Chapter 10
Management of Snow Avalanche Risk in the Ski Areas of the Southern Carpathians-Romanian Carpathians

Case Study: The Bâlea (Făgăraş Massif) and Sinaia (Bucegi Mountains) Ski Areas

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Abstract Snow avalanches represent an undeniable reality in the Southern Carpathians both as a geomorphologic process and as a type of natural risk with the highest number of fatalities and injuries and also substantial impact upon forests, highways and people. This study focuses on the Făgăraş massif and Bucegi Mountains, representative mountain units in the eastern part of Southern Carpathians with altitudes surpassing 2,500 m, large quantities of snowfall, between 6 and 8 months/year of snow depth and high occurrence of snow avalanches. The importance of management of snow avalanche risk resides in the fact that these mountains represent an attractive tourist area and have a high winter sports potential.

Keywords Management · Snow avalanches risk · Ski areas · the Southern Carpathians

10.1 Introduction

Management of snow avalanche risk represents a stringent aspect in several countries with a large proportion of mountain covered areas which are endowed with characteristic and complementary winter tourist activities in Europe, Canada and the United States. Snow avalanche risk has an important impact on human life (Fuchs and Bründl, 2005; Höller, 2009) and implicitly, on human activities such as skiing (Höller, 2007, 2009; Stethem et al., 2003) or other economic activities (Höller, 2009; Keiler et al., 2006). Winter tourism is a very important economic activity (Rixen et al., 2003). Alpine skiing as attribute of winter tourism, and in the same time sport activity, has generated an entire industry within mountain areas (Agrawala,

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G. Zhelezov (ed.), *Sustainable Development in Mountain Regions*,
DOI 10.1007/978-94-007-0131-1_10,

2007; Bürki et al., 2005; Hudson, 2002; Lew et al., 2008). Winter sports entail a series of investment as far as blue-printing, infrastructure and connected activities are concerned and they are destined for a tourist segment that is willing to invest time, money and physical effort.

This item becomes important through its affiliation to the global concern regarding the relationship between tourist practices, especially skiing, and natural risk within mountain areas, in the present case (Casale and Margottini, 2004; Herwijnen and Jamieson, 2007; Quinn and Phillips, 2000; Schweizer and Camponovo, 2001; Schweizer and Jamieson, 2001; Schweizer and Lütschg, 2001).

Snow avalanches are one of the most important natural risks and hazards of the mountain environment in ski areas and cause each year several fatalities (Höller, 2007; Jamieson and Stethem, 2002; Keiler, 2004; Keiler et al., 2005; Voiculescu, 2009) and serious damages upon human settlements and infrastructures (de Scally, 1994; Fuchs and Bründl, 2005; Fuchs et al., 2004, 2005; Jamieson and Stethem, 2002; Stethem et al., 2003; Voiculescu, 2009).

The purpose of this chapter is to present the state of the management of snow avalanche risk in two of the most representative mountain areas of Southern Carpathians, Bâlea ski area of the Făgăraş massif and Sinaia ski area of the Bucegi Mountains. These are known for their natural potential with regard to ski practices, but also for the high incidence of snow avalanches, some even triggered by skiers.

10.2 General Facts of the Studied Area

The Făgăraş Massif is situated in central Romania at the intersection of the 45° 30′ parallel with the 24° 30′ meridian, within the Făgăraş group from the Southern Carpathians (Fig. 10.1).

They are also known as the Transylvanian Alps due to their high altitudes that surpass 2,400–2,500 m (Modoveanu Peak-2,544 m, Negoiu Peak-2,535 m), their massiveness, their sharp glacial crests, their inherited glacial landforms (cirques and glacial valleys), but also due to their present periglacial processes of high spatial dynamics. The Făgăraş massif occupies over 1,500 m^2 and the alpine level, which represents the basis for skiing activities, occupies around 438.5 km^2, from which 148.8 km^2 is on the northern slope and 684.7 km^2 on the southern slope (Voiculescu, 2002). In the Făgăraş massif, skiing takes place traditionally in the Bâlea glacial area which includes the cirque and the glacial valley (Fig. 10.2). If until the 1989 Romanian Revolution, only the alpine skiing was practiced here, afterwards and especially in the latest years the skiing activities have been extended towards snowboarding, heli-skiing and especially towards free-ride and free-style skiing; which therefore complete the range of tourist activities practiced in the Făgăraş Massif and which pertain to the alternative forms of tourism according to Beedie and Hudson (2003), to Buckley (2006) and to Pomfret (2006).

It is the only area which apart from a good accommodation infrastructure has also ski trails. These trails are neither contoured nor smoothed during summer and during winter do not have buoys delineating their extent, nor do they have warning

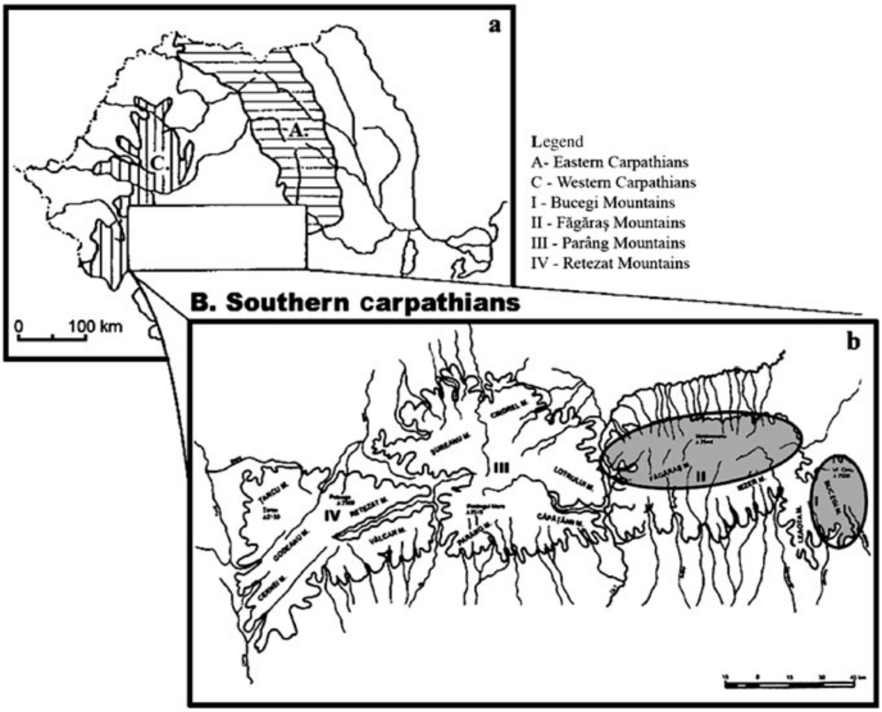

Fig. 10.1 The geographic location of Făgăraş massif and Bucegi Mountains

signs related to avalanche danger. As for cable transportation this ski area has only one cable car.

The Bucegi Mountains are located in the eastern part of the Southern Carpathians, within the mountain group that bears their name (see Fig. 10.1). The Bucegi Mountains are bordered by cliffs to the east towards the Prahova Valley, to the west towards the Rucăr-Bran-Dragoslavele Corridor and to the northern side towards the Braşov Basin and by the Ialomiţa's Subcarpathians in the south. They have the form of an amphitheatre with its opening towards the south, where the Ialomiţa Valley lies. The highest altitudes are concentrated in the northern part. The foremost important orographic knot is situated in the northern part of the Bucegi Mountains and is represented by the Omu Peak-2,505 m. The mountain mass appears as being suspended, the altimetry differences oscillating between 1,200 m, above the Prahova river (favourable element for the implementation of ski trails, due to the relief's high potential) and 500 m on the western part where the Rucăr-Bran corridor is located.

The most important ski area of these mountains is to be found in their southern part. This area pertains to the resort of Sinaia, covers about 116 ha (Bogdan, 2008) and it is divided into two sectors (Fig. 10.3).

This ski area is endowed with three cable cars, two chair lifts and only one ski lift. Apart from these, unfortunately, there are five more ski lifts which are dysfunctional at the present moment.

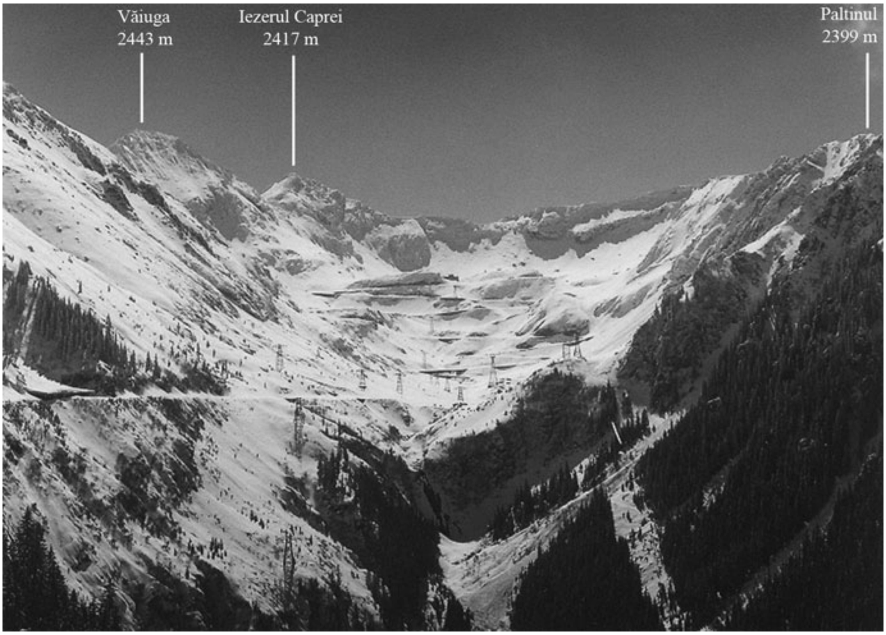

Fig. 10.2 Bâlea ski area (by Voiculescu, 2005)

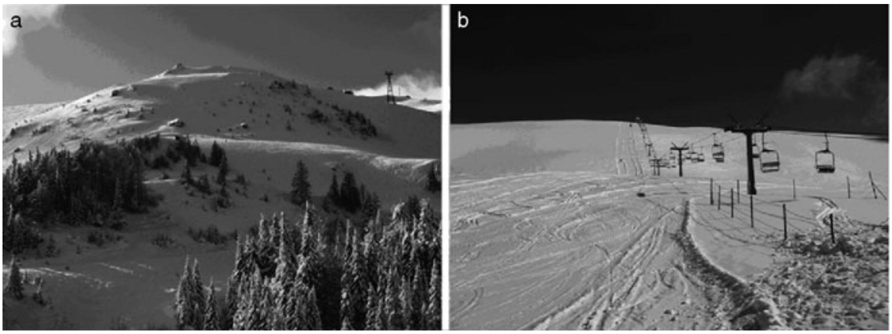

Fig. 10.3 Sinaia ski area, Carp sector (on the *left*) and Valea Dorului sector (on the *right*) (photos by Voiculescu, 2007 and Popescu, 2008)

10.3 Terrain and Climatic Analysis as Favourable Elements for Ski Practices

The ski natural potential is favoured first and foremost by the parameters of two components of the mountain environment (Jamieson and Johnson, 1998; McClung and Schweizer, 1999; Schweizer and Jamieson, 2001): terrain factors and climatic variables.

10.3.1 Terrain Factors

Terrain factors are represented by elevation, slope and aspect. Altitude is essential for skiing activities, and for the latitude of temperate climate in which our country is located, it has to be of at least 1,000 m (Besancenot, 1990) in order to maintain a favourable snow layer for at least 3 months/year.

Slope represents another factor of great importance for skiing activities. This is the element that separates the categories of this activity's practitioners into two large categories: skiers and beginners. The first category was defined as *users of skis, snowboards or other gravity-propelled recreational devices whose design and function allow users a significant degree of control over speed and direction on snow* (Penniman, 1999, p. 36) and as for beginning skiers or beginners as: *those individuals who are using one or another of these devices for the first time or who possess marginal abilities to turn or stop on slopes with incline greater than 20%* (Penniman, 1999, p. 36).

Performing a more analytical classification in accordance with the degree of slope declivity there have been established the following categories: beginners or novices that make use of slope gradients with a declivity not higher than 11.5°, intermediates that use the slope gradients between 18 and 19°, advanced, who use the slope gradients of 19° and experts who use slope gradients that surpass 19° or even 39° (Borgersen, 1977, quoted by Penniman, 1999; Gaylor and Rombold, 1964, quoted by Penniman, 1999). For economic exploitation we need to consider the slopes between 10 and 45°. Any ski area needs to comprise all the categories of slope gradients. It is a well known that most of the skiers would rather ski on slopes under 30° and that the beginners will usually not surpass the ones over 10°.

Using the applications of some GIS programmes (CartaLinx, Idrisi Kilimanjaro, ArcGIS) and making use of their working methods (Török, 2001–2002), we have created the digital elevation model (Fig. 10.4) which we used in generating the thematic maps (elevation, slope and aspect) for the Bâlea ski area and for the Sinaia ski area (Figs. 10.5 and 10.6).

The altitude of the ski trails is a crucial element for practicing the specific activities. The Bâlea ski area is situated at high altitudes where skiing is practiced on the glacial cirque walls, just under the cliffs, within the cirque, but also along the glacial valley. The elevation map highlights this mathematic element (Fig. 10.5).

The Bâlea ski area is endowed with trails that are not groomed or even named, for that matter, which have high slopes, and can only be used by expert or advanced skiers. The slope map points out the high degree of declivity for the studied area. The values between 1 and 15° represent 6.9% (3.4 km^2), the values between 15 and 25° represent 18.1% (9 km^2), the values between 25 and 35° represent 11.1% (5.52 km^2), the values between 25 and 35° represent 33.2% (16.4 km^2), the values between 35 and 45° represent 31.8% (15.8 km^2) and the values above 45° represent 9.5% (4.7 km^2) from the total of the Bâlea area.

Another important topographic factor is the aspect of the slopes, especially because it influences the insulation and the presence of the wind. For this purpose we have constructed the aspect map. For the Bâlea ski area the aspect map shows

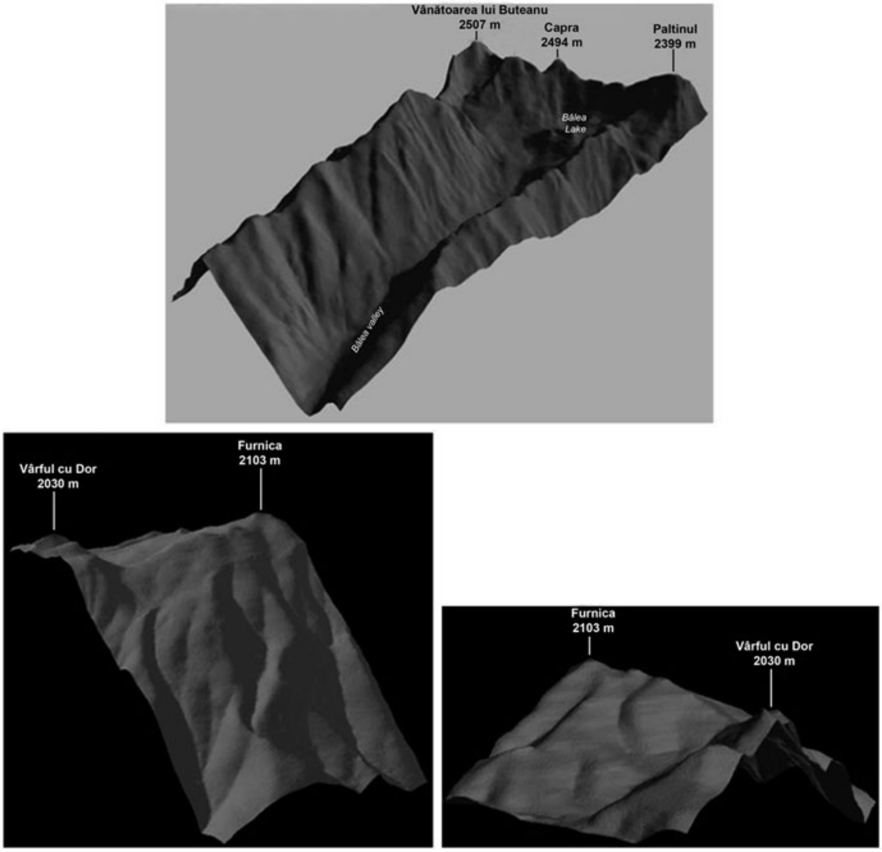

Fig. 10.4 Digital Model of Terrain of Bâlea ski area (on *top*), of Carp ski sector of Sinaia ski area (*bottom left*) and of Valea Dorului ski sector of Sinaia ski area (*bottom right*)

that western slopes cover 27.1% (1.86 km^2) of the area, the north-eastern slopes 20.3% (1.39 km^2) and the eastern slopes 19.5% (1.34 km^2).

Within this topographic context, the ski trails in the Bâlea area are especially prone to the advanced and expert skiers which practice free-ride or free-style skiing. Unfortunately, under these circumstances, the danger of producing snow avalanches is imminent and therefore human victims, fatalities and wounded are registered.

The Sinaia ski area has gradually enlarged its surface, the number of trails and their length: from 85.1 ha and 12 trails with a length of 15.1 km in 2001 (Ţigu, 2001), to 16 trails measuring 23.01 km (Bogdan, 2008) and even to 24 trails with a total length of 22.3 km (according to INCDT, 2009). The average declivity of this ski area ranges between 25 and 30°, which compels with the skier's preference (of under 30°), but neglects or overworks the beginners.

Within the Sinaia ski area there are 24 trails (Table 10.1) of which 11 are for expert skiers, which hold a percentage of 45.8% of the total, 6 are for advanced skiers, which represent 25% of the total area and 7 are for beginner skiers, which represent 29.1% of the total.

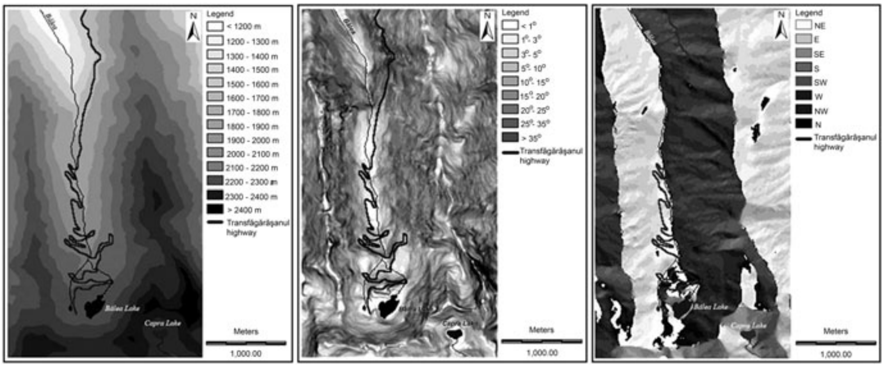

Fig. 10.5 Bâlea ski area – hypsometric map (*left*), declivity map (*centre*) and the aspect map (*right*)

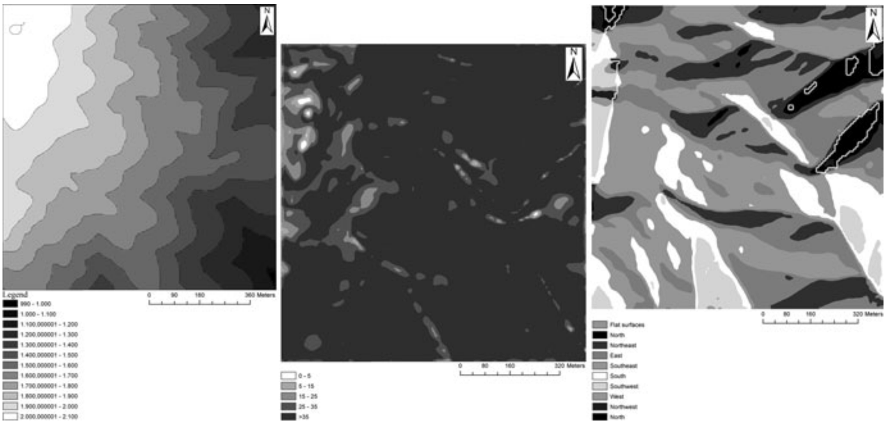

Fig. 10.6 Sinaia ski area – hypsometric map (*left*), declivity map (*centre*) and the aspect map (*right*)

The mathematic parameters of the terrain underline the high potential of the Sinaia ski area for tourist practices. Therefore the altitude of the ski trails is relatively high, around 2,000 m for both sectors of the ski area – Carp and Valea Dorului (Fig. 10.6). The slopes map emphasizes the predominance of high values, explaining the classification of trails predominantly for expert and advanced skiers (see Fig. 10.6). The aspect map shows two different situations: within the Carp area eastern slopes are predominant, while in the Dorului Valley the western orientation is predominant, both profiting from good insulation. In detail, especially for the Carp area, we note the eastern, south-eastern and north-eastern aspect, the latter favouring the persistence of snow until late spring. Small surfaces have south and south-western aspect, which have a good insulation, slopes between 25 and 35° and no woodland vegetation. These are prerequisite conditions of snow avalanche triggering, which influence the winter tourism and ski practices (see Fig. 10.6).

Table 10.1 Characteristics of Sinaia's ski trails (INCDT, 2009)

NR.	Trail name	Difficulty	Length(m)	Vertical drop (m)
1.	Carp (Vârful Furnica – Cota 1400)	Expert	2, 500	585
2.	Carp, Călugărul	Expert	800	400
3.	Carp, firul văii	Expert*	1, 200	300
4.	Carp faţa ascunsă	Expert*	150	60
5.	Carp faţa mare	Expert*	300	200
6.	Târle	Expert*	250	150
7.	Papagal (Telescaun – Cota 1400)	Expert*	300	180
8.	Valea Mioriţei	Expert*	500	250
9.	Spitz	Expert**	400	250
10.	Furnica	Expert**	600	350
11.	Vânturiş (Vârful cu Dor – Cota 1400)	Expert**	250	180
12.	Drumul de vară	Advanced***	2, 350	560
13.	Scândurari	Advanced***	400	180
14.	Valea Dorului-dreapta (Vârful cu Dor – Cabana Valea Dorului)	Advanced***	600	210
15.	Valea Dorului-stânga (Vârful cu Dor – Cabana Valea Dorului)	Advanced***	600	210
16.	Valea Soarelui (Vf. Furnica – Cabana Valea Dorului)	Advanced***	1, 180	210
17.	Valea Dorului-firul văii	Advanced***	1, 080	210
18.	Turistică (Cota 1400 – Sinaia)	Beginner****	2, 800	460
19.	Valea Soarelui-firul văii	Beginner****	900	210
20.	Laptici	Beginner****	650	180
21.	Drumul Vechi	Beginner****	3, 500	450
22.	Furnica – Platou	Beginner****	500	75
23.	Popicărie	Beginner****	300	50
24.	Poiana Stânii	Beginner****	200	25

Expert – trail recommended for experienced skiers; Expert* – off-trail terrain recommended for experienced skiers; Expert** – off-trail terrain, recommended for experienced skiers, can be accessed only by foot, have a high risk factor; Advanced*** – trail recommended for advanced skiers; Beginner**** – trail recommended for beginner skiers

10.3.2 Climatic Variables

The climate through its variables becomes an important tourist resource (Besancenot, 1990) and is analyzed considering the snow depth with regard to the ski activities, being safe to say we have a snow-reliable area if: *in seven out of ten winters there is snow covering of at least 30 cm on at least 100 days between 1 December and 15 April* (Becken and Hay, 2007, p. 38).

Romania is located within the temperate-continental climate zone which is characterized by large quantities of snowfalls and snow avalanches specific to maritime and transitional climate (Birkeland and Mock, 2001; Hägeli and McClung, 2004;

McClung and Schaerer, 1993; Mock, 1996; Mock and Birkeland, 2000). As a consequence of its geographic position, many types of climatic influences can be identified on the mentioned ski areas. The northern slope of the Făgăraş massif, where the ski area of Bâlea can be found, is under the humid oceanic influences. The Sinaia ski area is under continental influences. Therefore, the regional climate also determines the solar radiation, temperature, snowfall quantity and type of snow (McClung and Schaerer, 1993; Zingg, 1966). Characteristics of the climate of the Făgăraş massif are registered at the weather stations of Bâlea Lake (2,070 m) and Cozia (1,577 m) and at the weather stations of the Bucegi Mountains at Vf. Omu (2,505 m) and Sinaia (1,500 m). The collected values were subsequently analyzed to produce average annual values (Table 10.2):

Snow is the very important resource for winter tourism, especially for skiing (Breiling and Charamza, 1999). Snow cover and duration play a major role in environmental and socioeconomic practices within mountain regions (Beniston, 1997, 2003; Beniston et al., 2003).

On the other hand, the number of days with snow layer (Fig. 10.7) is another important factor for ski practices. This parameter is subjected to altitude variations but also to local conditions.

Therefore for the Bâlea area the highest values are registered within the December–March interval, the total number within the October–May interval summing up 150 days. For the Sinaia ski area, the highest values regarding the days with snow layer is reached within the November–March interval at the highest altitudes and November–April in the middle and lower part of area. The total number of days with snow layer is of 224 at the highest altitudes, around 66 in the middle and only 45–46 days in its lower part. Therefore we can ascertain that in the case of the Bâlea ski area also in the case of the higher part of the Sinaia ski area the prerequisite condition of a minimum of 100 days of snow depth, as it is stated in the dedicated literature (Becken and Hay, 2007; Besancenot, 1990) is accomplished. In order for skiing to take place in good conditions, it is necessary that the snow depth be of at least 30 cm (Agrawala, 2007; Becken and Hay, 2007; Besancenot, 1990; Freitas, 2005; Hall and Higham, 2005). In accordance with the snow depth, we have determined the type of the seasonal variation of snowfall or the type of nivometric regime (Besancenot, 1990), so that for the Bâlea Lake ski area the characteristic nivometric regime is bimodal which is characterized by a secondary maximum of the snow depth in February and the main maximum in April, and between the two existing a relative winter minimum. This type of regime is characteristic for high altitudes. For the Sinaia ski area we noticed a mutation from the monomodal regime, with a single maximum in the middle of winter towards the type of balanced regime, displaying similar quantities of snowfall in the months of December, January and February. Towards the highest altitudes the type of nivometric regime is bimodal as well (Fig. 10.7).

The necessary 30 cm of snow are provided in all cases (Agrawala, 2007; Becken and Hay, 2007; Besancenot, 1990; Freitas, 2005; Hall and Higham, 2005) (see Fig. 10.7).

Table 10.2 Main climatic characteristics of the Făgăraş massif and the Bucegi Mountains

		T°C								
Meteo St.	Sun rad. (Kcal/cm^2)	Ann.	Number of cold nights t°min≤–10°C	Number of winter days t°max≤0°C	Number of freezing days t°min≤0°C	Pp. (mm)	Humid. (%)	Days with snow	Depth of snow (cm)	Sunny days with snow cover
Vf. Omu (2,505 m)	92–93	–2.5	95.2	144.9	254.5	1,134	87	>220	37–38	34.8
Bâlea Lake (2,070 m)	80–100	0.2	68.2	120	207.9	1,246.2	83	>150	66–67	30.4
Cozia (1,577 m)	–	3	37.7	89.1	164.7	844.2	–	63–64	39–40	26.1
Sinaia (1,500 m)	–	3.7	37.7	72.2	163.3	1,226.9	78	90.6	29.1	32.8

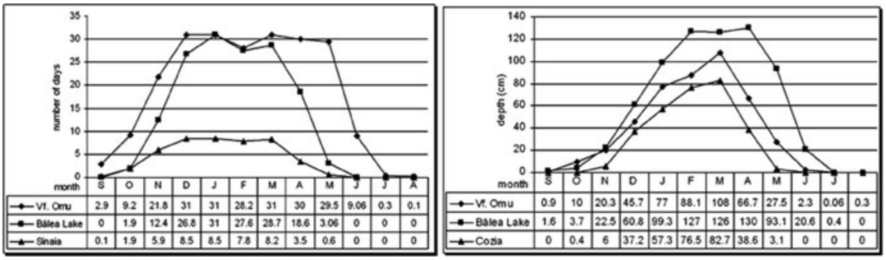

Fig. 10.7 The variation of number of days with snow depth within the Bâlea and Sinaia ski area (on the *left*) and the nivometric type of regime in the Bâlea and Sinaia ski areas

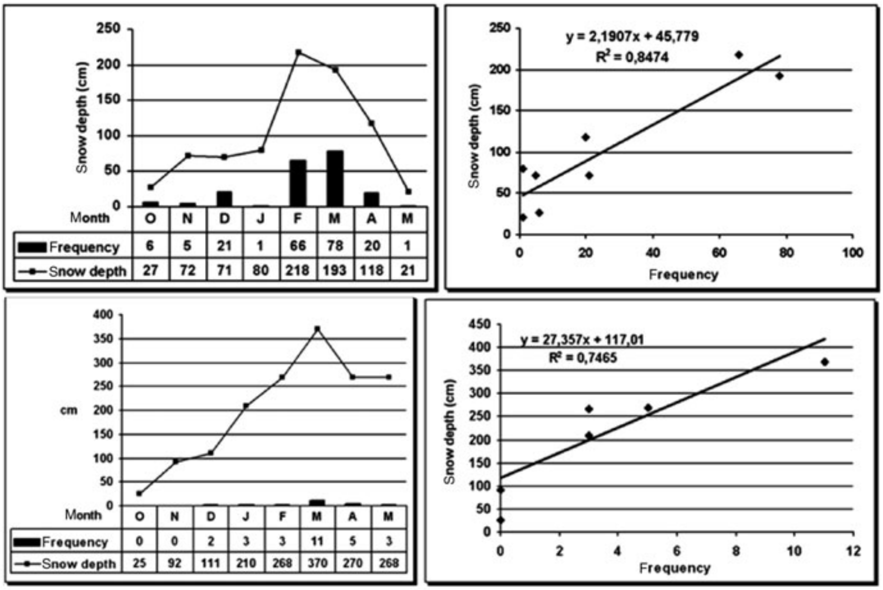

Fig. 10.8 Correlation between snow depth and snow avalanches, between 2005–2006 and 2006–2007

With regard to the same issue, the snow avalanche climatic potential, we have analyzed the relation between snow depth and the snow avalanche frequency in years with considerable snowfall (Fig. 10.8):

10.4 The Management of Snow Avalanche Risk

The Făgăraş massif is characterized by high snow avalanche activity, especially in the Bâlea ski area. Many snow avalanches are triggered by skiers as it is mentioned in several works (Grímsdóttir and McClung, 2006; Schweizer and Camponovo,

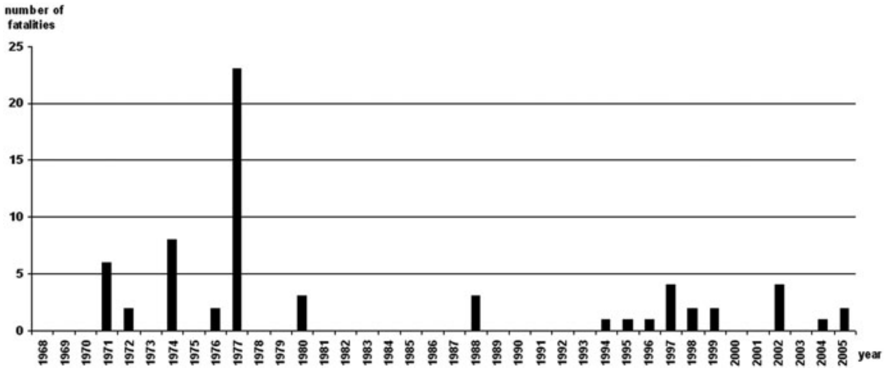

Fig. 10.9 Number of fatalities in Făgăraş massif, between 1968 and 2005

2001; Schweizer and Lütschg, 2001; Tremper, 2001). The statistics department of the Mountain Rescuers from the Sibiu County registered the largest number of accidents (Fig. 10.9) in the whole Carpathians over the course of time (Voiculescu, 2009). Here, in the Bâlea glacial cirque, on April 17, 1977 a huge snow avalanche took place and killed 23 skiers. Also other accidents with fatalities and buried under avalanches have been noted in the Bâlea glacial cirque and on the right side of the Bâlea glacial valley (Fig. 10.10).

Within the Sinaia ski area the frequency of snow avalanches does not have the intensity of the ones in the Făgăraş massif. Nevertheless, due to the large number of skiers, in the last 10 years and also due to the terrain and climatic factors which are favourable for skiing, here accidents also occurred (Fig. 10.11) which determined the local authorities to take some precaution measures.

According to topography and the new measures undertaken, especially after the year 2003, we can consider two large categories of management of snow avalanche risk. Thus, especially in the Bâlea ski area of the Făgăraş massif where snow avalanche activity is considerably high, we can identify the old, traditional forms of management of snow avalanche risk. In this category we include snow sheds, snowpack support structures, drainage systems and deflecting dikes as in other areas affected by snow avalanches (Höller, 2007, 2009; Jamieson and Stethem, 2002). All these appeared in Făgăraş massif at the same time with the construction of Transfăgărăşan highway between 1970 and 1974 (Fig. 10.12), but also for the safety of skiers.

In the Sinaia resort of the Bucegi Mountains the attention upon management of snow avalanche risk was drawn quite recently, due to several accidents that took place here. This mainly consists of delineating the ski trails by signs and marking the difficulty degree on the already mentioned signs, but also of the implementation of snowpack structures where the occurrence of snow avalanche is imminent, which are the most common and the most efficient form of avalanche preventions. Also warning signs as the ones met in other mountain areas have been implemented (Weir, 2002), which read “Danger of avalanches” or “Trail closed during winter” (Fig. 10.13).

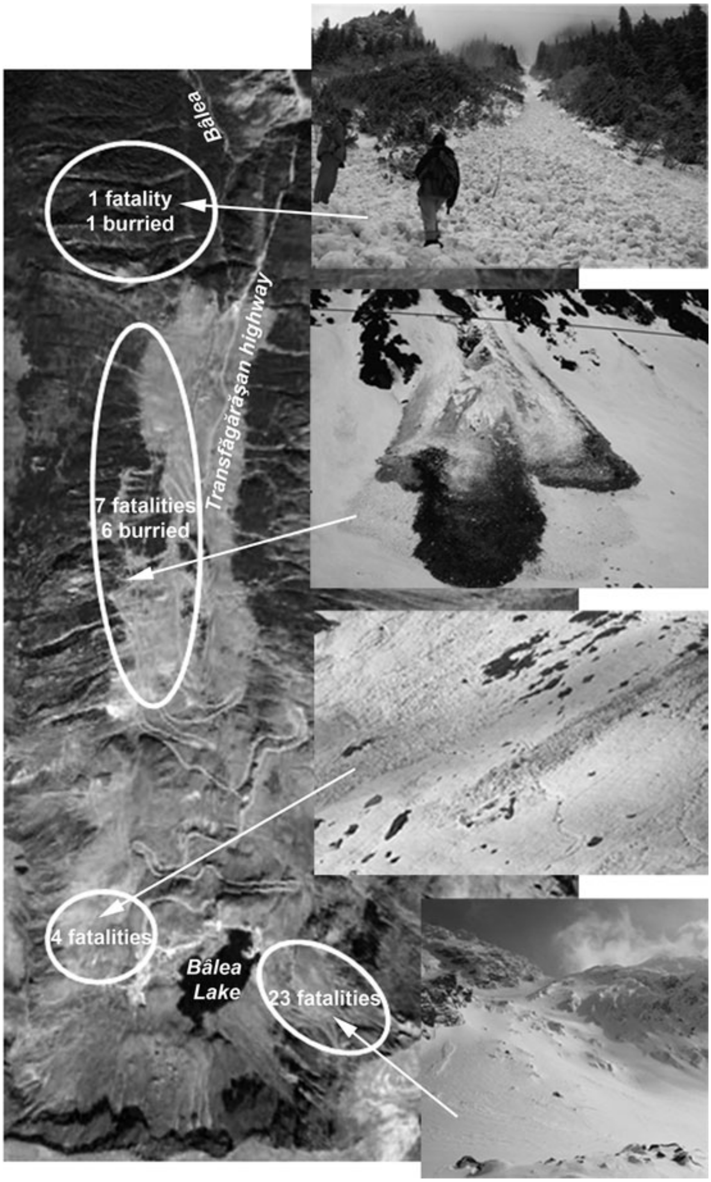

Fig. 10.10 Location of main important snow avalanches and number of fatalities and buried in Bâlea ski area (photos by David, 2010 and by Voiculescu, 2007, 2009)

On the other hand, starting with 2003 the management of snow avalanche diverted to other recent forms of managements required by topography. The first important step was in 2003 when the Programme of nivometeorology was created within the National Administration of Meteorology R.A. (Administrația Națională de Meteorologie) in partnership with Météo France, Centre d'Études de la

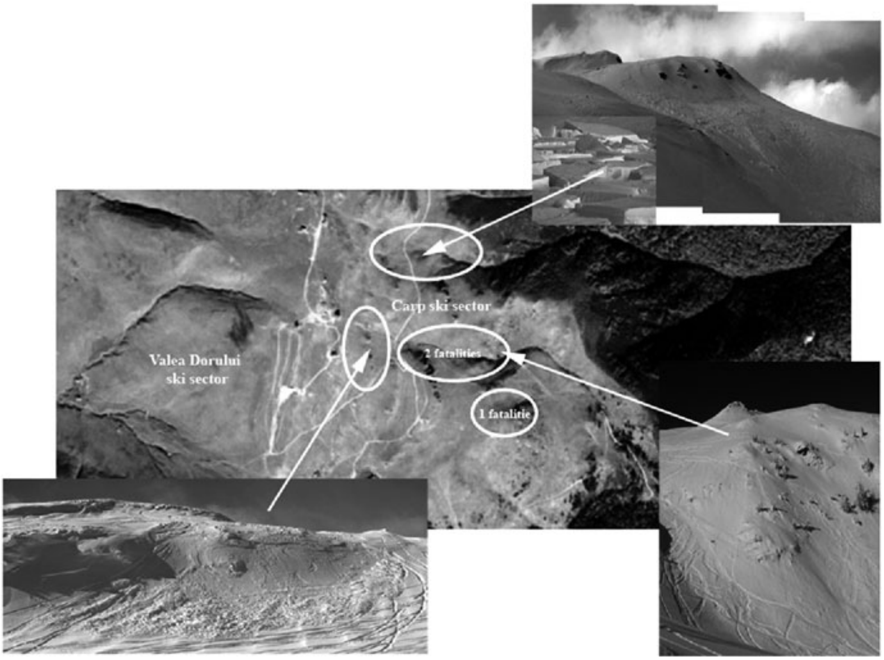

Fig. 10.11 Location of main important snow avalanches and number of fatalities and buried in Sinaia ski area (photos by Voiculescu, 2005)

Neige-Grenoble. The main purpose of the programme is to study snow and its future evolution as well as avalanche triggering conditions. The methodology used for the nivological programme is based both on classical observations and on the profile of snow layer resistance. All nivometeorological data is analyzed by means of two systems developed by Centre d'Études de la Neige-Grenoble known as GELINIV and CROCUS-MEPRA PC.

The nivometeorology programme has a Work Laboratory in the Făgăraş massif at Bâlea Lac. The laboratory studies snow conditions and monitors the frequency of snow avalanches in two glacial valleys: Bâlea on the northern slope of the massif and Capra on the southern. They represent attractive tourist areas and have a high winter sports potential. The second important step in the above-mentioned context is that the Nivometeorology Programme of the National Meteorology Administration R.A. (Administraţia Naţională de Meteorologie) apart from continuing its activity in the Făgăraş massif will expand in other mountain areas with high avalanche risk such as the Bucegi Mountains and Postăvaru Mountains. At the moment, there are only four points of snow research and snow avalanche hazard monitoring, all placed in the Southern Carpathians, in the Bucegi Mountains (in the Sinaia resort at Cota 1,500 m and at Vf. Omu –2,505 m) and in the Făgăraş massif.

It is an important fact that Romania has joined other European Union countries in both monitoring and snow avalanche hazard prevention; thus after the European

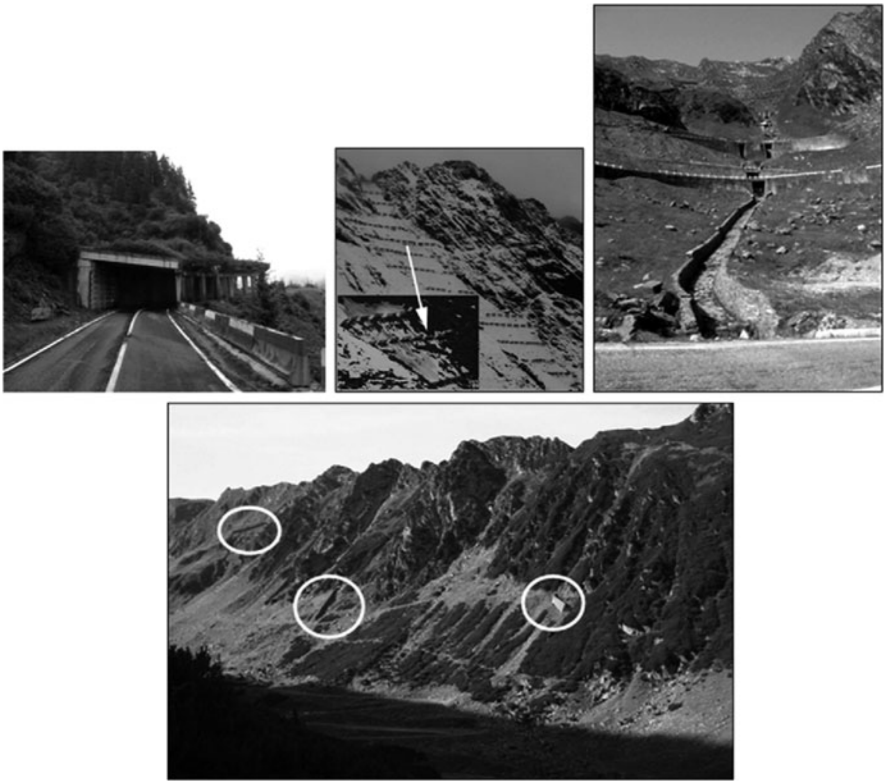

Fig. 10.12 Traditional forms of snow avalanche management: snow sheds (*top-left*), snowpack support structures (*top-centre*), systems drainage (*top-right*) and deflecting dikes (on the *bottom*) (photos by Voiculescu, 2004, 2008)

snow avalanche risk scale was launched in 1993–1994, Romania adopted it due to the need for unique snow avalanche prevention criteria. In this respect, there are permanent broadcasts regarding avalanche risks within periods with large quantities of snowfall according to National Administration of Meteorology (Administrația Națională de Meteorologie, 2004–2005, 2005–2006, 2006–2007, 2007–2008).

A large part of the Romanian Carpathians, such as Eastern Carpathians and Southern Carpathians (except the Western Carpathians), are areas exposed to avalanches. They are recorded in the European Spatial Planning Observation Network (ESPON). On the other hand, research institutes grant a heightened attention to the phenomenon. Therefore the Geographic Institute of the Romanian Academy is developing a general map (using ESRI GIS ArcView) of geomorphologic risks, including snow avalanche hazards. In this respect we need to mention that mapping snow avalanches on hazard maps, which include the zoning criteria *do not prevent avalanches, they reduce the probability of damage* (Höller, 2007, p. 96), and therefore are of high necessity within mountain areas with winter sports potential.

Fig. 10.13 The delineated trails and the snowpack support (on *top*) and the display panels (on the *bottom*) (photos by Popescu, 2009)

10.5 Conclusions

Unfortunately, the management of different natural risk does not yet represent a major concern. The increasing incidence of snow avalanches affects not only skiers, but also the entire economy of the ski areas. The responsible authorities for the management of the ski domains need to invest in:

– the surveillance of the phenomena;
– sending warnings through special services which would transmit meteorological and nivometric bulletins;
– drawing-up hazard maps on the mountain groups of the Southern Carpathians;
– emitting codes;
– risk reduction, the consolidation and extension of snow avalanches protection structures such as: deflecting dike, snowpack support structures, snow sheds and the introduction of explosive controls, as well as, artificial release of snow in ski areas and along roads;
– integrating and using the European avalanche risk scale, especially as Romania is part of the European Spatial Planning Observation Network (ESPON) Data base as far as mountain hazards are concerned;
– implementing standardized pennons (as in the French system) especially within ski domains (where the trail number and type or off trail would be stated) and to implement warning panels (European or North-American System);

- placing display panels which read, for example, “No Stopping” or “Avalanche Area” along the roads or in the ski areas (Weir, 2002) where snow avalanche hazard is imminent;
- establishing more nivology laboratories of the National Administration of Meteorology R.A. (Administrația Națională de Meteorologie) within mountains with snow avalanche risk in order to collect meteorological data useful for GELINIV and CROCUS-MEPRA PC programmes. Using these programmes the snow avalanche risk maps will be made as well as the warnings for skiers and tourists.

Also a more serious preoccupation regarding the use of preventive temporary or permanent measures needs to be undertaken. On the other hand, the management of crisis situations (present emergencies and future misfortunes) needs to be prepared and also the blue-prints of the territory need to be revised, by making snow avalanche zoning maps and other thematic maps of exposure to natural risk phenomena.

And last but not least, Romania needs to achieve international standards through the provision of a good education regarding the understanding and management of natural hazards or risk phenomena.

Acknowledgements The authors would like to express their appreciation to the members of the Work Laboratory of the Făgăraş massif at Bâlea Lake for having made available documentation of the nivological balances for the winters of 2003–2004, 2004–2005, 2006–2007 and 2007–2008 and to the Mountain Rescuers Sibiu and Sinaia for the information and observations on sites. This work was supported by National University Research Council (CNCSIS – UEFISCSU), Romania, project number PNII – IDEI 1066/2009, Creation of the data base and thematic maps for the ski areas in the Southern Carpathians using GIS. Analysis, up to date evaluation and prognosis within the global climatic changes perspective.

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