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THE GIS ASSESSMENT OF A WINTER SPORTS RESORT LOCATION. CASE STUDY: BELIȘ DISTRICT, WESTERN CARPATHIANS

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Abstract: The role played by the tourism infrastructure in the territorial development of specific areas remains debated, especially for the small municipalities located in marginal areas. This paper suggests an analysis model which predicts the best location for the planning of a ski resort. This model was tested and applied in Beliș District – Western Carpathians. The relationships between environment, natural heritage and resources for the six settlements comprised in Beliș District were analysed using GIS and specific spatial analysis methods. The analysis included four steps: (i) the setting up of the spatial database; (ii) the computation of the closest distance to localities, tourist attraction points and possible ski-tracks; (iii) the reclassification of the raster data; (iv) the combination of the datasets using raster calculator. Using Digital Elevation Model (DEM) analysis and vertical aerial photographs, several hundred possible ski tracks distributed among twelve areas in Beliș District were identified. The results show that the south-central part of the studied area represents the ideal territory for the winter resort location. The main contribution of this work is the proposal of a methodological approach that may be applied to different mountain areas.

Keywords: Spatial analysis, GIS, ski tracks, winter resort, suitability, Beliș District, Western Carpathians.

1. INTRODUCTION

Sustainable development of sites with rich natural heritage is considered to strengthen the protection and long term management of these sites at both local and national level (Pedersen, 2002). The fundamental characteristics of sustainable development are meant to ensure the future for next generations and the conservation of natural resources (Tvaronavicius & Tvaronaviciene, 2008; Kushwaha et al., 1996). Climate plays an important role for outdoor winter activities from two perspectives: the conditions for winters sports (Ilieş, 2007) and the sustainability of such activities correlated with climate change (Mooney et al., 2009; Tokimatsu et al., 2012). The high levels of anthropogenic activities contribute to the rise of greenhouse gas and may induce climate changes. As a consequence of recent global warming (Dong, et al., 2013; Kargel et al., 2005; Oerlemans, 2005), the present climate change may have a negative impact on winter sports.

Even if there are suitable conditions for winter sports in the Carpathian Mountains, tourism facilities are not well developed in Romania. The total length of the ski tracks is 126 km while the number of accredited ski-tracks is 147 (National Institute of Statistics (NIS, 2013). In the Western Carpathians, there are several marginal regions, mostly disadvantaged areas (Cocean, 2002). Beliș District belongs to such an area and, for the last decades, manners of development have been searched for. For such regions, the setting up of innovative plans is the right approach for a sustainable future (Benedek, 2004; Kotler et al., 2001). Tourism development should consider not only the natural conditions but also all social and cultural aspects as well as the human dimension of a

particular place (Ciangă & Dezsi, 2007; Cocean & Dezsi, 2009; Berbecaru & Botez, 1977). The development of disadvantaged areas through tourism investments is a priority for the National Tourism Authority (National Territory Master Plan, section VIII: Tourist Areas, 2009).

The objective of this paper is to provide an evaluation of an area suitable for further development into a ski resort, and also has a favourable location for tourism planning (in the neighbourhood of the main city of Transylvania – Cluj-Napoca - an economic, political and social growth pole).

The study combines geological and geographical aspects of field research with modern technology for land surveys: GIS and remote sensing. Spatial analysis was used to find the suitable location for a winter resort. More evidence (Rutherford, et al., 2014; Brigante & Radicioni, 2014; Pedrana, 2014; Mohammad et al., 2013; Fotheringham & Rogerson, 1994) highlights GIS usefulness for phenomenon simulations and ground models.

The paper is structured in five sections. Section 1 is focused on the GIS and spatial analysis applications in tourism. Section 2 outlines the methods for analysing the Beliş District. Section 3 presents the results obtained by applying the methodology. Section 4 discusses the advantages of spatial analysis for environmental research and the final section provides the conclusions of the study.

2. STUDY AREA

Beliş District is located in the northern part of the Western Carpathians, at the contact of Gilău Mountains, Vlădeasa Mountains and Bihor Mountains and range between 46°32’ and 46°41’ N and between 22°47’ and 23°04’ E (Fig. 1).

From an administrative point of view, Beliş District is located in the South-West of Cluj County and comprises six villages. The altitude of Beliş District is above 1000 m and the highest altitude is 1572 m.

The geology of the area includes crystalline schists, granite intrusions and limestones (Ianovici et al., 1976). From a geomorphological point of view, there are no landslides and rock falls, so the terrain is stable and improvements can be made safely. This is essential for territorial planning and risk management (Bowman & Take, 2014; Pirone, et al., 2014; Sugathapala & Rathnasiri, 2012; Nadim, et al., Jaedicke, 2006; Guzzetti, 2000; Posea & Popescu, 1967).

The main rivers that cross Beliş District territory are Beliş and Someşul Cald. The presence of Fântânele Reservoir in the area is an advantage for the development of winter sports due to its capacity to provide the amount of water necessary for snow production facilities.

Beliş District is one of the territorial administrative units included in the Apuseni Mountains Natural Park. This park is located in the Western part of Romania, within the Apuseni Mountains, partly covering the Bihor Range in the South and Vlădeasa Range in the North. Administratively the park is divided between three counties (Cluj – 40% of the area, Bihor – 32% and Alba – 28%) and includes 61 settlements.

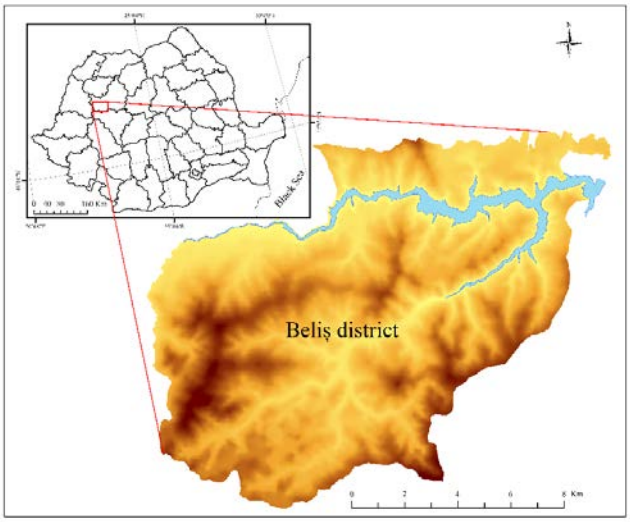

Figure 1. Location of the Beliş District in Romania

3. DATA AND METHODOLOGY

The used methodology is simple, fast, accurate and easily integrated for research in mountain areas. The investigation was focused on Beliş District, an administrative unit located entirely in a mountain area. The work was carried out in the whole district and represents an exhaustive study on slopes, valleys and positions of villages. The spatial analysis steps used to find suitable locations for a winter resort are similar to the ones proposed by McCoy & Johnston (2002). A geodatabase containing the main datasets (contour lines, plans of ski-tracks, built-up areas of the villages and tourist attraction points) was created in order to perform the operations of the spatial analysis.

The method of ski-tracks design is similar to the one suggested by Tourism Ministry Order No. 491 (2001). The vector information was extracted by manual vectorization and automatic extraction from 1:5000 topographic maps and aerial photographs. Many experts assert that digitization is more useful, even if it is tedious (Hadeel et al., 2010; Elshehaby

& Taha, 2009; Raup et al., 2007).

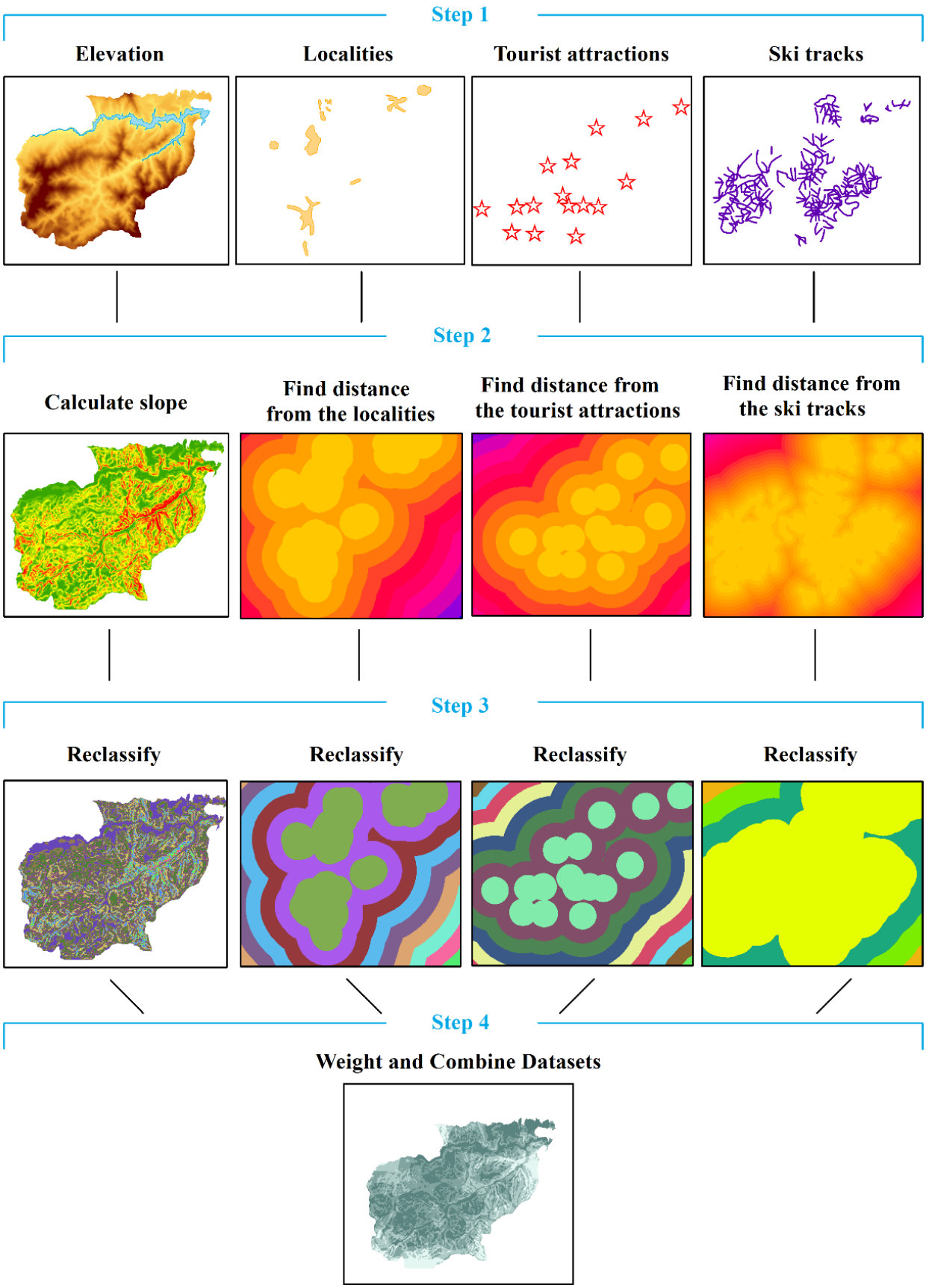

Figure 2. Spatial Analysis applied for Beliș District territory

The amount of precipitation, the temperatures, the snow cover characteristics, the wind speed and nebulosity are not analysed here. These elements were studied before within a feasibility study.

3.1. Spatial Analysis

The two main datasets used for the proposed analysis are ski-tracks data and DEM. Based on these, spatial analysis allowed the investigation of the terrain characteristics and their impact on winter sports. To identify the suitable location in Beliș District the analysis process was conducted in four steps.

First, we introduced raster data derived from contour lines and other three vector data: localities, tourist attraction points, ski-tracks. From the raster DEM we derived the slopes. Localities have a neutral role for spatial analysis, because they may be embedded in the construction of the new resort or may become neighbourhoods of the new winter resort.

Tourist attraction points and ski-tracks are fundamental for the model due to their role in tourism activities. In the second step, Euclidean distance between vector data and slopes raster was considered in the analysis process. The resulting rasters were reclassified in the third step. In the final stage of the analysis the data were weighted and combined in the final map (Fig. 2). To determine the suitable areas more accurately, the final map was converted in vector polygon layer. The classification of the suitable sites is illustrated in figure 3.

4. RESULTS

Using GIS and spatial analysis, the suitable areas for winter outdoor sports were precisely identified. The high number of opportunities offered by ESRI software allowed us to get information from DEM on different layers. The suitable areas were categorized with very low, low, medium, high and very high suitability. A total suitable area of 45.18 km² (Table 1) was identified in an area of high suitability using GIS on Beliș District territory. According to this Poiana Horea represents the largest and the most adequate area for the construction of a new resort. The results of this analysis were favourable for four areas surrounding Poiana Horea: Poiana Horea North-West, Poiana Horea North, Poiana Horea South and Poiana Horea East (Fig. 4).

Table 1. Suitability areas (km²) of Beliș District

Villages	Very low	Low	Medium	High	Very high
Beliș	-	-	0.00	1.15	2.88
Dealu Botii	-	-	1.42	9.57	2.87
Bălcești	-	-	0.12	2.47	3.91
Giurcuța	-	0.03	1.46	17.41	7.09
Smida	-	-	0.41	19.50	4.67
Poiana Horea	0.01	0.76	22.23	76.58	23.78
Total	0.01	0.80	25.64	126.67	45.18

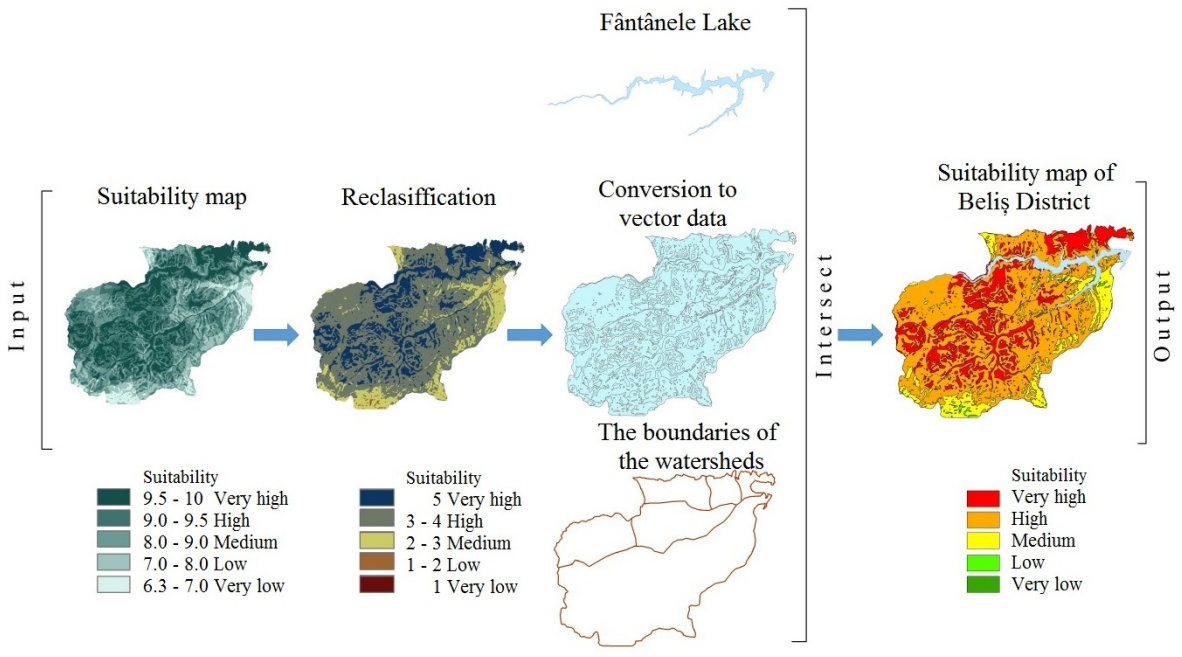

Figure 3. General framework of the suitable area

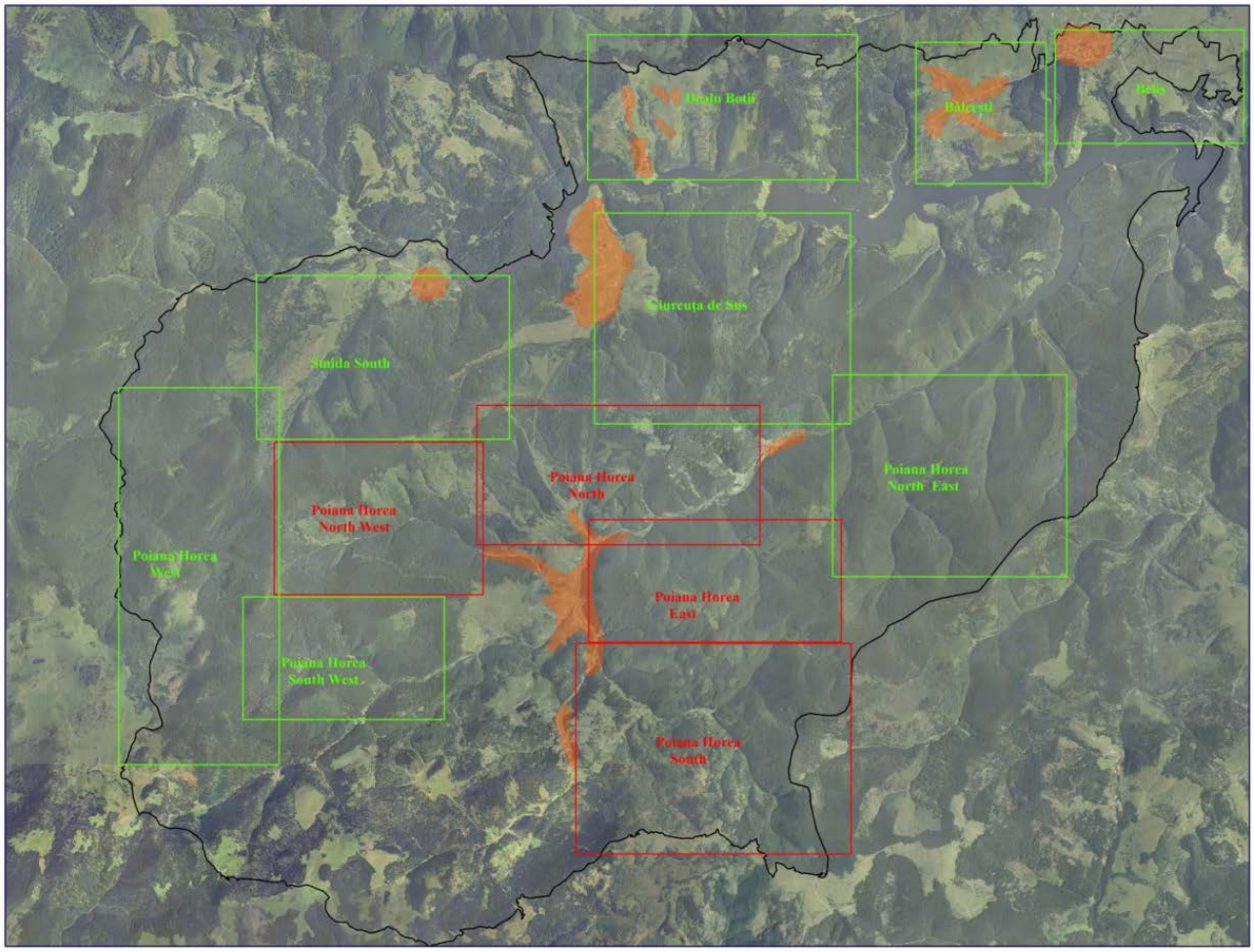

Figure 4. Localization of the favourable suitability areas (red coloured) on aerial photograph

Table 2. Tourist attraction points and ski tracks*presented in Beliș District villages

Villages	Tourist attraction points (TAPs)	Ski tracks (STs)
Beliș	1	7
Dealu Botii	1	7
Balcești	1	11
Giurcuța	1	14
Smida	1	8
Poiana Horea	11	135

*In this evaluation cross-country ski tracks are not considered, because they extend over more than one village

The distance (Euclidean distance) between elements was determined and the resulting rasters were reclassified using unsupervised classification algorithm (Barnsley & Barr, 1996). The final suitability map was realized according to the importance of each layer in the analysis (Table 3, Equation 1).The results for Poiana Horea village show an area covering 23.77 km² with very high suitability and an area of 76.57 km² with high suitability. An area of 22.22 km² has medium suitability and an area of 0.76 km² low suitability. Moreover, Poiana Horea village includes an area of 0.006 km² which has a very low suitability (due to the presence of hillocks and rugged terrain) located mostly in the South-West of Beliș District.

Table 3. Percentage criteria used for the Raster Calculator

Reclassification of the distance to TAPs	45%
Reclassification of the distance to STs	30%
Reclassification of slopes	20%
Reclassification of the distance to localities	5%

The main datasets used in the analysis are tourist attraction points and ski-tracks. While possible ski-tracks were previously identified, the tourist attraction points represent the main sites for winter sports and in this research they coincide with the starting points for funiculars. Highest values of tourist attraction points (11) and ski-tracks (135) were identified in Poiana Horea village (Fig. 5) and lower values are registered in Beliș village as an

effect of the predominant flat morphology, similar to a high platform (Mutihac & Ionesi, 1974). In this area only 2.88 km² of very high suitability and 1.15 km² of high suitability were found. Other classes of suitability were not found for Beliș surroundings (Table 2).

Accordingly, in that area there are no planned or proposed ski-tracks or tourist attraction points. Other very high suitable areas are: Giurcuța village (7.06 km²), Smida (4.66 km²), Bălcești (3.9 km²) and Dealu Botii (2.87 km²).

$$S = \text{Rec. dist. TAPs} \times 0.45 + \text{Rec. dist. STs} \times 0.3 + \text{Rec. sl.} \times 0.2 + \text{Rec. dist. loc.} \times 0.05 \quad (1)$$

S = Suitability
Rec. dist. TAPs = Reclassification of the distance to tourism attraction points
Rec. dist. STs = Reclassification of the distance to ski-tracks
Rec. sl. = Reclassification of slopes
Rec. dist. loc. = Reclassification of the distance to localities

Using this methodology 190 ski-tracks were identified and the entire area of Beliș District was classified in different classes of suitability for winter resorts. There are limitations to this methodology, especially due to the datasets included in the analysis: the distances were determined as straight-line distances while the major rivers were considered in the planning process of ski-tracks and were not included in the second stage of the spatial analysis process. However, these limitations did not alter the results of the model.

5. DISCUSSION AND CONCLUSIONS

Sustainable development is connected to the ability to minimize the impact of human activities and encourage the investment of companies (Benhabib, 2000; Kotler et al., 2001). The potential areas that can be capitalized in Beliș District by means of tourism have been indicated in this paper. The process of building and managing the ski-tracks will lead to some deforestation due to the vegetation cover of the area (80.25 % of Beliș District are forested areas). Any construction at district level is meant to change the forest area. Also, it will be necessary to modernize the old roads and build new ones for access. It is likely that some sectors of the forest will be cut.

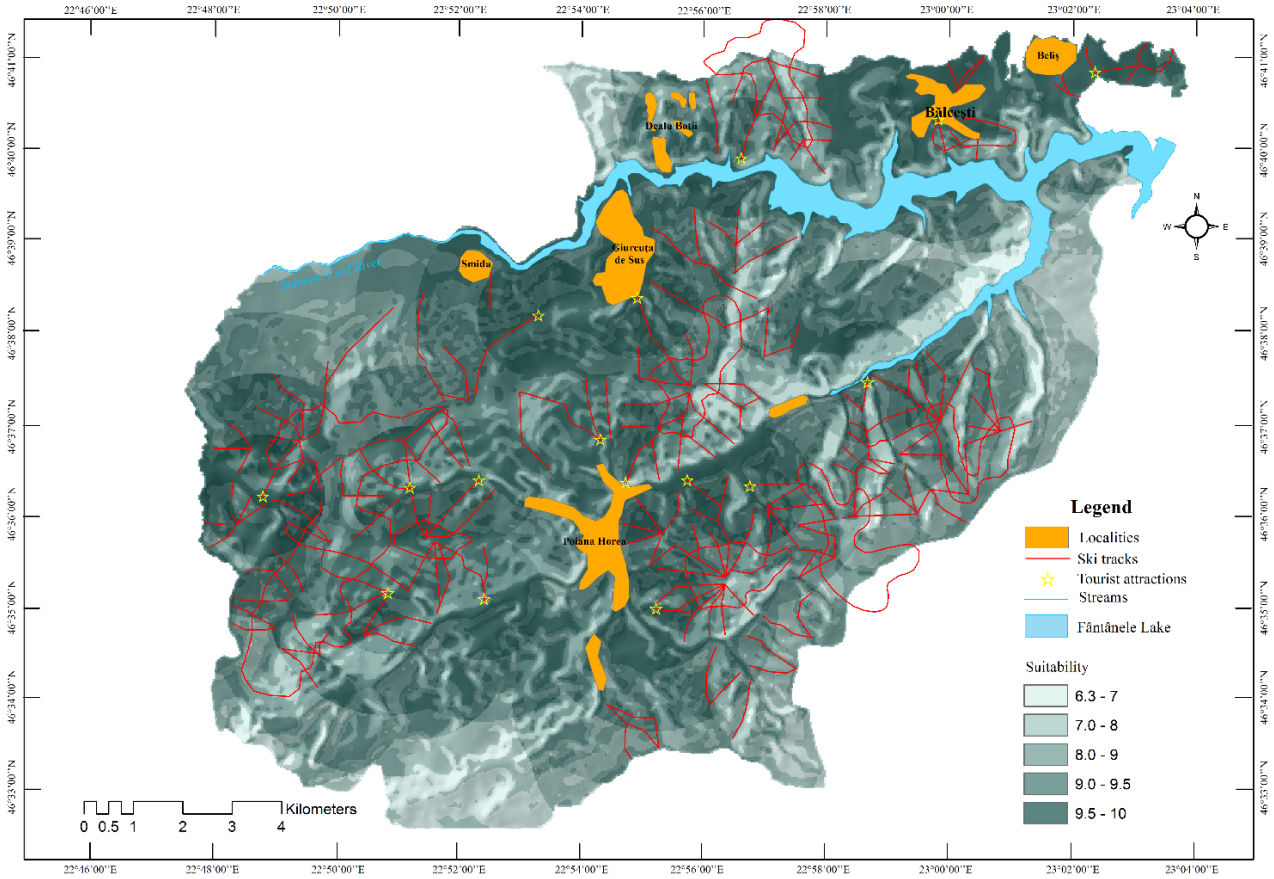

Figure 5. Ski tracks suitability map for Beliș District

This research proves the importance of GIS applications, field survey and remote sensing to find the best location for a new tourism winter resort.

In order to test the validity of the proposed method, this study is focused on Beliş District. It has been chosen due to the advantages resulting from its location in a mountain area which provides favourable natural conditions for winter sports, such as morphological fragmentation, length and aspect of slopes and suitable climate conditions. There are also reasons related to its strategic position which justify investments in tourism infrastructure: relatively high accessibility and the nearby presence of Cluj-Napoca, the largest city of the region.

The results of this research indicate that Poiana Horea village contains the largest suitable area in Beliş District. The suitable areas for tourism development at various levels of suitability were determined.

The research suggests that it is important for policy makers to encourage government funds, stakeholders and business people to develop tourism activities in Beliş District. Future work should focus on packages that promote tourism in Western Carpathians. The perspective of contributing to the change of the present situation in the studied area and of supporting the development of tourism is very appealing.

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