th Glade, M.G. Anderson, M.J.Crozier (ed), John Willey and Sons Ltd. London pp. 175-198, http://books.google.ro/books
3. Abraham, D., (1991), *Introducere în sociologie urbană*, Editura Ştiinţifică
4. Alcantara-Ayala, I., (2002), *Geomorphology, natural hazards, vulnerability and prevention of natural disasters in developing countries*, Geomorphology 47, p. 107–124, (www.elsevier.com/locate/geomorph)
5. Alcantara-Ayala, I., Goudie, A., (2010), *Gomorphological hazards and disaster prevention* p. 143 (http://books.google.ro/books)
6. Anghel, T., Bilaşco, Ş*., Estimatea cantitativă a pierderilor de sol din Bazinul Motru ca urmarea a eroziunii de suprafaţă utilizând tehnica GIS modelul ROMSEM de tip* USLE
7. Antonescu, D., (2003), *Dezvoltarea regională în România: concept, mecanisme, instituţii*, Editura Oscar Print
8. Armaş, I., Damian R., (2001), *Cartarea şi cartografierea elementelor de mediu*, Editura Enciclopedică, Bucureşti
9. Armaş, I., (2006), *Risc şi vulnerabilitate. Metode de evaluare în geomorfologie*, Ed.Univ., Bucureşti, p. 200
10. Armaş, I., (2007), *Riscuri naturale. Cultura riscului*, Editura Univ., Bucureşti, p. 1-27
11. Aykut A. et al., (2007), *Landslide susceptibility mapping for a landslide-prone area (Findikli, NE of Turkey) by likelihood-frequency ratio and weighted linear combination models,* Environmental, www.springerlink.com
12. Bădila, A., (2007), *Managementul riscului la dezastru - Ghidul de lucru pentru ONG-urile de mediu în prevenirea dezastrelor*
13. Bălteanu D., (1992), *Natural hazard in Romania*, RRGeogr., 36, Bucureşti, pp. 47 – 57
14. Bălteanu, D., Rădiţă, A., (2001), *Hazarde naturale şi antropice.* Editura Corint
15. Bălteanu, D., Chendeş, V., Sima, Mihaela., Enciu. P., (2010), *A country-wide spatial assessment of landslide susceptibility in Romania,* Geomorphology (www. elsevier.com/locate/geomorph 124), p. 102–112
16. Benedek, J., (2001), *Introducere în planning teritorial,* Editura Risoprint, Cluj Napoca
17. Benedek, J., (2002), *Riscurile umane*, în Riscuri şi Catastrofe, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
18. Benedeck, J., (2004), *Amenajarea teritoriului şi dezvoltarea regională*, ed. Presa Universitară Clujeană, Cluj-Napoca.

19. Belozerov, V., (1972), *Clima oraşului Cluj şi a împrejurimilor. Teză de doctorat*, UBB Facultatea de Biologie-Geografie
20. Bernard Jouve, Christian Lefevre, (2001) *Local Power, Territory and Institution in European Metropolitan Regions, Edit. Frank Cass Publishers, http://books.google.ro*
21. Bernard Jouve, Christian Lefevre, (2004*) Orizons Metropolitains*, *http://books.google.ro*
22. Bilaşco, Şt., Horvath, Csaba., Cocean, P., Sorocovschi, V., Oncu, M., (2009), *Implementarea USLE utilizând tehnica GIS, Studiu de caz Podişul Someşan*
23. Birkmann, J., (2007), *Risk and vulnerability indicators at diferent scales: applicability, usefulness and policy implications*, Environmental Hazards, no. 7, 20-31. *www.periodici.caspur.it*
24. Blaga, L., Rus, I., (2004), *Alometria şi controlul lateral al bazinelor hidrografice*, Studia, UBB, an XLIX, nr 1 Cluj Napoca
25. Bonham-Carter G.F. (1994), *Geographic Information Systems for Geoscientists: Modelling with GIS*. Pergamon, Ottawa, 398 pp. *www.periodici.caspur.it*
26. Canuti, N., Casagli, L., Ermini, R., Fanti, P., (2004), *Landslide activity as a geoindicato in Italy: significance and ne perspectives from remote sensing www.periodici.caspur.it*
27. Cheval, S., (2003), *Percepţia hazardelor naturale. Rezultatele unui sondaj de opinie desfăşurat în România (octombrie 2001-decembrie 2002), în Riscuri şi catastrofe,* coordonator V. Sorocovschi, vol. II, Casa Cărţii de Ştiinţă, Cluj-Napoca, pag. 49-60
28. Ciupagea, D., (1970), *Geologia Depresiuni Transilvanie*, Editura Academiei, Bucureşti
29. Covaciu, F., I., (2010), *Dinamica geomorfologică a sistemelor torenţiale din Podişul Someşan*, Teză de doctorat, Cluj-Napoca
30. Crozier, M.J., Glade. T., (2005), *Landslide Hazard and Risk: Issues, Concepts and Approach* in *Landslide Hazard and Risk,* edited by Thomas Glade, Malcolm Anderson and Michael J, Crozier, John Wiley, London, *(www.googlebook.com)*
31. Crozier, M., J., (2010), *Landslide geomorphology: An argument for recognition, with examples from New Zeland,* Geomorphology 120, p. 3-15, (www.elsevier.com/locate/geomorph)
32. Crişan, I., Zemianschi, S., Cacoveanu, H., (1994) *Corelaţii geomorfo-pedogenetice pe tipuri de versanţi în împrejurimile municipiului Cluj Napoca*, Studia Univ. Babeş Bolyai
33. Criste, V., Baciu, C., Gafta, D., (2002), *Municipiul Cluj Napoca şi zona periurbană*. Editura Accent, Cluj Napoca
34. Cocean, P., Irimuş, I.A, şi colab., (2004), *Planul de Amenajare a teritoriului Regiuni de Nord-Vest (PATR) Coordonate majore.* Editura Presa Universitară Clujeană, ISBN-973, p. 610-284
35. Cocean, P. (2007), *Tipologia riscurilor din bazinul inferior al Arieşului*, în Riscuri şi Catastrofe an IV, nr.4/2007, Casa Cărţii de Ştiinţă, Cluj-Napoca

36. Cutter, Susan, L., (2001), *American hazardscapes - The Regionalization of Hazards and Disasters*, (*http://books.google.ro)*
37. Dai F.C., Lee C.F., 2006. *"Landslide characteris-tics and slope instability modeling using GIS, Lantau Island, Hong Kong*", Geomorphology, no. 42. (*http://books.google.ro)*
38. Danci, I., (2012), *The Importance of Plans in Rural Land planning*, Journal of Settlements and Spatial Planning, vol. I, nr.2
39. Dauphine, A., (2001), *Risques et catastrophes*, (*http://books.google.ro)*
40. Dârja, M., (2000), *Combaterea eroziunii solului*, Editura Risoprint, Cluj-Napoca., pp.391
41. Del Prete M., Giaccari E., Trisorio-Liuzzi G., (1992) *Rischio da frane intermittenti a cinematica lenta nelle aree montuose e collinari urbanizzate della Basilicata*. Pubbl. n 841-GNDCI
42. Donisă, I., (1997) *Bazele teoretice şi metodologice ale geografiei.* Editura didactică şi pedagogică, Bucureşti
43. Duţu, M., (2009), *Dreptul urbanismului*, Editura Universul Juridic, Bucureşti, p. 370
44. Fall, M,. Azzam, R., Noubactep, C., (2006), *A multi-method approach to study the stability of natural slopes and landslide susceptibility mapping*, Engineering Geology 82 p. 241 – 263
45. Fell, R., (1994). *Landslide risk assessment and acceptable risk.* Can. Geotechn. J., 31 (2), 261-272. *www.periodici.caspur.it*
46. Fell, R., et al., (2008), *Guidelines for landslide susceptibility, hazard and risk zoning for land use planning*, Engineering Geology, 102, 85-98. *www.periodici.caspur.it*
47. Filip, S., (2009), *Fenomene şi stări geomorfologice de risc în Depresiunea şi Munceii Băii Mari,* Riscuri şi Catastrofe, vol. VIII
48. Floca, L., Floca-Reteşan, D., (2002). *Analiza percepţiei şi acceptabilităţii riscurilor environmentale – Premiză a Dezvoltării Durabile,* în *Riscuri şi Catastrofe*, Sorocovschi, V (Editor), Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
49. Fuchs, S., Holub, M., (2007), *Risk management strategies for landslides in European mountain regions – current practice in Austria and future needs,* Geographical Phorum, nr. 6, Universitatea Craiova, p. 5-21
50. Gares, P., A., Douglas J. Sherman, Karl F. Nordstrom, (1994), *Geomorphology and Natural Hazards,* p. 1-18, *www.google.book*
51. Giacomeli, P., Sterlacchini, S., Mattia De Amicis, (2003), *La valutazione del rischio di frana.* Aestimum nr. 42, www.periodici.caspur.it
52. Glade, T., Malcom, A., Crozier, M., J., (2005), *LandslideHazard and Risck, p. 801, (http://books.google.ro)*
53. Gordon, David L. A., (2006), *Planning Twentiet centerury capital Citye,* (*http://books.google.ro)*

54. Grecu F., (1997), *„Fenomene naturale de risc – geologice şi geomorfologice*", Editura Univ. din Bucureşti
55. Grecu, F., Palmentola, G., (2003), *Geomorfologie dinamică*, Editura Tehnică Buc.392 p.
56. Grecu, F., (2003), *Aspecte ale reprezentării cartografice a fenomenelor de risc geomorfic*, în *Riscuri şi catastrofe*, coordonator V. Sorocovschi, vol. II, Casa Cărţii de Ştiinţă, Cluj-Napoca, pag. 323-331
57. Grecu, F., (2004), *Hazarde şi Riscuri naturale*, Editura Universitară Bucureşti, p. 168
58. Guzzetti F., Carrara A., Cardinali M., Reichen-bach P., 1999. *"Landslide hazard evaluation: a review of current techniques and their ap-plication in a multi-scale study, Central Italy".* Geomorphology 31, 181–216, (*www.periodici.caspur.it)*
59. Guzzetti, F., (2005), *Landslide hazard and risk assessment*, 389 p. www.hss.ulb.unibonn.de/diss_online/math_nat_fak/2006/ guzzetti_fausto/.
60. Guzzetti F., Galli M., Cardinali M., (2006), *"Landslide hazard assessment in the Collazzone area, Umbria, Central Italy"*, Natural Hazards and Earth System Sciences, no.6,*(www.periodici.caspur.it)*
61. Hubert Heinelt, Daniel Kubler, (2005) Metropolitan governance – Capacity democracy and the dynamics of place, (*http://books.google.ro)*
62. Ianoş, I., (1987), *Orașele si organizarea spațiului geografic : studiu de geografie economica asupra teritoriului României,* Editura Academiei, Bucureşti
63. Ianoş I., (1994), *Riscul în sistemele geografice*, SCC, XLI, Ed. Academiei, Bucureşti
64. Ianoş, I., Tălângă, C., (1994), *Orașul si sistemul urban romanesc in condițiile economiei de piața*
65. Ianoş, I., (2004), *Dinamica urbană aplicaţii la oraşul şi sistemul urban românesc,* Editura Tehnică, Bucureşti
66. Ielenicz M., Roşu M., (1986), *Porniturí de teren pe valea Slănicului (Buzău)*, Cercetări geografice asupra mediului înconjurător în judeţul Buzău, Institutul de Geografie, Universitatea Bucureşti
67. Ielenicz, M., (2004), *Geomorfologie Generală,* Editura Universitară Bucureşti, p. 72-73
68. Ioniţă, I., (2000), *Geomorfologie aplicată*, Editura Universităţii "Al. I. Cuza" Iaşi, p. 230
69. Ioniță, I,. Niacșu, L,. *Uland Degradation and soil Conservation within the Pareshivul Mic Catchment – Tudova Rolling Hills*, Lucrări Științifice, vol. 53, nr. 2/2010
70. Iordan, I., (1973), *Zona periurbană a Bucureştilor* Editura Academiei, Bucureşti
71. Iordan, I., (2003), *România încotro? Regionalizare Cum? Când,* Editura CD Press, p. 22
72. Irimuş, I.A., (2002), *Riscuri geomorfice în regiunea de contact interjudeţeană din Nord-vestul României*, în Riscuri şi catastrofe, coordonator prof.univ.dr. Victor Sorocovschi

73. Irimuş, I. A., Vescan. I., Man, T., (2005), *“Tehnici de Cartografiere, monitoring şi analiză GIS”*. Editura Casa Cărţii de Ştiinţă, Cluj Napoca, p. 244
74. Irimuş, I. A., (2006) *Hazarde şi Riscuri asociate proceselor geomorfologice în aria cutelor diapire din Depresiunea Transilvaniei*. Editura Casa Cărţii de Ştiinţă, Cluj Napoca, p. 287
75. Irimuş, I. A., (2007), *Riscurile geomorfice şi planningul teritorial. Aplicaţie în periurbanul Municipiului Bistriţa*, în Riscuri şi catastrofe, an IV, nr. 4/2007
76. Irimuş, I. A., Pop, O., (2008), *Vulnerabilitatea teritoriului şi riscurile geomorfice în Judeţul Mureş,* în Riscuri şi catastrofe p.169-179
77. Irmuş, I. A., Petrea, D., Rusu, I., Corpade, A., (2010), *Vulnerabilitatea spaţiului clujean la procesele geomorfologice contemporane.* Studia Universitas Babeş Bolyai, p. 19-32
78. Keating, M., (2010), *The Govertment of Scotland, Edinburg University Press Ltd* (*http://books.google.ro)*
79. Keating, M., (2001)*, The European Union and the regions, Clarendon press Oxford*
80. Keating, M., (2004), *Regions and Regionalism in Europe* (*http://books.google.ro)*
81. Keating, M., (2010), *The Govertment of Scotland,* (*http://books.google.ro)*
82. Klein J.T. Richard, Nicholls J. Robert, Thomalla F., (2003) – *Resilience to natural hazards: How useful is this concept?,* Environmental Hazards, no. 5, pp. 35 – 45 Elsevier (*http://books.google.ro)*
83. Lee, S, Choi, J., Min, K., (2002) *Landslide susceptibility analysis and verification using the Bayesian probability model.* Environmental Geology 43, 120–131,(*http://books.google.ro)*
84. Lee, S., (2004) *Application of likel ihood Ratio and Logistic Regression Models to Landslide Susceptibility mapping in GIS,* Environmental Management 34 (2), 223–232, (*http://books.google.ro)*
85. Lee, S. and Choi, J., (2004) *Landslide susceptibility mapping using GIS and the weights of-evidence model.* Int J Geo gr Inf Sci 18 , 789–814, (*http://books.google.ro)*
86. Mac, I., (1976-1980), *Geomorfologie – Manual Universitar*, (Curs), Cluj Napoca
87. Mac, I., (1980,a), *Modelarea diferenţiată şi continuă a versanţilor din Depresiunea Transilvaniei,* Studia, Universitatea Babeş Bolyai, an XXV, nr. 2 Cluj Napoca, p. 60-66
88. Mac, I., (1986), *Elemente de geomorfologie dinamică*, Editura Academiei, p. 2007
89. Mac, I., Irimuş, I.A., (1991)*, Zonele susceptibile fenomenelor geomorfologice de risc în sectorul căii ferate Apahida-Câmpia Turzii,* Studia, Universitatea Babeş Bolyai, XXXVI, nr. 1, p. 3-8
90. Mac, I., (2000), *Geografie Generală,* Editura Europontic, Cluj-Napoca
91. Mac, I., Petrea, D., (2002), “*Polisemia evenimentelor geografice extreme.*” In Vol. *Riscuri şi catastrofe*. Casa Cărţii de Ştiinţă, Cluj Napoca, p. 11-23
92. Mac, I., Petrea, D., (2003), *Sisteme geografice de risc*, Rev. Riscuri şi catastrofe, Editor Sorocovschi, V., Casa Cărţii de Ştiinţă, Cluj-Napoca, p. 13-26

93. Magnaghi, A., (2006), *Dalla citta metropolitano alla regione urbana, (http://books.google.ro)*
94. Magnaghi, A., Fonfani, D., (2009), *Patto citta campagno – Un progetto di bioregione urbana per la Toscana centrale (http://books.google.ro)*
95. Majid H. Tangestani, *Landslide susceptibility mapping using the fuzzy gamma operation in a GIS, Kakan catchment area, Iran,* http://www.gisdevelopment.net/
96. Maxim, I. AL., (1960) *Calcarele grosiere de pe teritoriul orașului Cluj Napoca.* Studia Universităţi Babeş Bolyai, Seria II, Fasciculul 1
97. Mănăstireanu, D., I., (2010), *Generalităţi şi managementul riscurilor-Manual*, Bucureşti
98. Mejia-Navarro, M., Wohl, E.E., Oaks, S.D., (1994), G*eological hazards, vulnerability and risk assessment using GIS: model for Glenwood Springs, Colorado*, Geomorphology, 10, 331-354, http://books.google.ro/books
99. Micu, M., (2011) *Landslide assessment: from field mapping to risk management. A case-study in the Buzău Subcarpathians* Volume 10, Issue 1 / June 2011, pp. 70-77
100. Morariu. T., Mac, I., (1969), *Regionarea geomorfologică a teritoriului oraşului Cluj Napoca şi împrejurimilor.* Studia Universităţi Babeş Bolyai
101. Moţoc, M., Stănescu, P., Taloiescu Luminiţa, (1979), *Modele de estimare a eroziunii totale şi efluente pe bazine hidrografice mici*, Buletin ICPA, Bucureşti.
102. Moţoc, M., Sevastel, M., (2002), *Evaluarea factorilor care determină riscul eroziunii hidrice în suprafaţă*, Editura Bren, Bucureşti.
103. Neagu, Maria, L., (2011), *Riscurile natural şi dezvoltarea durabilă în bazinul morfohidrografic al Gurghiului* – Teza de doctorat, p. 220
104. Onac, B. I., (2010), *Podişul Măhăceni – Studiu geomorfologic*, Teză de Doctorat Cluj Napoca
105. Panizza, M., (2001), *Manuale di geomorfologia applicata,* http://books.google.ro/
106. Parichi, M., (2000), *Eroziunea și combaterea eroziunii solului*, Ed. Fundaţia Romania de Mâine, Bucureşti, pp.102
107. Patriche, C.,V., (2004), *Cuantificarea eroziunii solului pe baza USLE folosind SIG şi impactul acesteia asupra fertilităţii. Aplicaţie la teritoriul podişului central moldovenesc dintre râurile Vaslui şi Stavnic,* Analele universităţii „Ştefan cel Mare" Suceava Secţiunea geografie XIII, p. 39-50
108. Polemio, M., Sdao, F.,(1996) *Rischio di frana indotto dagli eventi pioggia in Avigliano (P. Basilicata),* Estratto da Geologia applicata e idrogeologia p. 23-30, Bari -Volume XXY
109. Pop, G., (2001 a) *Depresiunea colinară a Transilvaniei*. Editura Presa Universitară Cluj Napoca
110. Pop, G., (2001,b), *Carpaţii şi Subcarpați României.* Editura Presa Universitară Cluj Napoca, p. 263

111. Popescu, C., (1981), *„Aprecieri geografice asupra factorilor de mediu, a populaţiei şi aşezărilor din zona subcarpatică şi montană dintre Buzău şi Teleajen*", Bucureşti
112. Posea, Gr, A., Cioacă, (2003), *Cartografiere geomorfologică,* Editura Fundaţiei România de Mâine, Bucureşti
113. Poszet, S., (2011), *Studiu de geomorfologie aplicată în zona urbană Cluj Napoca – Teză de doctorat,* Cluj Napoca
114. Prefac, Z., (2008), *Dinamica versanţilor din bazinul hidrografic al Râmnei,* Teză de doctorat, Bucureşti
115. Radoane, M. Rădoane. N., (2001), *Geomorfologia aplicata în analiza hazardelor naturale,* Editura Universităţii p.1-9
116. Rădoane, M, Rădoane, N., (2007), *Geomorfologie aplicată,* Editura Universităţii Suceava
117. Rădoane, M., Cristea, I., Rădoane, N., Oprea, D., Chiriloaei, F., (2010), *Cartografierea geomorfologică bazată pe GIS,* Comunicare prezentată la Simpozionul Naţional de Geomorfologie, Iași, p.1-9
118. Reteşan Floca, D., (2007), Metode multicriteriale de analiză a riscului environmental, Editura Casa Cărţii de Ştiinţă 2001-2007, p. 66-74
119. Roşianu, Gh., (2010), *Modele de geomorfologie funcţională ale sistemului vale-versant din Depresiunea Transilvaniei,* Teză de doctorat, Cluj Napoca
120. Savu, Al., (1963), *Podişul Someşan – studiu geomorfologic*, *Teză de doctorat,* Cluj Napoca
121. Schilleci, F., (2008), *Visioni Metropolitane – Uno studio comparato tra l'Area Metropolitani di Palermo e la Comunidad de Madrid (http://books.google.ro)*
122. Smith K., (1996), *Environmental hazards. Assessing risk and reducing disaster*, Ediția a doua Routledge London, 389 p. *(http://books.google.ro)*
123. Sorocovschi, V., (2003), *Riscurile Hidrice,* în Riscuri şi Catastrofe Vol.2, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
124. Sorocovschi, V., (2003), *Complexitatea teritorială a riscurilor şi catastrofelor*, în Riscuri şi catastrofe, vol. II, Casa Cărţii de Ştiinţă, Cluj-Napoca, pag. 39-48
125. Sorocovschi, V., (2005), *Prevenirea riscurilor naturale,* în Riscuri şi Catastrofe an IV, nr. 2/2005, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
126. Sorocovschi, V., (2007), *Vulnerabilitatea componentă a riscului. Concept, variabile de control, tipuri şi modele de evaluare*, în Riscuri şi Catastrofe an IV, nr.4/2007, Casa Cărţii de Ştiinţă, Cluj-Napoca
127. Stănescu P., Taloiescu, Iuliana., Grăgan Livia, (1969), *Contribuţii în studierea unor indicatori de evaluare a erozivităţii pluviale*, Anuarul I.C.P.A. vol. 11 (XXXVI), Bucureşti
128. Surd, V., (2002), *Introducere în Geografia spaţiului rural*, Editura Presa Universitară Clujeană
129. Surd, V., (2003), *Geografia Aşezărilor*, Editura Presa Universitară Clujeană

130. Surdeanu, V., (1998), *Geografia terenurilor degradate*. Editura Presa Universitară Clujeană
131. Surdeanu, V., (2002*), Gestionarea riscurilor – o necesitate a timpurilor noastre*, în Riscuri şi catastrofe, vol. I
132. Surdeanu, V. Goţiu, D., Rus, I., Creţu, A., (2006), *Geomorfologie aplicată în zona urbană a municipiului Cluj Napoca,* Revista de Geomorfologie, vol. 8, p. 25-34 http://www.geomorfo.ro
133. Surdeanu, V., Goţiu Dana, (2007), *Noţiuni fundamentale în studiul hazardelor naturale,* Editura Presa Universitară Clujeană
134. Surdeanu, V., Goţiu Dana, (2008), *Hazarde naturale. Studiu de caz: Ţara Haţegului*, Editura Presa Univ.Clujeană, Cluj-Napoca
135. Thywissen Katharina, (2006), *Components of Risk. A comparative glossary,* (www. book.google.ro)
136. Voiculescu, M., (2005), *Cultura riscului şi fundamentarea ei în geografia contemporană. Un punct de vedere*, Riscuri şi Catastrofe an IV, nr.2/2005, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca
137. Weichselgartner, J., (2001), *Disaster mitigation: the concept of vulnerability revisited. Disaster Prevention and Management, 10, p. 85-94, www.periodici.caspur.it*
138. Wischmeier, W.H., (1976), *Use and misuse of the Universal Soil Loss Equation*, Journal of Soil and Water Conservation, v. 31, no.1, p. 5-9.
139. Wisner, B. et al., (2005), *At Risk: Natural Hazards, people`s vulnerability and disasters*, second edition, Routledge ed. *www.periodici.caspur.it*
140. Yilmaz Işık, (2009), *Landslide susceptibility mapping using frequency ratio,logistic regression,artificial neural networks and their comparison: A case study from Katlandslides*, Computers & Geosciences 35, www.elsevier.com/locate/cageo, p. 1135-1138
141. Y. Veyret, N. Meschinet de Richemond, N., (2003), *Les risques naturels en Europe: la dicersite des reponses*. ”Les risques” Y. Veyret, Editura SEDES Paris
142. Zăvoianu, I., Dragomirescu, S., (1994), *Cercetări asupra terminologiei folosite în studiul fenomenelor naturale extreme,* Studii şi cercetări geografice
143. **** Corine Land Cover 2002
144. ****Autorità di Bacino della Puglia, (2004), *Piano di Bacino Stralcio Assetto Idrogeologico*
145. ****Autorità di Bacino della Puglia, (2005), *Norme Tecniche di Attuazione*
146. ****Délégation aux Risques Majeurs, DRM, (1990). *Mesures de prévention. Mouvements de terrain. Plan d'Exposition aux risques. Ministčre de l'Environnement. Direction de l'Eau et de la Prévention des Pollutions et des Risques. La Documentation Franįaise.*
147. *****HG 447/10.04.2003*, Pentru aprobarea normelor metodologice privind modul de elaborare şi conţinutul harţilor de risc natural la alunecări de teren şi inundaţii

148. **** OUG 21/2004 cu modificările şi completările ulterioare
149. ****Institution of Professional Engineers New Zealand (IPENZ)
150. ****International Decade for Natural Disaster Reduction (IDNDR)
151. ****Federal Emergency Management Agency (FEMA)
152. ****International Decade of Disaster Reduction - Decada Internaţională de Reducere a Dezastrelor (IDNDR)
153. ****Planul de dezvoltare al judeţului (PDJ), Cluj 2006 – *Consiliul Judeţean Cluj*
154. **** Strategia de dezvoltare a judeţului Cluj 2007-2013
155. **** Strategia de dezvoltare a judeţului Cluj 2014-2020
156. **** Planul Urbanistic Generala al *municipiului Cluj Napoca*
157. ****Planul Urbanistic General (PUG), al comunelor; *Aiton, Apahida, Baciu, Bonţida, Borşa, Căianu, Chinteni, Ciurila, Cojocna, Feleacu, Floreşti, Gârbău, Gilău, Jucu, Petreştii de Jos, Tureni, şi Vultureni*
158. **** PID-ul Cluj Napoca
159. ****Plan de Amenajare a Teritoriului Regiuni de Nord-Vest 2003
160. ****Hărţile topografice 1:25000, 1:50000, 1:100000
161. ****SC Primul Meridian, Prospecţiuni SA, C.N.G.C.F.T. - "*Analiza fizico-geografică a teritoriului şi analiza stării hazardurilor naturale,cutremure, alunecări de teren şi inundaţii identificate şi delimitate la nivelul teritoriului judeţean şi al unităţilor administrativ* teritoriale *componente"*, Regiunea 6, jud. Cluj, 2000
162. ****SC EXPERCO ISPIF – 2009 – Harta de risc la alunecări de teren – *Studiu de caz comuna Cojocna, Feleacu*, 2010 (Consiliul Judeţean Cluj)
163. ****SC Minesa S.A – *Studiul riscurilor expuse riscurilor naturale din jud. Cluj, (2000*)
164. www.fema.qov/
165. http://www.unisdr.org/
166. http://de.wikipedia.org/wiki/UNDRO
167. http://www.fema.gov/
168. http://hazarde.lx.ro/clas.htm/
169. http://www.racai.ro/
170. http://www.igsu.ro/prevenire.htm
171. http://www.ufz.de/
172. http://books.google.ro/books
173. http://epp.eurostat.ec.europa.eu; www.insse.ro - Institutul de statistica Cluj.
174. http://ro.wikipedia.org/wiki/Categorie:Zone_metropolitane_în_România
175. http://ro.wikipedia.org/wiki/Lista_zonelor_metropolitane_după_populaţie
176. http://www.admpubl.snspa.ro/

177. http://fr.wikipedia.org
178. http://www.geography.ro/
179. http://www.apubb.ro/Documents/Neamtu_B
180. http://www.scritube.com/geografie/PROIECT-GEOGRAFIE-Valea-Hartib95336.php
181. http://www.inoventis.ro/glosar_riscuri.php#toleranta_risc#toleranta_risc
182. http://eea.eionet.europa.eu/Public/irc/eionetcircle/airclimate/library?l=/public/20
183. http://www.ziare.com/cluj-napoca/articole/salariu+mediu+net+cluj
184. www.ihs-romania.ro/dld/20051115/00_introducere.pdf
185. www.periodici.caspur.it
186. www.mmediu.ro@