Analele Universităţii din Oradea, Seria Geografie, Tom XIX, 2009, pag. 109-116

TERRAIN AND CLIMATIC ANALYSIS OF THE BÂLEA VALLEY FOR THE DEVOLPMENT OF A SKI RESORT

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Résumé: ***L'analyse des éléments topographiques et des variables climatiques de la Vallée Bâlea pour l'aménagement d'une station de ski.*** La région d'étude est une des plus importante de la Romaine pour le tourisme montagneux. Celle-ci représente un excellent endroit pour le développement d'une station de ski en tenant compte de sa position centrale dans le pays et des hautes altitudes qui favorisent la persistance de la neige beaucoup plus que du minimum temps nécessaire pour avoir de bonnes revenues économiques. Les plus importants éléments topographiques pour l'analyse de l'aménagement sont l'altitude, la déclivité et l'exposition. Ainsi, la différence de niveau entre les plus hautes crêtes et la périphérie des pistes de ski dépasse 1000 m. La déclivité touche grandes valeurs, entre 0-45° (pour satisfaire tous les catégories des skieurs), tandis que l'exposition générale est nordique, nord-ouestique et nord-estique, en favorisant la conservation de la couche de neige longtemps. En ce qui concerne les variables climatiques nous avons analysé le nombre des jours à couche de neige et l'épaisseur de la couche de neige. Entre les grandes altitudes et les baises altitudes de la Vallée Bâlea il y a une différence qui touche 30 jours concernant la conservation de la couche de neige. La valeur moyenne des jours à couche de neige touche 130, qui représente un grande avantage du point de vue touristique. C'est pourquoi, dans ce contexte topographique et climatique on peut considérer que l'utilisation de la neige artificielle ce n'est pas recommandé.

Mots-clés: declivité, exposition, nombre des jours à couche de neige, épaisseur de couche de neige

1. Introduction

The Bâlea glacial valley is one of the most visited Romanian mountain area during the summer season especially due to the fact that it is crossed by the highest altitude road – the Transfăgărăşan. During the winter season even if it is snow-packed and equipped with a cable car the number of tourists that visit the area is considerably less than one would expect, considering the opportunities for winter-sports. In terms of location it is fairly advantageous situated in the centre of Romania, on the north side of the Southern Carpathians (fig 1.). This glacial valley is closely situated to the highest mountain peaks in Romania, the Negoiu Peak, 2535 m towards the west and Moldoveanu Peak, 2552 m, towards the east. The area has already been mentioned by two other scientists for planning as resort in the 1970s (Berbecaru, Botez, 1977), but unfortunately nothing has been finalized in this direction.

In the present paper we are analyzing the natural elements of the valley as they are favorable or unfavorable for the development of the proposed ski resort.The development of a ski resort in this area in an era when winter-sports are among the most fashionable pastimes of Romanians would bring undeniable revenues. This is confirmed by the rising in sales of winter equipment in cities that have the closest mountain resorts at 130 km distance with difficult access (eg. in Timişoara winter-gear sales went up close to 45% between 2004 -2008; personal query).

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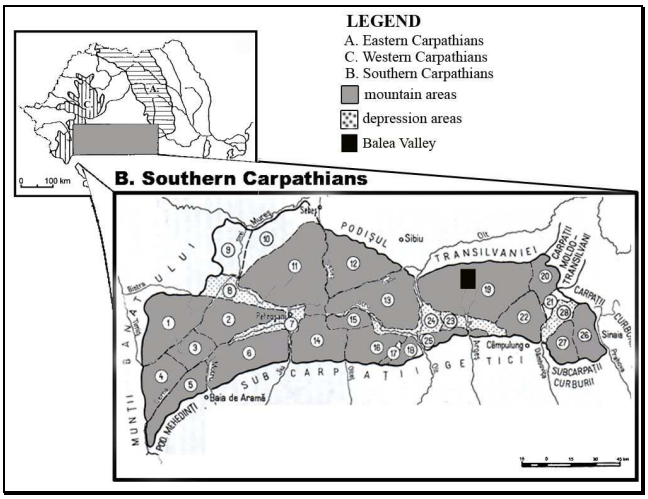

Fig. 1. Location of the Bâlea Valley within the Southern Carpathians

This was a short presentation regarding to the demand side of the market. In this paper we shall analyze the basis of the supply side, meaning if a reasonably large economic investment would be feasible as far as the natural conditions are concerned.

2. Methodology

In such an analysis the basic elements that need be analyzed are: the terrain elements such as altitude, slope, aspect and curvature (plane and profile); climate elements: temperature, precipitation – especially solid ones, wind speed and direction, insulation, snow depth, snow-cover in respect of the number of days with snow cover; and also vegetation where the most important parameter is type – woodland or not.

For the terrain analysis we have used as input data a digital elevation model, which has a spatial resolution of only 90 m, which is indeed of a poor quality. For bettering our analysis we have also used topographic maps 1: 25 000, and foremost importantly ortophographs. For the analysis we have used the following GIS software ArcGis 9.1 and Idrisi Andres. As shown in the methodological flow (fig. 2) we used spatial analyst tools to determine the stated parameters. The determination of curvature in the case of the DEM (digital elevation model) we used would have been useless (due its poor quality). We also performed spatial statistics afterwards to determine de percentages of slopes in particularly, because the slopes play the foremost important role in determining the type of resort we are able to build in a specific location.

The daily climate data was processed as far as mean values are concerned for some parameters such as temperature, precipitation, wind speed and direction, fog and insulation. For others, apart from monthly values, decadal ones have been used especially for snow coverage and snow depth, where the critical months have been the first and the last, especially for the determination of the ski season.

3. Relief and terrain parameters

The characteristic relief for the Bâlea Valley is the glacial one. That implies a cirque that bears the same name as the valley, which is surrounded by pointy crests, which follow the valley slopes until they reach the timberline where they become softer. At the bottom of the cirque, just under the sub-glacially eroded step, there is a glacial lake. Within the valley there are other glacial forms as shoulders, roches moutonées (terrain observations).

In terms of altitude, the valley does fall back beyond 1300 m altitude, but we have decided that the development of the resort should not go under that altitude (fig.3), due to two

main reasons: the existence of a second structural-glacial step, where the present waterfall is today. This disrupts the continuity of the ski area and would be out of the question regarding the planning of the ski domain having in view the high slope and the density of avalanches that take place in this area every year. From this point on the valley does also become narrower and unjustifiable to plan and manage having in view the climate change and the duration of the snow layer under this altitude. The second reason is that at this altitude the chalet Bâlea Cascada (1234 m) is situated together with the bottom station of the cable car and from here on downwards there is no other human settlement for more than 10 km, where the tourist village Cârțișoara is located.

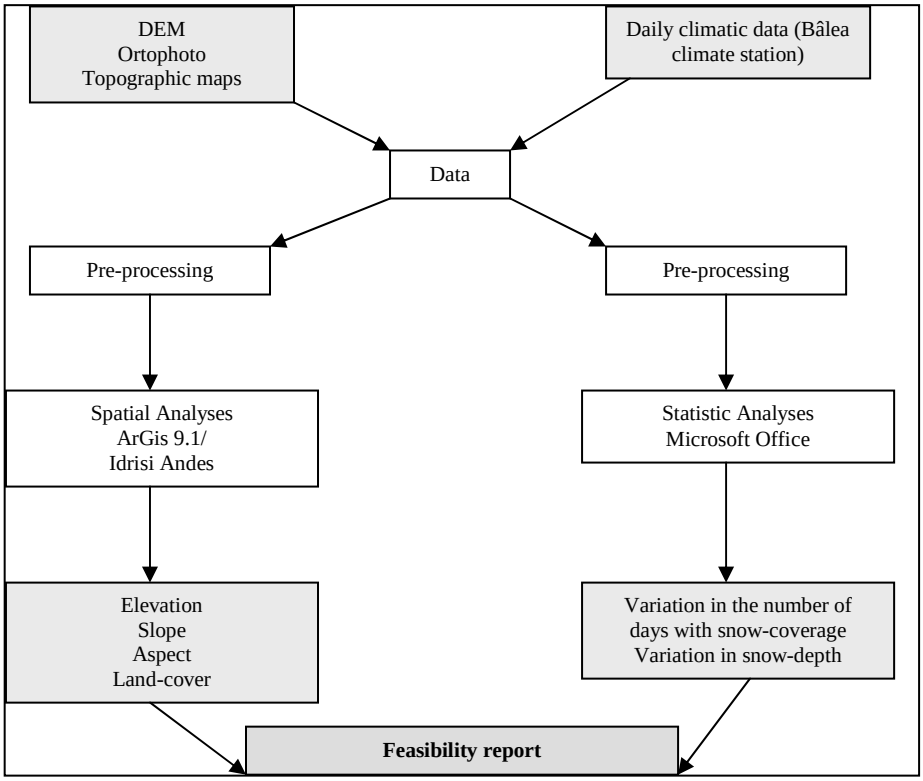

Fig. 2. Methodological flow

The level difference is a key factor in the evaluation of ski resorts (Petterson, 2005). While evaluating this parameter, there is another one, closely attached to the previous one that should not be neglected due to the fact that it super imposes its own set of limitations – this parameter is the maximum altitude. Having in view also the other parameters from a natural environment- that is the climatic ones and even the vegetation we conclude therefore that the superior area of the ski domain will be located in the alpine level and the bottom part in the subalpine level, with the very end of the ski domain below the timber line. In this particular valley the timber line is at about 1300 m (terrain observations) due to the fact that this is not a natural one. This area has been and is still being used for centuries for grazing sheep; therefore it was this habits and traditional occupations that pushed the timberline down a few hundred meters.

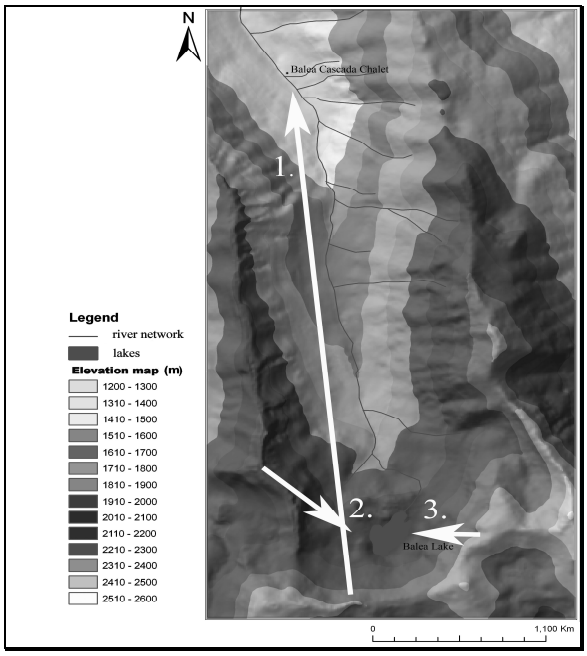

Fig. 3. Altitude map of the Bâlea Valley with the main tracks to be planned and developed

The altitude plays an important role in determining the types of tracks developed in each altitude level. This comes in addition to the slope criterion which is the fore most important in this respect and which we will analyze in the next paragraph. The altitude is limitative in the sense of the harsher climatic conditions at higher altitudes, especially within the alpine level, where the wind speeds are higher than in the lower levels and has a high coverage in the number of days with fog throughout the whole year. This would be without a doubt a restrictive environment for the beginners who need to concentrate all their strength towards learning the new practices and not to overcome harsh alpine conditions. Therefore the alpine areas are recommended to very good skiers and experts for they are also combined with high slopes as we shall analyze in the next paragraphs. Most of the subalpine is destined to medium and beginners – the latter category would be most comfortable with tracks that follow the bottom of the valley.

The level difference of a ski area is considered to be the distance between the highest and the lowest point of a continuous track within the area utilized with cable transportation. This level difference should be between 1600-400 m (Petterson, 2005). In our case study the level difference is of around 1000 m, which would make the Bâlea resort a fairly good one from this point of view. The level difference is always associated for analysis with the length of the tracks which most often exceeds the length of the cable transportation since the tracks would chose to follow the natural curvature of the relief and not the shortest distance. The track that would follow the road would be around 14 km, but such tracks would not be feasible to plan but for cross-country skiing, which usually lack the need of planning and are destined to a small category of practitioners. One of the best routes would be around 3 km long (the longest such track in Romania) and would be destined to good and advanced practitioners (arrow noted 1 in fig 2). The assignment to which category of skiers one or the other track is suitable is given by the mean slope that is calculated as a ratio between the length of the tracks and the level difference but most of the time with the present day technology it is simply measured (ArcGis Spatial Analyst Tools).

Than there are the two present used tracks in the Bâlea Cirque (noted 2 and 3 in fig 2.) which have a higher slope and a shorter distance. They cannot be called proper pistes since they are not groomed or managed in any way. On the west side from the Bâlea Saddle until the Bâlea Lake (track 2.) the distance is around 600 m and level difference of 300 m. Here a baby-ski-lift used to function. On the other side of the cirque, just on the right of the Capra Saddle until the Bâlea Lake (track 3) there is another track that has an even shorter distance of 400 m and a level difference of 300 m. Unfortunately it is here where the 23 skiers died in 1977 in an avalanche.

Moving on to slope analysis we can ascertain that this is among the most important morphologic parameter that needs to be considered when planning such a resort. Literature (Țigu, 2001) specifies that the slopes which can be economically efficient exploited for entertainment purposes are within the range of 10-45°. In real practice all slopes are used, even the ones under 10° for cross-country skiing and the ones over 45° by expert skiers which prefer freeride/off-piste skiing. The difference resides in their management. The ones under 35° can and must be groomed, properly delineated and the others over 35° cannot be groomed or they can but with very much difficulty and the most that can be done is to delineate them and place signs where access should be denied due to high avalanche risk and where little avalanche risk management is possible.

The Bâlea Valley's declivity is quite high having in view that 46% of the area is covered in slopes grater than 45° (fig. 4) – here as mentioned before only free-ride skiing/snowboarding can be done and it is currently exploited into the form of extreme competitions which usually take place in March (eg. Inferno 14.03.09).

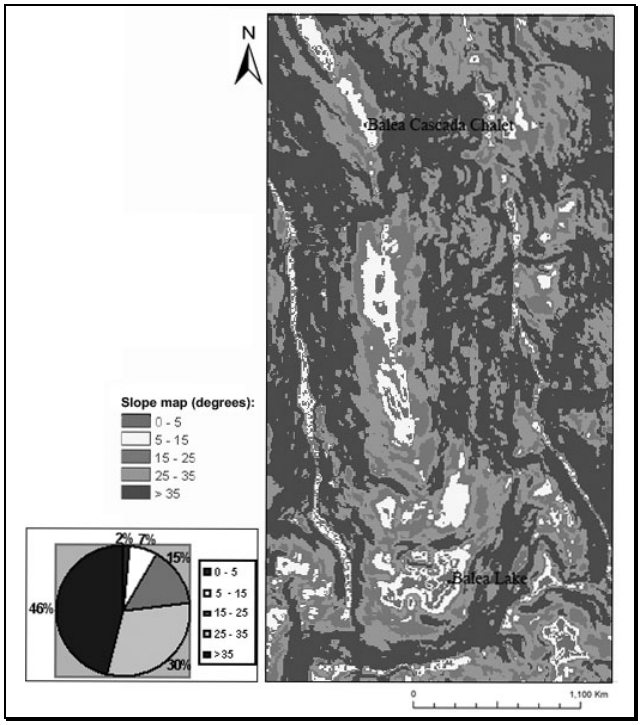

Fig. 4. Slope map and the different category percentages of slope in the Bâlea Valley

The downside of this free-riding is the high risk of avalanches – this very slopes are the most dangerous even at a small snow depth (Voiculescu, 2002) and the smaller the slope the larger the snow depth for the same high risk to be maintained. But unfortunately it is nor the

object of this paper or the space in which to argue for risk management and prevention for the resort – this should be treated as a separate topic for its importance cannot be dealt with into one or two paragraphs – but it goes without saying that without a rigorous management of the whole valley no development should take place (having in view that there are 15 avalanche channels reactivated each year in the valley) (Voiculescu, 2002).

The slopes between 25-35° cover a considerable 30% - these slopes are destined for good or advanced skiers/riders, 13% of the surface is covered in 15-25° slopes destined to medium level skiers/riders and only 7% of the area covered in 5-15° slopes destined for beginners (Țigu, 2001 and fig. 3 and 4). We could say the cross –country skiing has no place here since only 2% of the valley has slopes between 0-5°.

Concluding the slope analysis we mention that this ski resort would be destined mostly to expert, advance and good skiers but with the existing possibility even for beginners to learn and practice winter-sports, fairly said that such tracks shall have more of a singular appearance. The last parameter we shall analyze in terms of morphology is aspect. As we already noticed on the previous two maps, the overall direction of the valley is north-south. Aspect is an important parameter du to its connection to insulation. The north-facing slopes will be the most appreciated during late spring for here the snow layer is maintained until the month of June or even July in extreme cases. This is the area of the backdrop of the cirque. For the north-east oriented we have about 20% of the valley – on its left side and another 10% facing north-west. These are the most favorable aspects for the long storage of snow. But apart from saving snow (for the eventual snow-farming technique – Scott, McBoyle, 2007), we study appreciate aspect in the matter of risk management – most channels having an eastern or south eastern orientation (Voiculescu, 2002 and terrain observations). Aspect is not as strict a parameter as slope is, but we need to take it into consideration within the planning process as a risk management indicator, but also as a factor that is necessary to appreciate when analyzing tourist needs (Țigu, 2001) and one of these is skiing in sunny conditions.

As a conclusion to the brief morphomertric analysis we state that the area is favorable for the development of a resort destined mostly to advanced and good skiers accustomed to the harsh alpine and sub-alpine wither conditions. Furthermore that the whole area should be carefully monitored by the already existing work station of the Nivometeorology Programme that started in 2003 within the framework of the National Administration of Meteorology R.A. (ANM) in partnership with Météo France, Centre d'Études de la Neige-Grenoble with regard to the avalanche risk management.

4. Analysis of the most important climatic parameters

All climatic parameters are important with regard to an area that is analyzed for developing a ski resort, but the vital ones for the economic efficiency of a resort are the number of days with snow coverage and snow depth. In addition we mention that all other factors such as temperature, precipitation, number of days with snow fall and insulation participate and influence the two above mentioned parameters and the analysis of each one individually in the present paper should not be a vital requirement.

The number of days with snow coverage would be included with the ones with snow fall, but having in view the altitude we can experience snowfall in each month of the year. We shall take into consideration the months with a snow coverage that can sustain winter-sports, that is with a higher depth than 20 cm (in the past we mention that the need for 40 cm was required since the slope management during the summer months was inexistent).

For the analysis of the climatic parameters the data has been provided for by the meteorological station Bâlea Lac, located at 2070 m altitude. For a viable economic investment it would be necessary of 120 days of snow coverage (Țigu, 2001). As we can observe in fig.5 the average number of days over an analyzed period of 20 years surpasses 150 days. This holds

true for the upper part of the ski domain. Unfortunately there is not another station within this valley, but on the southern side of the Făgăraş Mountains there is another meteorological station at Cozia located at 1577 m altitude and we can use the data there in order to realize to what extent the 120 days of minimum coverage would still stand true in the lower part of he ski area. So for the Cozia station over the same period of time we have a registered value of about 110days, which is rather close to the necessary minimum. At this point we realize that for the latter part of the season at the inferior part of the ski area snow supplies should be provided for. An investor would probably think just about immediately at snow cannons, but one should know that they are not efficient at positive temperatures unless additives are provided for either organic or inorganic (Rixen, et al., 2003)

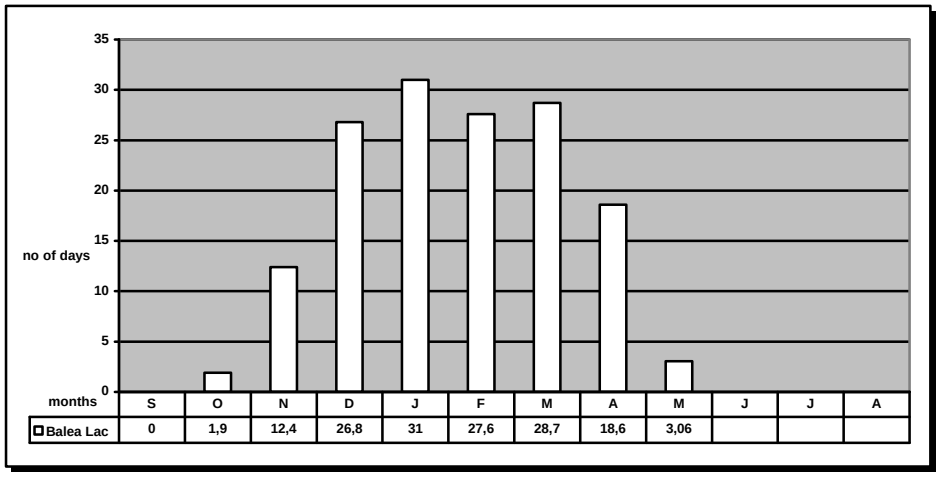

Fig. 5. Number of days with snow coverage – average values for the years 1979-1999 at Bâlea Meteorological Station

If we take a look at figure 6 one can realize that there is enough snow in the upper part of the ski area to "harvest" for the lower part. This is another adaptive technique (which accounts for the recapturing the moving snow), according to Scott and McBoyle (2007) called snow-farming which is environmental-friendly.

As far as snow depth is concerned (fig. 6), one can realize that the required conditions are met even in the month of November. Nevertheless before deciding on an opening day of the first of November one should look at the snow depth on a decadal term and than we would notice (according to the meteorological data) that the season could start after the 20th of the month of November. As we corroborate the values with the data from Cozia station we realize that the season would better start on the first of December. From here on the snow depth is quite continuously growing until April when it starts decreasing. As the snow passes 1.3 meters as an average value at the Bâlea station we should mention that it is imperious to have such amount of snow leveled down and groomed (wherever possible) so that the skiing activities are a pleasurable endeavor and not a survival camp activity since such snow-depth is quite difficult to ski in. As for the end of the season again it is vital to observe the decadal values, which would end the season about 40 days earlier in the lower part of the ski domain if there are no adaptive measures undertaken, which would mean that at Bâlea Lake the season ends in mid June and at Bâlea Cascada at the end of April.

Another important parameter that cannot be quantified in the snow parameters is the number of days with fog phenomenon which is very restrictive for the ski activities, depending on the visibility limitations can cause actual days of interruption in the ski calendar especially

for free-ride and off-pistes and for the advanced pistes as well where the distance in-between skiers should be greater that 20 m (Țigu, 2001)

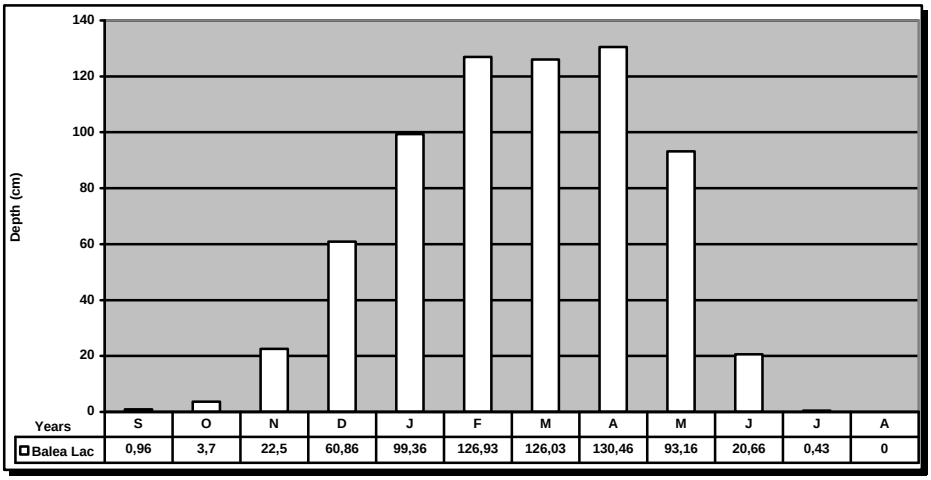

Fig.6. Snow depth at the Bâlea Lac meteorological station - average Values for the years1979-1999

According to the data from both meteorological stations there is no month that has less than 15 days with fog (apart from February) for the analyzed time span. This would mean that the 120 days are not as certain as they appeared when analyzing the snow depth. Another more restrictive parameter that would definitely close down the resort for the affected days are snow-storms which are more frequent at higher altitudes (varying from 3-5 days in the months of December, January and February in the area of the Bâlea station).

5. Results and concluding remarks

Morphologic parameters would recommend this area for the establishment of a ski resort with the specification that is destined to expert and advanced skiers, with most of the area in the alpine and subalpine areas, if a rigorous avalanche risk management is undertaken (having in view that more than 46% of the valley is covered in slopes over 35°).

In terms of climatic conditions, even if the snow coverage and snow layer would ascertain more that 120 days of ski, there are other climatic limitations as snow-storms and foggy days. In order to give a correct answer to the question regarding the establishment or not of an important resort in this area would hare to wait the establishment of more devices for the avalanche management and for the study of a parameter that would be called actual ski days (considering the restrictive parameters limitations through location-based observations). If all conditions are met this will become without a doubt the largest ski resort in Romania.

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