CINQ CONTINENTS
REVUE ROUMAINE ELECTRONIQUE DE GEOGRAPHIE

Volume 1 / Numéro 1
Printemps 2011
ISSN: 2247 – 2290
p. 40-54

OBSERVATIONS ON THE CAUSES AND EFFECTS OF THE AVALANCHES IN PIATRA CRAIULUI MASSIF

Mădălina TEODOR

Master in Geography
Faculty of Geography, University of Bucharest
mada_4478@yahoo.com

Contents:

Cite this document:

Teodor, M., 2011. Observations on the causes and effects of the avalanches in Piatra Craiului Massif. *Cinq Continents* **1** (1): 40-54 [Available online]| URL: http://www.cinqcontinents.lx.ro/1/1_1_Teodor.pdf

Observations of the causes and effects of the avalanches in the Piatra Craiului Massif

Mădălina Teodor

Observations sur les causes et les effets des avalanches en Massif Piatra Craiului. Les avalanches représentent un hazard naturel qui se manifeste comme un glissement imprévu, dans des distances plus que 50 metres d'une quantité grande de neige, qu'arrive dans les pentes montaignes après la rupture de l'equilibre de la neige (qui a des causes diverses: climatiques, mécaniques, anthropique). Il est un de premiers agents responsables de la modélisation de relief dans l' étage cryo-nival du massif Piatra Craiului. Les régions favorables pour la formation d'avalanches sont representées par la partie supérieure des vallées torrentieles où arrivent des conditions potentielles (la pente, la manque de la vegetation, le vent, l'exposition du pentes, l'accumulation de la neige, les conditions meteorologiques etc). L'importance d'evaluer et de surveiller les avalanches n'est dû qu'elles peuvent se transformer dans un événement menaçant qui présente la probabilité à se produire dans une certaine période, étant nuisible pour l'homme, pour les bons produits par il et pour l'environnement.

Mots clés: avalanches, neige, Massif Piatra Craiului hazard.

Observații asupra cauzelor și efectelor avalanșelor din Masivul Piatra Craiului. Avalanşele reprezintă un hazard natural ce se manifestă prin alunecarea bruscă, pe distanţe mai mari de 50 de metri a unei cantităţi mari de zăpadă, ce apare pe versanţii montani în urma ruperii echilibrului zăpezii (ce are cauze diverse: climatice, mecanice, antropice). Este unul dintre agenţii principali ai modelării reliefului în etajul crio-nival al Masivului Piatra Craiului. Zonele favorabile pentru formarea avalanşelor sunt reprezentate de partea superioară a văilor torenţiale unde apar condiţii potenţiale (pantă, lipsa vegetaţiei, vânt, expunerea versanţilor, acumulări de zăpadă, condiţii meteorologice, etc). Importanţa evaluării şi monitorizării avalanşelor apare deoarece acestea se pot transforma într-un eveniment ameninţător ce prezintă probabilitate de apariţie într-o anumită perioadă, fiind dăunător pentru om, pentru bunurile produse de acesta şi pentru mediul înconjurător.

Cuvinte cheie: avalanșă, zăpadă, Masivul Piatra Craiului, hazard.

1. INTRODUCTION

Considered as a hazard, a geographical risk phenomenon, "a threatening event that shows a probability of incidence in a certain period of the year, a potentially harmful phenomenon for the human being, for the goods that he produces and for the environment" [1], we must consider time and space coordinates, which are essential in order to establish a geographical phenomenon; but the social element, the interaction with the human being and with his goods must also be taken into account.

Avalanches have three areas: detachment area, avalanche corridor and avalanche deposit. Avalanche risk is determined by the presence of geomorphic work of avalanche, by the possibility of exposing the people or their goods in its range of action. In order to measure this risk, 5 scales that asses the degree of avalanche risk (made by EISL Davos and adopted by many European countries) has five risk levels (low risk, moderate risk, considerable risk, big risk, imminent risk).

2. DATA AND METHODS USED

I have carried out observations and measurements in the areas most prone to avalanches. i have inventoried the avalanche corridors after i made researches on the field, analysed the photographs i had taken in the key points and the ortophotoplans, the satellite images from different periods of time, the topographic maps (1:25.000, 1:100.000), but also the srtm images. the observations on the field were made in each of the four seasons. the deposits made by the avalanches and the micro relief forms were charted using the ortophotoplan of the respective areas. this way, a bridge was created between the detachment area, the avalanche corridors and the forms of relief that resulted. the photographs taken on field on winter and summer helped me identify the areas most prone to avalanches.

Configuration information (slope, land cover, slope orientation, etc), climate and weather information, assessments of the hints found in the field (affected areas, deposits of debris on the base of the corridor) were taken into consideration in order to chart the avalanche production potential.

3. STUDIED ZONE

Piatra Craiului Massif is located in north-western part of Bucegi upland (Fig. 1.) and consists of a 25 kilometres ridge, being located in Braşov and Argeş counties.

This massif is formed by limestone and conglomeratic rocks, fragmented by torrent valleys and avalanche corridors. Piatra Craiului was modelled both by torrential and by snow and ice as well. Periglacial landforms are often present in the alpine and sub alpine zones.

From the geological point of view, Piatra Craiului Massif is a flank of a suspended synclinal. The limestone is from Jurassic (Kimmeridgian) and the conglomerate layer from Cretaceous (Aptian). The geologic structure is fragmented by a number of faults, disposed east-west.

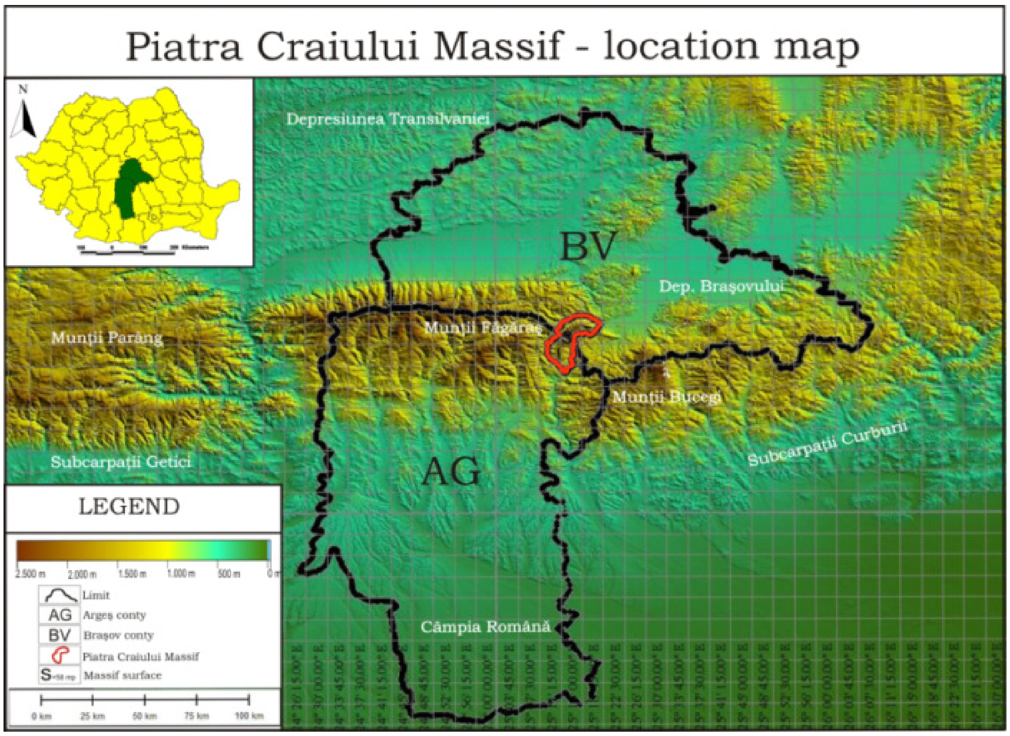


Fig.1. Piatra Craului Massif – location map

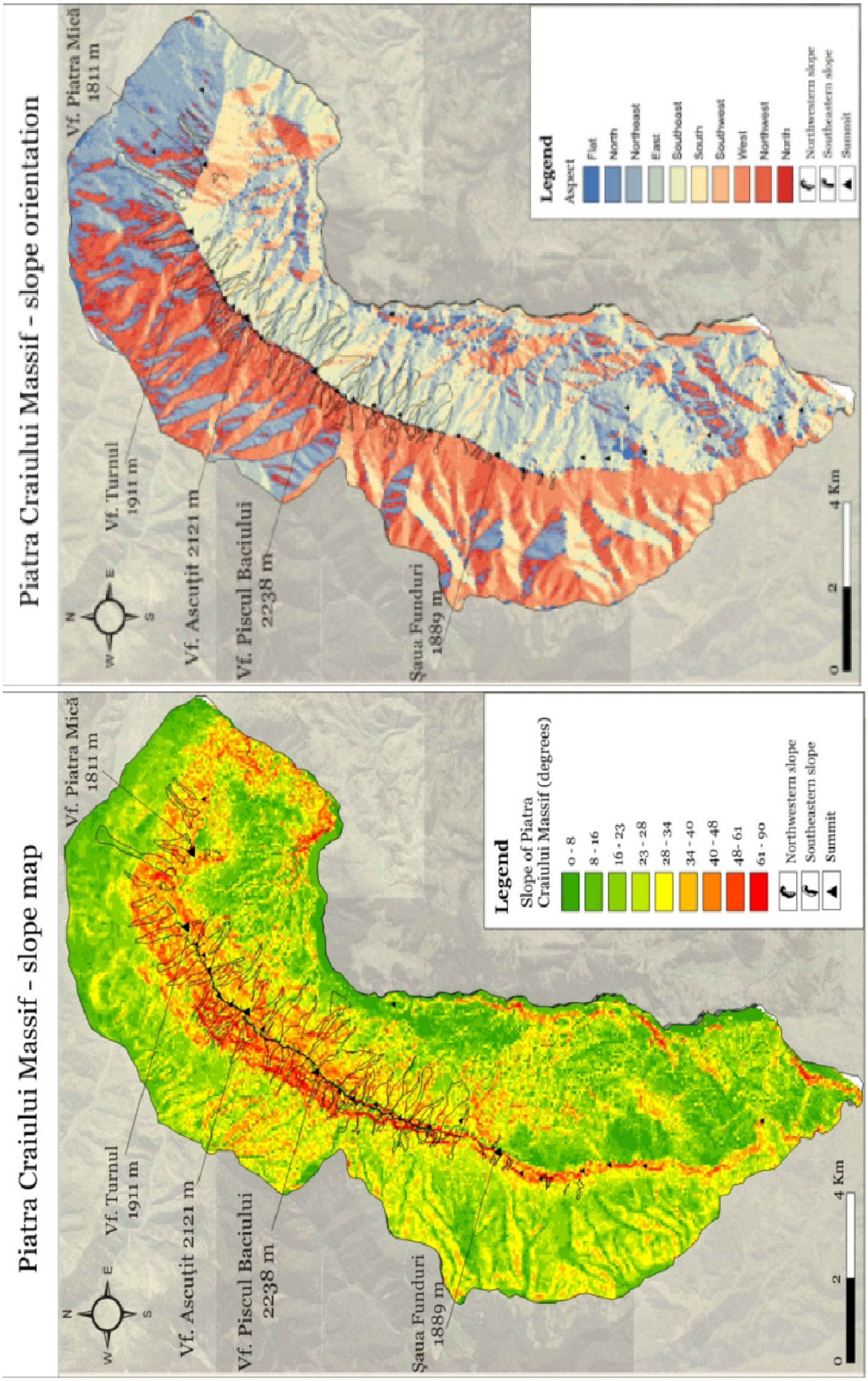
The history of avalanche researches in Romania

The first avalanches ever registered in Romania were made in the interwar period. Clubul Alpin Român (CAR) and Siebenburgischer Karpatischer Verin (SKV) talk about such recordings. Mountain tourism development in Romania, the building of the first chalets and refuges have led to accidents (avalanches) in which tourists and climbers were involved.

The present study of preoccupations regarding avalanches and methods of prevention is somehow more advanced because special teams were organized to study avalanches.

The causes of avalanches in Piatra Craiului Massif

The causes can be natural, anthropic or multiple. These are determined by the relief, snow or weather conditions.


Piatra Craiului Massif - slope orientation
Vf. Piatra Mică 1811 m
Vf. Turnul 1911 m
Vf. Ascuţit 2121 m
Vf. Piscul Baciului 2238 m
Şaua Funduri 1889 m
N
E
S
W
0
2
4 Km
Legend
Aspect
Flat
North
Northeast
East
Southeast
South
Southwest
West
Northwest
North
Northwestern slope
Southeastern slope
Summit
Piatra Craiului Massif - slope map
Vf. Piatra Mică 1811 m
Vf. Turnul 1911 m
Vf. Ascuţit 2121 m
Vf. Piscul Baciului 2238 m
Şaua Funduri 1889 m
N
E
S
W
0
2
4 Km
Legend
Slope of Piatra Craiului Massif (degrees)
0 - 8
8 - 16
16 - 23
23 - 28
28 - 34
34 - 40
40 - 48
48 - 61
61 - 90
Northwestern slope
Southeastern slope
Summit

↑ *Fig. 2. Piatra Craiului Massif – slope orientation and Fig. 3. Slope of Piatra Craiului Massif*

The relief is related to avalanches because it represents the path on which they accumulate and the corridor on which the snow slips.

The instability in the snowpack depends on the snow, on the weather conditions, but especially on the relief. In Piatra Craiului Massif the areas in which the snow mostly accumulates and forms avalanches are the ones in the upper side (the area where they form) of the valleys, e.g. Grind Valley, Vlăduşca Valley, Padinile Frumoase Valley, Urzicii Valley, etc. Thus, in summer, the valleys are represented by torrential organisms and in winter they turn into avalanche corridors

The most suitable disposition for snow accumulation and dry avalanches are the North, North-East slopes, represented in map slope orientation (Fig. 2) in blue colour. These slopes are cold and wet. The South and South-West slopes are warm and dry and are represented in slope map (Fig. 2) in light yellow and orange. These are more likely to form spring avalanches.

The relief is in association with the avalanche starting by slope and the morphology of the soil surface. Slope inclination (Fig. 3) is very important because it can determine the snow accumulation and its detachment. "Avalanches start on slopes with an angle of inclination of 30-55 degrees"[5], represented in Piatra Craiului slope map in orange and red colour, on the upper part of the ridge. Green and yellow colours represent the favourable inclination for snow accumulation.

Piatra Craiului Massif is characterized by the presence of narrow valleys with v-shaped transversal profile. These valleys are ravines, so called "Piatra Craiului-type valleys". Thus, this massif is more disturbed by spontaneous avalanches started in the accumulation area.

Soil surface morphology refers to "long, flat, convex or concave slopes and are more dangerous than the ones in treads" [5]. The rocky and grassy field in grey and turquoise present in land cover map (Fig. 4), representing the upper part of massif, are the most favourable surfaces to avalanches. The soil is missing or is very thin on a large surface and

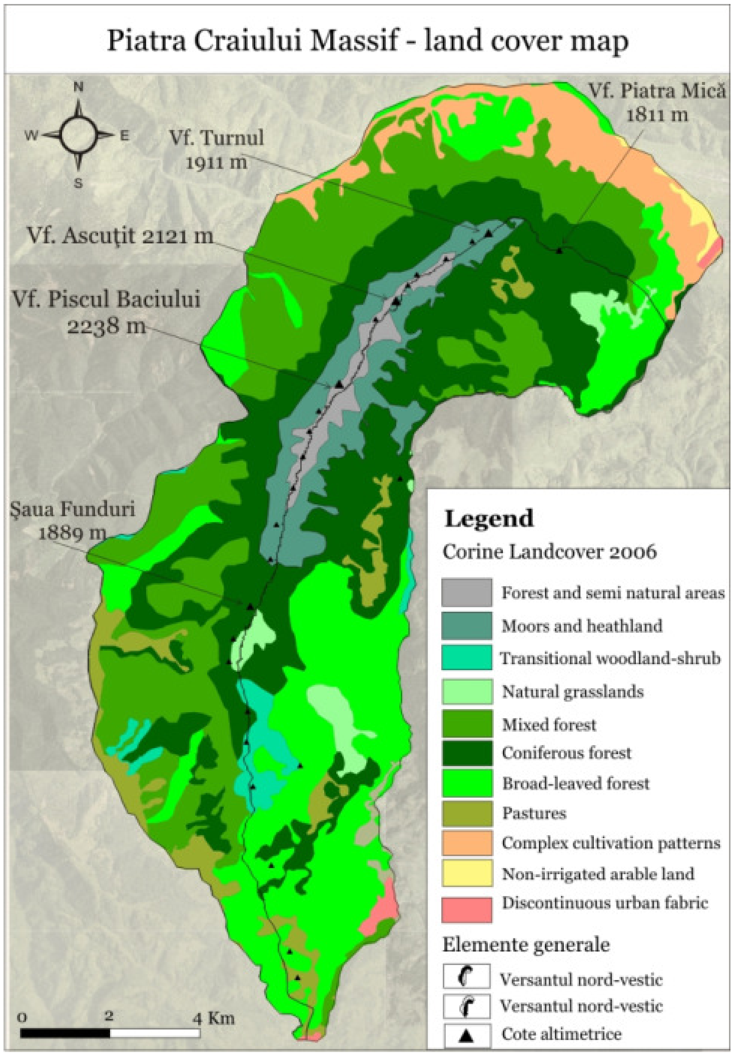


Fig. 4. Land cover of Piatra Criului Mountains

so the avalanche corridors are created. The slopes on which there are trees, juniper trees, rocky blocks, treshholds, dislevelments are less dangerous.

The snow is the main condition of starting avalanches. On its morphology depends the size, the material the avalanches take on their way down, as well as the damages and the effects caused by them. *The thickness of the snow layer* must reach 30 cm in order to become dangerous. The presence of wind determines the uneven deposit through the accumulation of a larger quantity of snow in the direction of the wind, in the areas where there are obstacles. These inhomogenous deposits are the most dangerous beacuse they can cause the forming of cornices (snow deposits on the superior side of the ridge), of wind crust,etc. *The density of the snow layer* is important because its variation influences avalanches characteristics. *The microscopic structure of the snow layer* refers to the shape of the crystals, to the percentage of water in liquid and gaseous state, but also to their variation in the same snow layer. Snow structure varies according to weather conditions during the snowfall, but also to the next ones.

Weather conditions influence directly the snow structure, determining the appearace of some layers with different structures and adhesions. Temperature through cold (under 0 ^{o}C cohesion between the snowflakes and between the new layer and the old one does not take place anymore). The warming that starts moderately favors the settlement of the new snow layer and determines the cohesion of it with the old one. If any sudden warming takes place, this will determine the melting of the snow layer (the snow becomes watery). This warming determines the appearance of „spring" avalanches during sunny days. *The wind* associated to the snowfall determines the filling of valleys and ravines with snow blown from the main ridge.

Moreover, the wind creates "wind crusts" (germ. „windgertt", fr.„palque a vent" eng. „wind slab").

Factors that cause the starting of avalanches. Avalanches take place because of a decrease in adherence; this may happen due to changes in the properties of the snow layer, to an increase or a decrease of temperature that diminishes the attraction force between the crystals. *The increase of snowpack weight* is another factor. By increasing the weight of the snowpack with new deposits, the avalanche will self-trigger.

The increase in weight can be joined by other forces such as cornices breaking, tourists, skiers, chamois passing by, sound vibrations, strong wind, etc can also provoke avalanches.

Avalanche types [11] and their effect on human factor

Avalanches are divided into five types depending on the snow quality that determines the avalanches' characteristics. The type of the snow varies in the same place everyday, every hour. Avalanches have different effects on the people caught up in them. The snow is accumulated through a succession of snow layers which are relatively different from one another and have different characteristics depending on the weather condition.

Avalanches with dry snow divide into:

a. Powder avalanche – take place when the snow is light. This type of avalanche starts after snowfalls, when there are low temperatures, especially on the Northern slopes.

These avalanches are triggered spontaneously. They have two elements: the proper avalanche and the snow cloud which comes with a loud noise. In this case, the avalanche may produce a block or an explosion of the respiratory tract of the human being, because of the high pressure, or may drown the victim because of the smooth snow particles. The chances to survive are minimal.

b. Granular avalanche: "this type of avalanche is triggered with snow formed by micro granules of 2-5 mm (fr. "gobelet", eng: „cup crystal)". The micro granules can be polyhedral crystals, with regular shapes or ellipsoidal amorphous structures."[5] The snow that corresponds to this type of avalanche can be just fallen or can be older, but whose structure has changed. These avalanches are self-triggered or can be provoked. They are silent and without cloud. The chances to survive in this case are higher. For example, such an avalanche triggered on Grind Valley in March 2005 (Photo. 1) on the eastern slope, stroked Grind Hutt and damaged it (Photo 1). In the same place, a big avalanche destroyed Radu Negru Chalet in 1953.

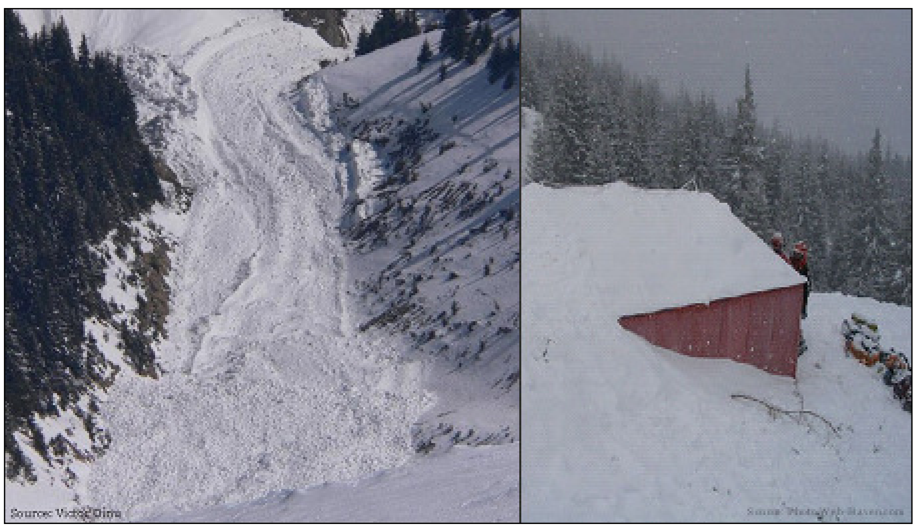


Photo.1. The avalanche which destroyed Grind Hutt in March 2005

c. *Avalanche on wind slab*: these avalanches are mainly provoked by the victims that "cut" the crust. They are called wind crusts avalanches (fr. „plaque a neige", germ „schneebrett"). This type of avalanche starts under the action of the wind that (in dry snowfalls) determines the deposit of an inhomogeneous layer of snow, with accumulations in colour and on the superior side of the two slopes of the ridge, on both sides and sometimes it can join the cornices. The danger for the victims is not that high in this case.

Avalanches with humid snow have smaller speeds and the chances to survive are higher. They divide into:

a. Avalanches with humid crusts : this type of avalanche is generally self-triggered at the warmest hours of the day and endangers people that are imprudently on the slopes at that time. They are also called ground avalanches because they sweep most of the times the entire layer of snow on the valley, boulders, vegetation and has obvious effects on the corridor. The victims surprised by this type of avalanche are buried because the snow has large density and thus, the chances to survive are low.

b. The snowball avalanche (fr. „en boule") starts in spring, on the humid and soft snow. They start with small fragments that roll down on the sunny slopes and corridors (western, south-western exposure). The snowballs can grow bigger and can trigger all the snow on the corridor, becoming dangerous for the human factor.

The effects of avalanches on the relief

"The avalanche is one of the main agent of under airy modelling of the relief in the cryonival/periglacial level, being a main agent in the periglacial and fluvionival relief" [6].

"The main action of snow avalanches is the avalanche of erosion and transport of materials on the slope, but also the accumulation of materials in the deposit area (cones of detritus, avalanche deposits, trains of detritus, etc.). Avalanches are a major factor of relief destruction.

The morphogenetic role of avalanches consists both of forming the avalanche corridors, of periglacial relief, of micro-relief and of creating favourable conditions for the development of some geomorphologic processes by removing soil and vegetation." [6]. Thus the ravines grow narrower and wider, the detritus keep on moving and the surface erosion continues.

Forms of relief that resulted from avalanche: the forms of relief that resulted from avalanches are influenced by the way in which avalanches act, by the mechanical and erosion forces with which they act. The snow can be stored on both sides of the ridge from Turnul peak to Funduri peak (Fig. 5). The eastern slope is gentle and covered by vegetation. The western slope is steeper, formed by a big limestone wall where fluvio-nival valleys are present. The "Forms of relief that resulted from avalanches" (Fig. 5) map reflects the areas exposed to avalanche risk. The results are represented by stone torrents (both sides, eastern and western – Brâul de Mijloc (1600m)), cones of detritus, avalanche corridors, etc.

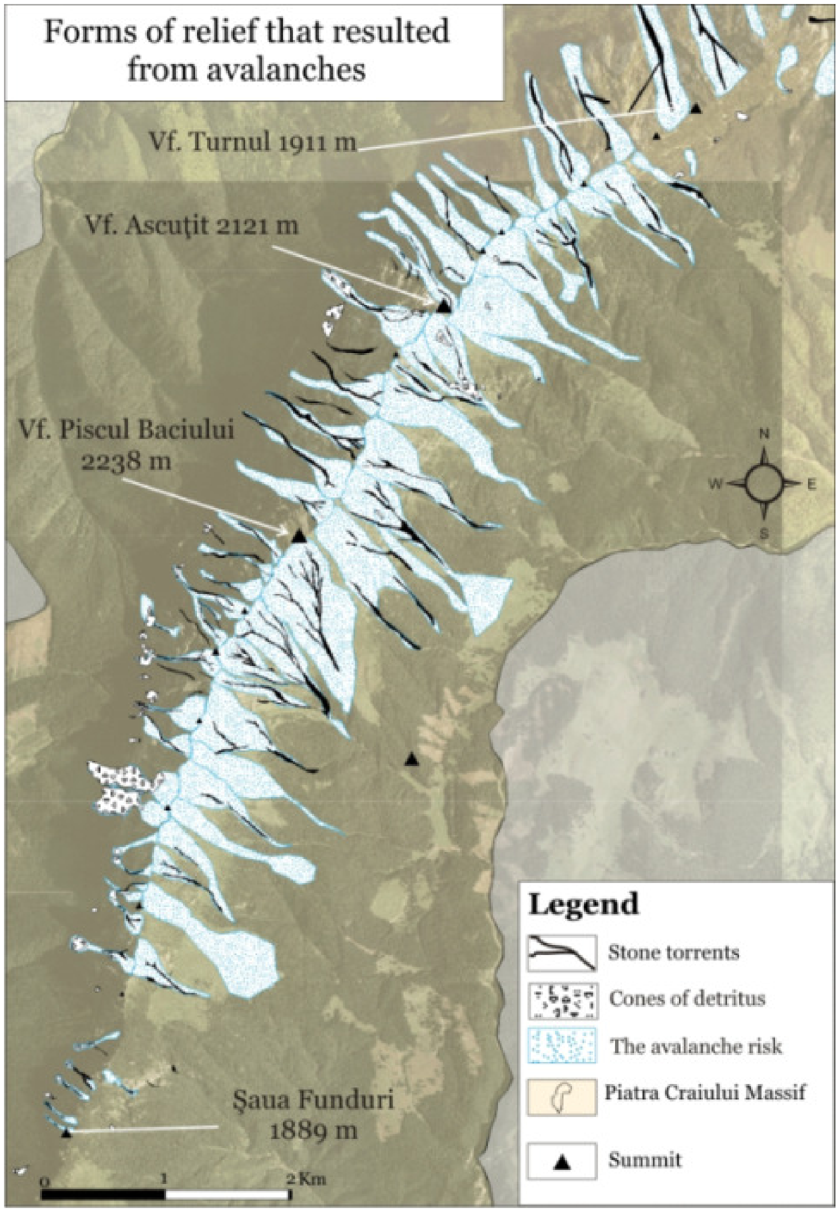


Fig. 5. Forms of relief that resulted from avalanches

Main forms of relief: "avalanche corridors are specific forms of erosion – see figure 5. They are being modelled by the torrents during the summer as well. They are considered to be the result of alternative cryo-nival and pluvial modelling" [3]. Avalanche corridors represent the surface on which the snowpack moves during an avalanche and they are usually located on the western slope (Photo. 2). Complex corridors on the eastern slope (Photo. 3) are made by a gully well-individualized on the inferior side. On the superior side there is a reception area, on the base of the avalanche corridor there are cones of detritus.

The moving snow has a mechanical destructive action triggering previously disintegrated materials, but it also dissolves everything in the way because of the chalk-stones.

Photo. 2. Western slope - avalanche corridors

"Re-established chalk-stone layers, almost vertical are specific for Piatra Craiului Mountains. These layers are part of the re-established synclinal."

The vertical development of karstic forms of relief is specific for Piatra Craiului Mountains. Due to the very inclined slopes, there are many avalanches determined by the cornices detachment."[4]

Photo. 3. Eastern slope - avalanche elements

"Nival semi-mouths" (ro. "semipalnii nivale") are negative forms of relief, often associated with stone torrents and avalanche corridors, being developed on the superior side through stronger deepening in the axial zone" [6]. Their surface is usually small. "Nival horseshoes" (ro. "potcoave nivale") are accumulation forms of relief asymmetrically arched-wave-shaped. There are big gelifracts, unsorted, which form at the base of the avalanche corridors. Secondary forms of relief: cones and trains of detritus often found both at the base of the avalanche corridors and in the reception zone. The cones of detritus are specific to the base of slopes, at the end of the avalanche corridors and at the base of the western slope. Rivers of detritus are formed by materials of different sizes, deposited along the valleys. Avalanches have a destructive characteristic from this point of view, which determine movements of the deposits towards the base of the corridors.

"Stone torrents are permanent only in the areas with a small angle of inclination (30^0). The flattened lobes, the terraces and the stone torrents are called stripes placations, stone-banked, lobes and terraces and are triggered both by avalanches and by torrents." [6]

4. CONCLUSIONS

The most dangerous snowfalls that most certainly lead to avalanches are those with dry snow or powder snow (germ. „pluverschnee", fr. „neige poudreuse") because the new layer of snow does not settle or weld with the old layer. Moreover, dry granular snow, that appears from changing the first snow under weather conditions. In the case of humid and heavy snow, the important aspect is the quality of the snow layer on which it deposits. If this is represented by a frozen layer of snow, the new layer will weld with the old one. But if the under layer is not frozen, but humid, the snow will not weld. And this is the case where an avalanche will start. Humid snow, resulted from a sudden warming of the weather, is also dangerous. It raises a high risk of strong avalanche (in which all the snowpack will be moved, also triggering the old layer of snow).

Avalanches are an important factors of destruction the forms of relief, as it also has a very important morphological role. Thus, the effects of avalanches can be noticed when the micro relief or potential conditions for the development of certain geomorphologic processes appear, processes such as removal of vegetation and other damages such as: killing people, destroying roads, forests, houses.

Charting the avalanche corridors (see the avalanche hazard map) is important because this way you can miniaturize the size and the effect of the avalanches. By making maps of avalanche risk (Fig. 6) you can asses the possibility of starting the avalanches. They can be avoided or categorised as areas with potential risk, represented in the next map.

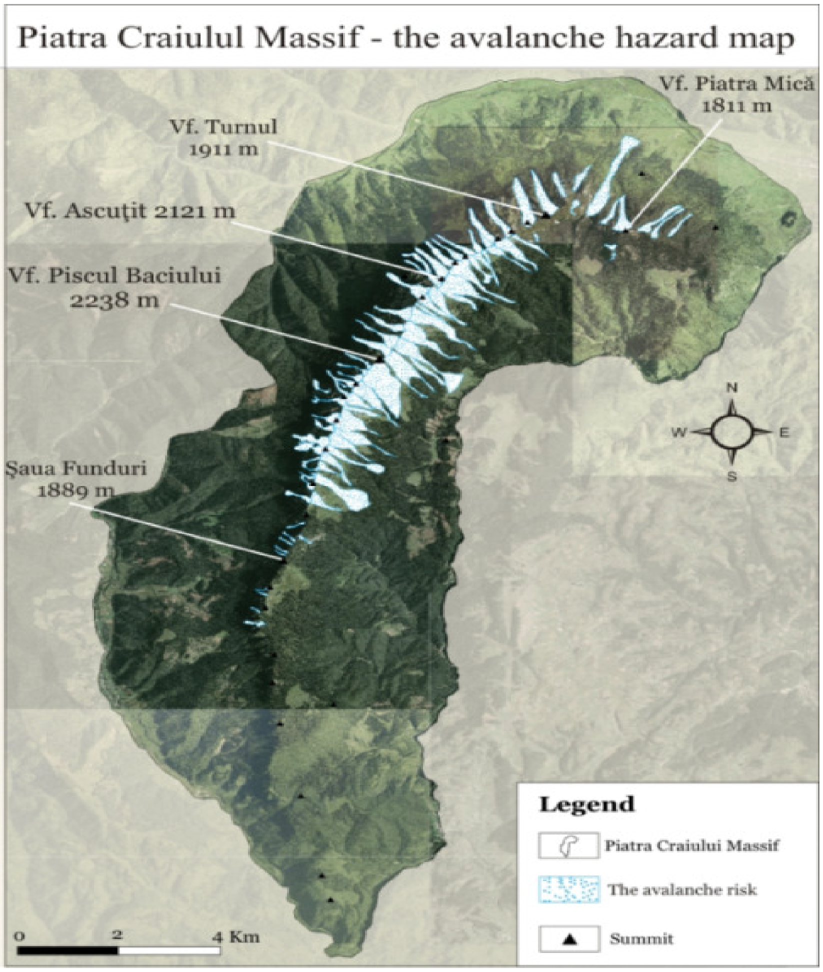


Fig. 6. The avalanche hazard map

You can take into account: the size of the starting zone, the altitude, the distribution of the snow layer, the nival erosion, the type of the draining, morph metric properties of the avalanche corridor and the effects. Thus, you can warn people and decrease potential disasters.

5. REFERENCES

[1] BĂLTEANU D., ALEXE R. Hazarde naturale şi antropogene, Editura Corint, Bucureşti, 2000.

[2] CONSTANTINESCU T. Masivul Piatra Craiului. Studiu geomorfologic, Editura Universitară, Bucureşti, 2009.

[3] FLOREA M., Munţii Făgăraşului. Studiu geomorfologic,Editura Foton, Braşov, 1998.

[4] MICHALEVICH-VELCEA V. Masivul Piarta Craiului. Studiu geomorfologic, Editura Academiei R. P. R., Bucureşti, 1961.

[5] MITITEANU D. Despre avalanşe,Bucureşti, 2004.

[6]. MOŢOIU D. M. Avalanşele şi impactul lor asupra mediului. Studii de caz în Carpaţii Meridionali, Editura Proxima, Bucureşti, 2008.

[7] MUNTEANU A. Morfologia actuală, riscuri și hazarde naturale în masivul Piatra Craiului, teză de doctorat, Facutatea de Geografie, 2009

[8] NEDELEA A. Valea Argeşului în sectorul montan. Studiu geomorfologic, Editura Universitară, Bucureşti, 2006.

[9] TOBIN G.A. Monty B.E.: Natural hazards. Explanation and integration. The Guidford Press, New York, 1996.

[10] TRICART J. Etudes experimentale du probleme du la gelivation, Bul. Perzglac no. 4, 1965.

[11] XAVIER M., Survive en milieu, Editura Albin Michel, Paris, 1988.

[12]*** CENTRUL NAŢIONAL DE STUDIU A ZĂPEZILOR ŞI AVALANŞELOR (ANENA), Guide de Niege et Avalanches, Editud Aix en Provence, Grenoble, 1998.

[13] *** ASOCIAŢIA CLUBUL ALPIN ROMÂN: TEHNICA ASCENSIUNILOR DE IARNĂ, Secţiunea Timişoara, 2000-2001.

[14] *** INSTITUTUL DE GEOGRAFIE, Universitatea din Bucureşti: Geografia României – volumul I, Editura Academiei Republicii Socialiste România, Bucureşti, 1983.