

The Impact of Snow Avalanches on the Tourist Activities in the Upper Area of the Piatra Craiului Massif

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Abstract: This paper aims at presenting the tourist activities that have impact by the snow avalanches occurring in the upper area of the Piatra Craiului Massif (The Southern Carpathians, Romania). The local features of this mountain unit are given by the presence of a calcareous ridge rising to over 2200 m, having clearly defined and steep slopes, dissected by a stream network. Climatic and vegetal elements specific for this region encourage the accumulation of a thick snow cover and consequently avalanches are common. Their occurrence has a negative impact on the winter tourist activities going on in this area. Starting from this observation, we undertook a general analysis both of the avalanches and the different components of tourist activities. The paper presents a series of data regarding the present situation, which are synthesized in a map of tourist infrastructure showing the tourist paths and mountain shelters in the avalanche prone areas. The study is intended to be a follow up and a deepening of the pioneer studies dealing with the avalanches that occur in this massif. The ultimate goal is to understand the natural hazards and their impact on the tourist activities going on in an area that is part of the most famous natural protected areas in Romania – The Piatra Craiului National Park.

Key words: *local conditions, snow avalanches, tourist activities, tourist infrastructure, impacted areas, Piatra Craiului Massif*

1. Introduction

This paper aims at highlighting the tourist activities in the Piatra Craiului Massif (The Southern Carpathians, Romania) that are negatively impacted by snow avalanches. This massif is extremely favorable for avalanche occurrence, due to the local conditions, which are explained by the structural, lithological, morphological, climatic and biological features. It is a territory with a rich natural tourist potential, especially because of the alpine features of its narrow ridge, with steep slopes, on which one can find endemic elements of fauna and vegetation.

This is the reason why it presently belongs to one of the most famous natural protected areas in Romania – The Piatra Craiului National Park (Pop, 2008). The beauty of the scenery attracts thousands of tourists who come every year here and in all seasons to relax and have a good time. Many of them, whether hikers, climbers or skiers, wish to get to the top of the mountain, even when there are good conditions for

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avalanche occurrence (Mititeanu, 2012). For instance, where the tourist paths or mountain shelters are found in avalanche prone areas tourist activities are in jeopardy.

In general, the infrastructure in this area, roads or other constructions, is poor, because avalanches act as a hindering factor.

The purpose of this paper is to present in detail the connections that exist between avalanche occurrence and tourist activities.

The investigation supplements the studies regarding the avalanches occurring in this massif and emphasizes the anthropogenic activities carried out in this area (Cristea, 1984; Constantinescu, 2006; Constantinescu, 2009; Munteanu, 2008; Munteanu, 2009; Munteanu, Moțoiu, 2006; Munteanu et al. 2011). In addition, it makes a synthesis of the tourist infrastructure in the avalanche prone areas lying on the high ridge of the Piatra Craiului Massif.

2. Methods and Data

This paper is about the way in which the avalanches may impact the tourist activities. Avalanches are natural hazards that impact people and their properties, when the intense activities make them vulnerable to such phenomena (Hervas, 2003). The natural conditions and the human activities are strongly connected, because tourist activities depend on the way in which natural hazards occur (McClung, Schaerer, 2006; Sivardiere, 2003; Voiculescu, 2009). In order to support this assertion we will present below the local features of the study area, the general characteristics of the avalanches, as well as the tourist activities and infrastructure that are exposed to avalanche threats. In order to ensure that human activities take place without unwanted events, people should pay attention to the issues discussed further.

This paper relies on a number of specialty studies, which treat avalanches as natural hazards occurring in various mountain areas, with negative effects on the environment or on the human activities (Anecey, 1998; Barbolin et al. 2011; Brundl et al. 2004; Copien et al. 2008; Hervas, 2003; Margreth, Romang, 2010; McClung, Schaerer, 2006; Simenhois, Birkeland, 2010; Sivardiere, 2003; Voiculescu, 2009).

In analyzing the avalanche prone areas, the tourist activities, the track network and the tourist mountain shelters, we relied on mappings and observations in the field, as well as on cartographic materials (topographic and tourist maps of various scales and editions, satellite imagery, photos, aerial photographs and ortophotoplans). The Ikonos 2004 satellite image (provided by the Administration of the Piatra Craiului National Park) was processed using the ArcView 3.2 software. Thus, we were able to determine the relationships between the tourist activities and the avalanche prone areas (Barbolin et al. 2011; Hervas, 2003; Margreth, Romang, 2010; McClung, Schaerer, 2006; Munteanu, 2008; Munteanu, 2009; Munteanu, Moțoiu, 2006; Sivardiere, 2003; Voiculescu, 2009). Likewise, we employed various data and information provided by the Administration of

the Piatra Craiului National Park, the members of the Mountain Rescue Services and the NGOs engaged in mountain tourist activities.

3. Problem Solution

This paper examines the upper area of the Piatra Craiului Massif (Figure 1) and highlights its particular morphology, which is given by the existence of a calcareous-conglomerate ridge, representing the western flank of the Piatra Craiului synclinorium. The ridge, which is approximately 25 km long, rises to over 2200 m (maximum altitude 2238 m in Piscul Baciului peak) and generally trends northeast-southwest. The slopes show significant differences, being steeper to the west (almost vertical or with gradients higher than 45°) and gentler to the east (gradients of 25-30°). They are dissected by numerous valleys, which often turn into avalanche chutes, (Cristea, 1984; Constantinescu, 2006). These local morphological conditions, typical for the mountain areas, encourage snow accumulation and relief shaping (Munteanu, 2009). Climatic conditions are also favorable: mean natural precipitation ranges from 1000 to 2000 mm, the snow layer averages 120-140 cm in the starting zone, the number of days with snow layer is 170-180 and the mean annual temperatures vary between 0°C at 2200 m and 6-7°C below 1000 m (Teodoreanu, 2006).

Vegetation is also important, especially in avalanche triggering because on the upper part of the Piatra Craiului ridge one can see alpine and subalpine elements that encourage snow sliding. At lower altitudes, the corridors scarring the mature forests have long been turned into permanent avalanche tracks, (Margreth, Romang, 2010; Pop, 2008).

The avalanches are very likely to happen, due to the combination of the previously discussed controls (Constantinescu, 2006; Constantinescu, 2009; Margreth, Romang, 2010) (Figure 2).

The Piatra Craiului Massif, depending on the local conditions, can be divided into three subdivisions: *Piatra Mare*, lying in the central part, having the highest altitudes and the best conditions for avalanche occurrence; *Piatra Mică*, to the northeast; and *Pietricica*, the lowest unit, to the south, with the fewest and smallest vulnerable areas (Figures 1, 3), (Constantinescu, 2006; Munteanu, 2009).

We will proceed now with a general discussion regarding the avalanches that affect each of these subdivisions, in order to highlight their importance as a natural hazard.

Avalanches are extraordinarily complex processes, with significant impact on society, affecting more or less directly the people living in the avalanche prone areas (McClung, Schaerer, 2006) They occur in the mountain areas, whenever a number of favorable conditions meet and disturb the snow balance (Anecey, 1998).

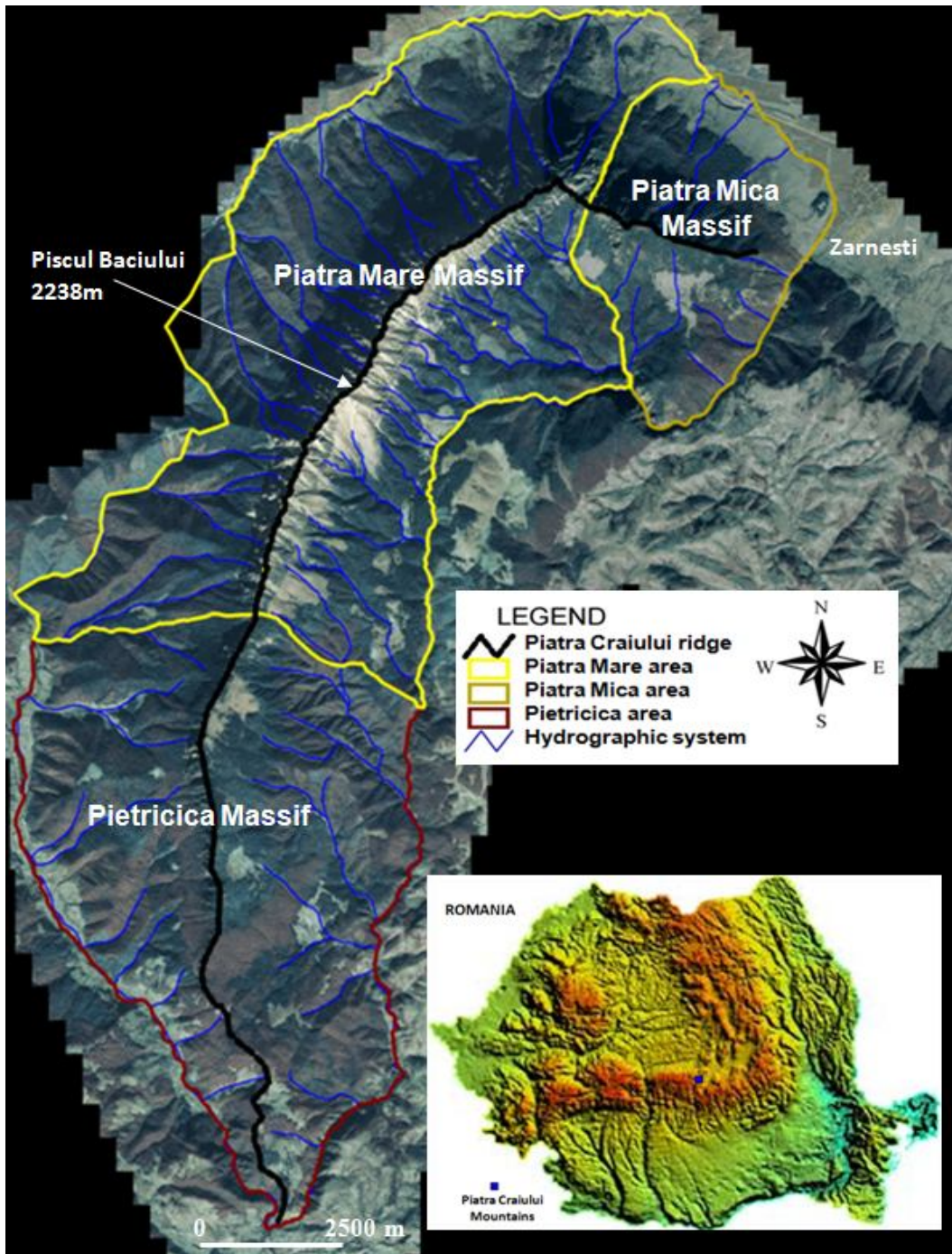


Figure 1. The location of the Piatra Craiului Massif within Romania and Southern Carpathians

There are several elements that contribute decisively to avalanche starting. The danger that snow stability will be lost is the greatest under the following circumstances:

immediately after abundant snowfalls; after a sudden rise of air temperature; and after short lasting snowfalls accompanied by the wind, which entail the formation of snow slabs (McClung, Schaerer, 2006; Mititeanu, 2012).

The fundamental problem in forecasting avalanche magnitude is to know the extension of avalanche prone areas and the spatial distribution of unstable snow, which is difficult to assess because a large part of the territory is inaccessible (McClung, Schaerer, 2006). On the other hand, the slopes of the Piatra Craiului Massif exhibit some morphological features that make access extremely difficult, especially in winter. This is the reason why in preparing the map of avalanche-affected areas we primarily used the data gathered during the field investigations carried out in other seasons. We were particularly interested in delimiting the main valleys that scar the slopes, which are often turned into avalanche tracks, and in determining their functional and morphometric elements, as well as the effects they have, especially on the distribution of avalanche deposits. Particular attention was given both to the places in which people carry out various activities and to those where tourist infrastructure is present, in order to see if they are prone to avalanche risk (Figure 2).

The main features of the avalanches occurring in the Piatra Craiului Massif are the following: they often have medium or small sizes, comparable to those in the Alps or the Tatra Mountains; they occur along well-established tracks or on the steep slopes; they come into existence whenever the snow cover is thick enough, but especially in spring, when are fully developed; most of them start spontaneously or are triggered by tourists and skiers. In this area, avalanches are not monitored, artificial triggering devices are missing and so are the avalanche protection measures. There is no avalanche prevention program and no warning system in operation, except for some brief information written on tourist signposts telling which tracks are forbidden in winter. However, there are tourists or skiers who disregard or minimize the danger and venture on the paths leading to the ridge.

Unfortunately, Romania does not have a culture in the field of avalanche protection, because, on one hand, the authorities do not possess detailed information on their occurrence, and on the other, number of human casualties caused by avalanches is relatively low.

Usually, human triggered avalanches make only 1-4 victims among the tourists, skiers and climbers who venture on dangerous itineraries. It is also the case of three avalanches that occurred in the Piatra Craiului Massif, which resulted in seven human casualties (Munteanu, 2009).

Although, in the Piatra Craiului Massif, the permanent settlements and the important roads are missing, there are still some social components that are prone to avalanche risk. Of these, the most exposed are the tourist activities (hiking, climbing, skiing, and speleology), especially when they occur in avalanche prone areas. For instance, there

are many tourist paths starting either at the foot of the mountains or from the existing chalets, which climb to the high ridge after previously crossing vulnerable areas (Figure 2).



Figure 2. Examples of tourist path affected by avalanches in the upper area of the Piatra Craiului Massif– tourist path (red) and avalanches directions (black) (photo by Mihai Zegrea)

The tourist infrastructure is represented by paths marked with distinct colors and signposts, unmarked, but frequently used, paths, as well as tourist refuge and chalets. In general, the paths connect the foot of the mountains or the high ridge with the chalets or places of tourist interest. It is worth noting that the massif has no artificial ski track. The tourist sights and the alpine attractions are represented by various natural spots, but the highest interest seems to be raised by the tourist track that goes along the main ridge. Likewise, the karst pits situated near the crest are highly appreciated by speleology enthusiasts.

Of the mentioned paths and tourist mountain shelters, some are found in avalanche prone areas as shown in Table 1. One can notice the largest vulnerable areas are on the western (10.5 km²) and eastern (9 km²) slopes of the Piatra Mare Massif. Other avalanche prone areas can be seen in the other two massifs, Pietricica (3.1 km²) and Piatra Mică (2.1 km²). In the vulnerable areas, there are 30 marked tourist trails (totaling 47.8 km) and 7 refuges (all of them situated in the Piatra Mare). Most of the tourist trails are found in Piatra Mare, 16 on the western slope and 6 on the eastern one while in Piatra Mică and Pietricica there are only 4 and respectively 2. Those on the eastern slope are longer (17.2 km) in comparison with those on the western slope (15 km). The trails on the Piatra Mare ridge total 8.5 km, those in the Pietricica massif 4 km, while those in Piatra Mică have only 3.1 km (Munteanu, 2009). All these aspects can be seen in Fig. 3. The map shows the avalanche prone areas of the three subdivisions of the

Piatra Craiului Massif and each of the two slopes of the Piatra Mare. Apart from these areas, the marked tourist paths and all the mountain shelters and chalets are also represented, so that anyone

Table 1. Tourist areas and paths exposed to avalanche risk (Munteanu, 2009)

Vulnerable area	Total area vulnerable to avalanches (km ²)	Tourist path		Refuge No.
		No.	Length (m)	
Western slope of Piatra Mare	10,5	16	15000	3
Eastern slope of Piatra Mare	9	6	17200	1
Piatra Mare Ridge		2	8500	3
Piatra Mică	2,1	4	3100	
Pietricica	3,1	2	4000	
Total	24,7	30	47800	7

can easily see the elements of tourist infrastructure that are permanently in danger.

The separate analysis of each subdivision highlighted not only the avalanche risk, but also the tourist potential of these areas. Thus, we were able to observe that Piatra Mare includes the largest vulnerable areas, the most numerous paths (24), totaling the highest length (19.5 km), and most of the tourist mountain shelters. The higher number of facilities suggests that this area is the most desirable tourist destination. As far as Piatra Mică is concerned, there are only four tourist trails, but these are extremely used by tourists. This is normal if we take into account that this mountain unit lies close to Zarnesti town and its railway station. Consequently, tourists access is easier in comparison for instance with the Pietricica, which lies farther from the transportation routes. From this reason, Pietricica, which has a good natural potential, is less affected by tourist activities in comparison with the northern ridge (Fig. 3).

Drawing the map of the avalanche prone areas is an important, yet difficult, stage in the study of avalanches (McClung, Schaerer, 2006). Such maps can support the future investigations and analyses, but they can also serve as a means of information for all those interested to travel in the area.

4. Conclusions

Piatra Craiului Massif offers good conditions for avalanche occurrence, but at the same time, it represents an significant tourist area. Consequently, avalanches are likely to impact tourist activities because here are found important tourist paths, chalets and

mountain shelters, which are vulnerable to snow accumulation and sliding. The whole area bears the influence of human activities, although morphology does not betray it. But, it is this particular morphology that attracts many tourists, who beat up the marked and unmarked paths. Here, there are areas where, depending on the local conditions, avalanches may occur quite frequently. The traces left over the years consist in the numerous avalanche chutes that scar the slopes of the Piatra Mare massif. From this point of view, Piatra Mică is less affected because the length of tourist paths is the lowest, while in the Pietricica, there are only two trails lying in the vulnerable area. The separate analysis of each of the three subdivisions of the Piatra Craiului Massif highlighted the tourist potential and the characteristics of the tourist infrastructure.

In order that human activities may continue without being affected by unwanted events, all the conditions capable of producing such extreme phenomena must be thoroughly known. Thus, tourist activities must be scheduled by taking into account the situation of the moment, after carefully assessing the risks posed by the local conditions.

This paper is a step further towards elucidating the relationships between avalanches and tourist infrastructure. Its ultimate goal is to understand the natural hazards and the way they impact the tourist activities in this area belonging to the Piatra Craiului National Park.

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