

Some current data and observations regarding the ski slopes in Suceava County, Romania

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ABSTRACT: Current climate change poses numerous challenges for humanity. People's leisure activities are affected by climate warming, here including winter sports, in general, and skiing, in particular. In this study, we inventoried the ski slopes in Suceava county and selected the most important ones for an analysis of their length, facilities and potential. The 18 ski slopes on which we focus are located in 7 administrative-territorial units, of which 4 are resorts of national interest - Vatra Dornei, Câmpulung Moldovenesc, Gura Humorului and Sucevița - and 2 are resorts of local interest - Mălini and Pojorâta. Most of the selected ski slopes are of medium difficulty level (72.2%), those with easy difficulty are 16.7%, while those with high difficulty represent 11.1%. Due to favorable climatic conditions and history, Vatra Dornei is the administrative unit with most ski slopes and most kilometers of ski slopes in Suceava county, followed by Câmpulung Moldovenesc. A long-term strategy should be established for building a sustainable ski slope in the mountain area and geographers are specialists who can cover important chapters in a pre-feasibility or feasibility study.

KEY WORDS: ski lift, artificial snow, floodlight, average and maximum slopes.

1. Introduction

Ski slopes are very popular today for recreational alpine/downhill skiing and are sometimes important sources of revenues for local communities; the creation of ski slopes brings advantages and disadvantages for the environment and human society, and the final result has not yet been fully evaluated (Burt and Rice, 2009; Křenová et al., 2020).

Mostly due to a lack of dedicated studies, ski resorts do not have an ecologically-sound management that should protect the biodiversity (Sato et al., 2013). The construction of ski slopes is not always well regulated within specific frameworks. Illegal actions may occur if the ski slopes are located within national parks (e.g. deforestation, construction of unofficial buildings), leading to land degradation, pollution of various types and habitat fragmentation (Ćurčić et al., 2019). The consistent and persistent snow cover on a ski piste is also altering the grass species composition and decreases the biodiversity (Rixen et al., 2003).

The construction and maintenance of ski slopes have a visible impact on alpine soils - the soil suffers various physico-chemical changes and even an accelerated erosion, leading to changes in plant communities around ski resorts (Pintaldi et al., 2017). Efforts are made in the last years in developed countries for protecting the soils along ski slopes and recommendations arise from various research studies for best practices of soil protection (Pintaldi et al., 2017).

Noise and light pollution impacts both humans and wildlife. Most studies on the impact of winter sports and tourism on fauna were conducted in Europe, which contains some of the traditional places for winter tourism (Sato et al., 2013). Birds and mammals are affected by landscape changes caused by ski slopes and skiing, which lead to lowered diversity and abundance of the affected fauna (Sato et al., 2013).

Ski slopes are studied today for their social side too. Skiing may bring health benefits, but is also associated with injuries or death risks caused by falls or cardiac problems; however, the mortality is low in groomed ski runs (under 1 death per 1 million exposure days (Niedermeier et al., 2020)). Avalanche burial is also a non-negligible cause of insecurity (Hohlrieder et al. 2005). Improving sport-specific skills and using protective gear are among preventive measures for skiers (Niedermeier et al., 2020).

Climate variability impacts the ski industry through the increase in air temperature. As result of climate change and changes in mass tourism, the production of artificial snow has increased in the last decades (Rixen et al., 2003). Under actual climate warming conditions, low altitude ski slopes have to rely more and more on snow cannons (with impressive water and electricity consumption) and artificial snow - the dependency is shaped by a series of factors, such as the latitude, the exposition of the slope (the northern exposition is favorable in the northern hemisphere, where most groomed ski slopes are located) and the regional air circulation. Therefore, the reduced snow quantity and duration under natural conditions impacts ski resorts differently, depending not only on terrain elevation, but also on snowmaking infrastructure (Gilaberte-Búrdalo et al., 2014).

According to the scientific articles in journals included in Web of Science, the 60% most frequent words in the literature related to ski runs/slopes are grouped in 3 clusters (Fig. 1). One can observe that main research directions are indicated by the sum of the most relevant words in each group; relevant words are as follows:

- Cluster 1 (red color; especially about the environmental consequences of past and present ski-related activities and the current ski-environment relationship): alpine ecosystem, artificial snow, biodiversity, biomass, bird, climate change, conservation, construction, density, distribution, disturbance, diversity, ecosystem, erosion, forest, grass, habitat, human activity, maintenance, management, native species, negative impact, recovery, restoration, revegetation, ski run, soil erosion, temperature, vegetation, wildlife; the most frequent spaces in the papers that have the mentioned research interests are: Alps/Swiss Alps, Europe, Italy;

- Cluster 2 (green color; focused on the social side of skiing, mostly on the assessment of the skiers' population and the security of skiing): accident, age, behavior, cause, collision, death, fall, frequency, gender, helmet use, injury, patient, questionnaire, rate, risk, safety, skill level, ski slope, skier, skiing, speed, sport, weather condition; spaces belonging to this group are Austria and Japan;

- Cluster 3 (blue color; on the technical aspects related to the ski as a sport, the ski runs and the ski tourism): angle, athlete, competition, correlation, direction, friction, future, infrastructure, landslide, measurement, performance, prediction, project, road, simulation, ski track, structure, system, trail, tourism, tradition, visitor; the spaces are described using generic words such as "country" and "world", suggesting national and global approaches.

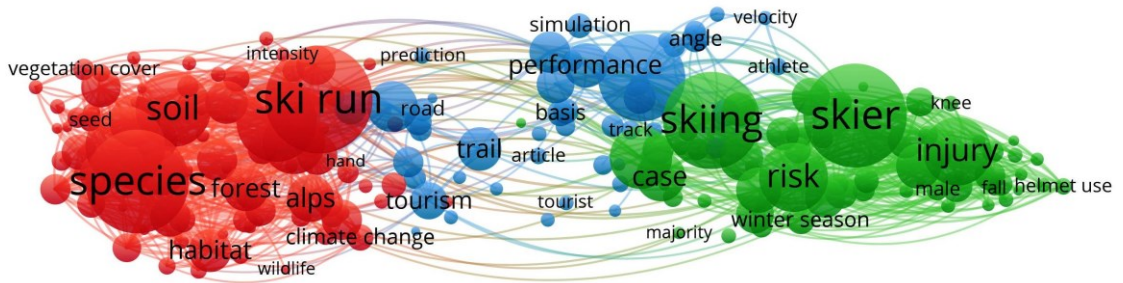


Figure 1 Co-occurrence network map of the most frequent words in the titles and abstracts of articles in Web of Science Core Collection that appear when searching for the following words in the topic field: "ski piste*"OR"ski slope*"OR"ski run*"OR"ski trail*"OR"ski track*" (* means including derived words; data has no supplementary filtering; 605 papers found as of November 27th, 2023; the size of circles and letters indicates the importance of the words, while the lines are their connections; the colors indicate the grouping of the words in clusters; obtained with VOSviewer 1.6.18 (<https://www.vosviewer.com/> - Van Eck and Waltman (2010)), default settings, excepting the visualization scale and the size variation of the labels, which are set to maximum values for a better contrast).

In the Romanian Carpathians, the climate change is associated with a lower incidence of the snow cover in areas with an altitude under 1700 m above sea level (a.s.l.) (Micu, 2009). The ski slopes are open for dedicated activities mostly from December until March, but the cumulated days of functioning are roughly, on average, the equivalent of 2 months (Cernaianu and Sobry, 2021). Many Romanian settlements constructed ski slopes in the last decades without taking into account all the necessary natural conditions for a functional slope – a known example of this sort is Cocoș ski slope in Bistrița county (Bîca et al., 2018). Romania has over 200 ski slopes with various degrees of functionality, most of them being affected by climate change and bad investments (Cernaianu and Sobry, 2021). In Romania, 226 groomed ski slopes were identified and have a total length of ~257 km (Teodor, 2016), resulting that an average Romanian ski slope is a bit longer than 1 km. According to a more recent source, Romania had 242 ski slopes in 2020 (205 are officially homologated), with a total of ~239 km total length (meaning that an average ski slope has a length slightly less than 1 km) (Herman et al., 2021).

In Suceava county, a high risk of becoming unfunctional and certainly not profitable in the near future have the ski slopes from Gura Humorului, Sucevița and Mălini (Teodor, 2016), because of their position in the marginal area of the Eastern Carpathians.

The beginnings of the constructions for practicing skiing in Suceava county are relatively difficult to define, but older ski practitioners mention the Austro-Hungarian period, before 1918, when there were places, within the localities of Câmpulung Moldovenesc and Vatra Dornei, where skiing was practiced by a relatively limited number of people. The lack of solid traditions in the practice of this sport is later reflected in the late developments of the ski resorts, which appeared in the county after the 80s of the previous century.

The aim of this study is to provide an assessment of the current state of the main ski slopes in Suceava county using field observations and terrain measurements. Therefore, our analysis will be similar to some studies in the cluster 3 (previously described). We focus on measuring the length and slopes of the usable parts of the ski runs, and the obtained numbers may provide a basis for further studies.

2. Study area

The mountainous area of Suceava county, through its morphological configuration (some altitudes close to 2000 m, long summits with small slopes), climatic characteristics, transport accessibility and socio-cultural potential has a high level of favorability for the practice of tourism as a whole (Briciu and Oprea-Gancevici, 2011). Winter tourism, for the practice of winter sports, does not have a particular tradition in Romania, but there is certainly an upward trend determined by the fairly rapid filling of this gap in Romanian tourism.

Currently, Suceava county has 7 localities with ski facilities - Vatra Dornei, Câmpulung Moldovenesc, Cârlibaba, Gura Humorului, Valea Putnei (Mestecăniș), Mălini, Voievodeasa (Sucevița). We can also mention 3 more locations where there were similar facilities for short periods of time - short ski sections, currently non-functional: Negra Șarului, Putna and Hotel Rarău (Fig. 2).

The construction of the ski slopes represented an opportunity for the private economic environment, but also for the Romanian state, which financed and continues to finance such facilities through the national program for the development of mountain tourism, "Superski in the Carpathians" (Romanian Law 526/2003 - the national program for the development of mountain tourism "Superschi în Carpați"). The strategy of both developers is not without errors, which is why unsustainable private and state investments are doomed to failure, at least from the perspective of capitalizing the investments for the purpose for which they were made.

3. Data and Method

We counted the ski slopes in Suceava county and the length of the main ski runs. The morphometric characteristics of the ski slopes were obtained using GIS software dedicated to geographic analysis - ArcMap 10.2, Global Mapper 10, Google Earth Pro - and detailed topographical materials - topographic maps at a scale of 1:25000 (1980 edition) and orthophoto plans (2005 and 2011 editions) produced by the Romanian national specialized services; CNES/Airbus satellite images from the last 2 decades - for spatial verification of locations on current images. The terrain data was used to extract the altitude along ski slopes and the elevation data was then used to obtain average and maximum slopes (Fig. 3).

The determination of the lengths of the ski sections took into account only the skiable surfaces, not the transfer spaces from the ski lift to the upper edge of the track or those related to the access areas to the ski lift (thus, we measured the ski slope length that is frequently used by skiers and this is shorter than the value that is usually promoted in the informative materials). In many cases, the study required the direct validation of information from the owners or administrators of ski facilities. Some information in mass media regarding the extent or track of a ski slope are outdated due to recent changes. The evaluation of each ski slope is the result of observations from personal interactions over time with the ski areas in Suceava County.

Currently, the design, layout and homologation of ski slopes is standardized by ministerial order no. 491/2001, which provides the criteria for their classification according to the degree of inclination of the track. Four categories of ski slopes are defined: beginner ski slopes / very easy - green color, $\leq 10\%$; light ski slopes - blue color, 10.1 - 20%; ski slope of medium difficulty - red color, 20.1 - 30%; difficult ski slopes - black color, 30.1 - 40%.

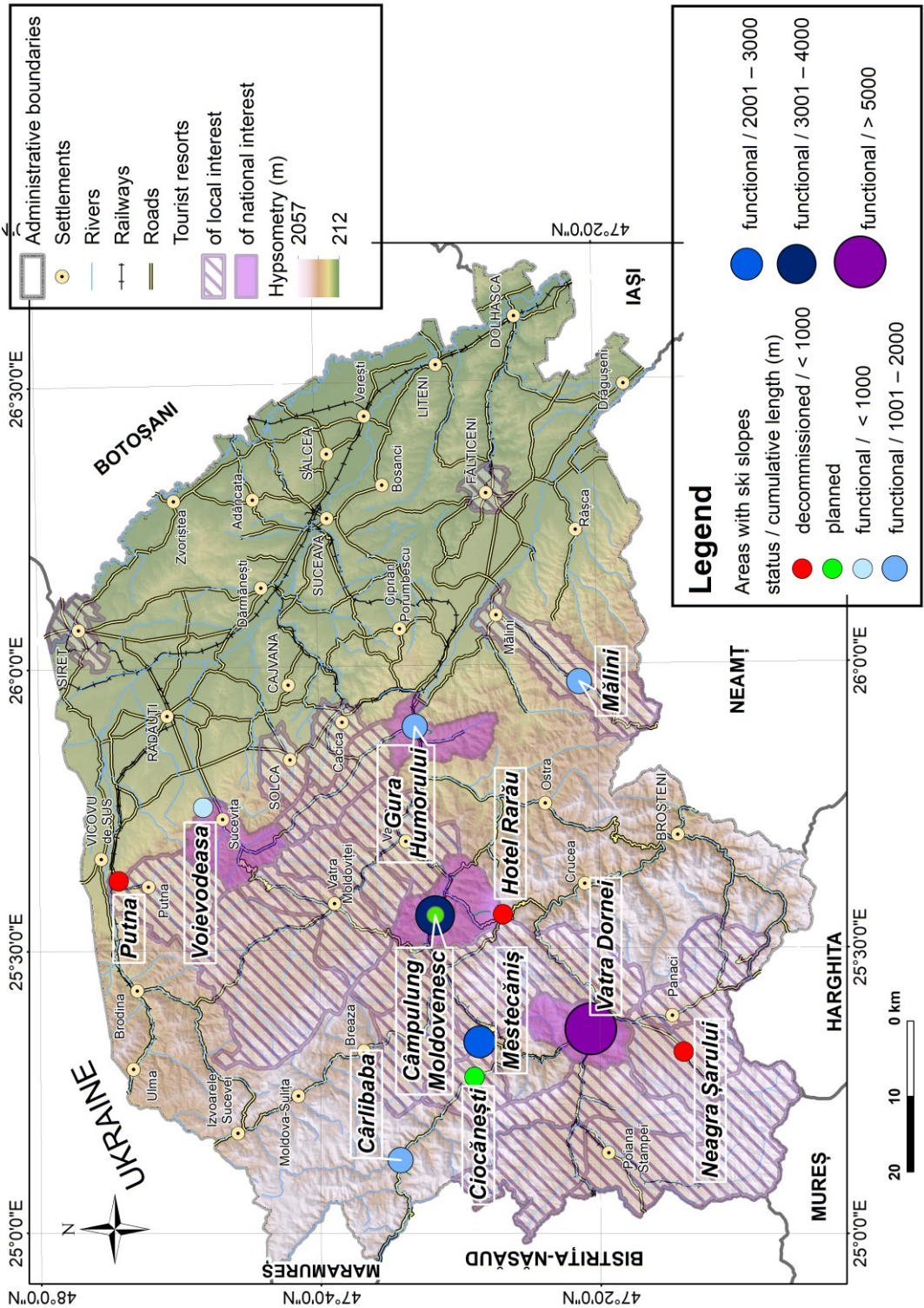
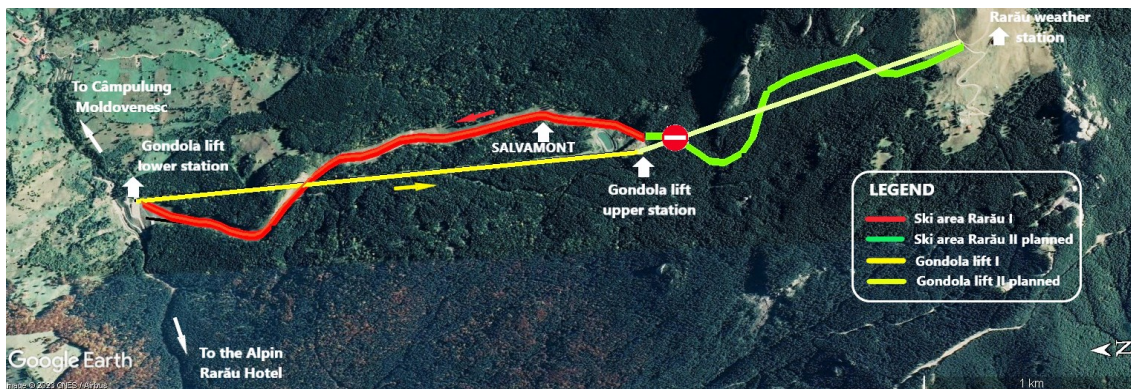
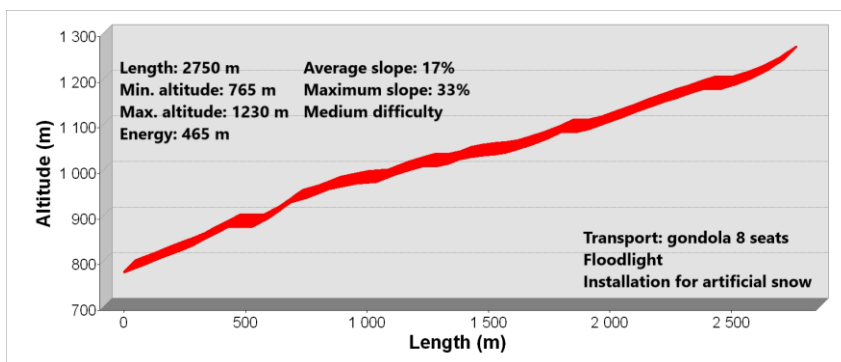


Figure 2 The distribution of the ski slopes in Suceava County.



a



b

Figure 3 An example of identifying and measuring the ski slope (in this case, the Rarău slope): a. tracing the ski slope (sections I and II) using a satellite image; b. the graphic representation of the spatial variation of the ski slope elevation (section I) and the calculation of the derived parameters.

3. Results and discussion

From the point of view of investment resources, the ski facilities in Suceava county are the result of some projects financed by various governmental or European programs with the partial participation of local administrations, but also the result of some private investments. Most of the time, in Suceava county and beyond, the decision to invest in ski facilities was the result of a political decision, which is why funding from government or European programs did not target the sustainability of the project, but only its implementation. This is the case of a ski slope in Gura Humorului (Șoimu 1 - which faces problems in ensuring the snow layer and which, in recent years, has not ensured a sufficiently long ski season or an adequate morphological configuration of the track), as well as the case of Rarău ski slope in Câmpulung Moldovenesc (oversized project at the level of the sliding track – the section II is almost unfeasible, in terms of ensuring a continuous slide, due to some segments with unsuitable slope configurations) or the case of the ski slopes in Mălini (insufficient exposure and altitude). With regard to private investments, many times the choice of locations for ski facilities was not made according to the principle of favorability, conditioned by a series of standardized factors, but according to the principles of the availability of owned land, as is the case with the ski slopes of Voivodeasa (Sucevița), Putna, Neagra Șarului and Pojorâta (Mestecăniș).

Our counting revealed that, on the territory of Suceava county, there were, are or will be added ski facilities in 10 administrative-territorial units (Fig. 2), some of them having several ski slopes - Vatra Dornei, Câmpulung Moldovenesc, Valea Putnei, Gura Humorului. Obviously, some of the mentioned places have a tradition of skiing - Vatra Dornei, Câmpulung -, but others have ski slopes as result of a change in the economic structure of the localities, consisting in focusing on tourism and tourist services - Mălini, Gura Humorului and even Valea Putnei (Mestecăniș ski slope).

In Suceava county, a number of 31 ski slopes were inventoried, in various stages (construction, operation or decommissioning):

- 2 development projects, blocked for various reasons - Rarău ski slope, section II - lack of funding, overlap with protected areas; Ciocănești – design flaw of the ski lift that passes under a 20kV medium voltage line;
- 3 decommissioned, never homologated - Poiana Putna, Floria Neagra Șarului and Hotel Rarău;
- one approved, but not functional for now (Stânișoara 2 – Cârlibaba), the reason being loses of the transport facility, which currently requires rehabilitation;
- 2 ski slopes were completed in 2013, but are not yet approved, in Dealul Negru (Vatra Dornei);
- 23 ski slopes are functional and have different levels of use and difficulty.

In the analysis of some morphometric elements of the ski slopes in Suceava county, we proceeded to a selection of the ski slopes, eliminating from the statistical analysis the decommissioned ski slopes, the non-homologated ski slopes, the initiation and learning slopes, the sliding variants (Izvor Vatra Dornei) and those designed, but in technical blockages (Rarău - section II, Ciocănești ski slope).

The 18 ski slopes on which we focus (Tab. 1), totaling approx. 15326 m, are located in 7 localities, of which 4 are resorts of national interest - Vatra Dornei, Câmpulung Moldovenesc, Gura Humorului and Sucevița, 2 are resorts of local interest - Mălini and Pojorâta. Cârlibaba, which currently does not have a specific status for tourism, has a potential that can be exploited in this sense. Several aspects can be distinguished from the statistical analysis:

1. most ski sections have short lengths, respectively up to 500 m or slightly exceeding this limit - 12 ski slopes;
2. a few ski slopes are in the length range of 750-1000 m, 1000-1500 m and 2500-3000 m, the longest being the Dealul Negru ski slope (Vatra Dornei), served by a chairlift, but whose operation is hindered by the owners of the lands crossed by the ski slope; the second longest ski slope is Rarău, section I, served by a gondola lift;
3. most of the ski slopes are of medium difficulty level (red color) - 72.2%; those with easy difficulty (blue color) are 16.7%, while those with high difficulty (black color) represent 11.1% of total;
4. in terms of length, the red ski slopes add up to over 74% of the total lengths, the blue ones almost 14%, and the black ones 12%;
5. regarding the arrival altitude of the slopes, most of them are below 1000 m - 13 slopes, and 5 are above (only one ski area would have a track above the altitude of 1200 m - Stânișoara 2 from Cârlibaba, but this is currently not functional).

Vatra Dornei is by far the administrative unit with most ski slopes and most kilometers of ski slope (Fig. 4). Vatra Dornei and Câmpulung Moldovenesc together have approximately half of the cumulative length of the ski slopes in Suceava county.

Table 1 The list of the eighteen ski slopes that were selected for quantitative measurements and supplementary assessments (all ski slopes are homologated and their background color indicates the level of difficulty according to the official national assessment).

settlement	ski slope	creation year	property type	ski slope length (m)	ski slope start point (m a.s.l.)	ski slope end point (m a.s.l.)	elevation difference (m)	average slope (%)	maximum slope (%)	ski lift type	ski lift length (m)	artificial snow	floodlight
1 Vatra Dornei	Parc 1	1974	private	490	925	825	100	23	36	surface lift	485	✓	✓
2 Vatra Dornei	Parc 2 / Poienița East	>1990	private	530	1015	915	100	22	32	surface lift	430	✗	✗
3 Vatra Dornei	Parc 2 / Poienița West	>1990	private	510	1015	915	100	24	35	surface lift	430	✗	✗
4 Vatra Dornei	Veverița	2011	state	725	1030	850	180	24	39	surface lift	765	✓	✓
5 Vatra Dornei	Dealul Negru	1980	private	2870	1255	870	395	14	32	chairlift	2730	✗	✗
6 Câmpulung Moldovenesc	Rarău I	2019	state	2750	1230	765	465	17	33	gondola lift	2525	✓	✓
7 Câmpulung Moldovenesc	Bucovina I	2021	private	420	690	625	65	16	26	surface lift	350	✓	✓
8 Câmpulung Moldovenesc	Bucovina II	2021	private	350	690	625	65	18	32	surface lift	350	✓	✓
9 Călibaba	Stânișoara I	2007	private	915	1185	990	195	21	34	surface lift	920	✓	✗
10 Gura Humorului	Șoimul I	2010	state	1380	745	470	275	22	45	chairlift	1315	✓	✓
11 Gura Humorului	Șoimul II	2014	state	380	760	688	72	19	36	surface lift	365	✓	✓
12 Valea Putnei (Pojorâta)	Drumul Tătarilor A	2014	private	1078	1255	1110	145	14	29	surface lift	470	✓	✗
13 Valea Putnei (Pojorâta)	Drumul Tătarilor B	2014	private	454	1230	1110	120	23	39	surface lift	470	✓	✗
14 Valea Putnei (Pojorâta)	Drumul Tătarilor C	2014	private	457	1215	1110	105	21	37	surface lift	470	✓	✗
15 Valea Putnei (Pojorâta)	Drumul Tătarilor D	2014	private	447	1255	1110	145	28	51	surface lift	470	✓	✗
16 Văleni-Stânișoara (Mălini)	Pojorâta I	2007	state	515	705	615	90	18	32	surface lift	500	✓	✓
17 Văleni-Stânișoara (Mălini)	Pojorâta II	2007	state	505	705	615	90	19	36	surface lift	500	✓	✓
18 Voievodeasa (Sucevița)	Voievod	2014	private	505	635	550	85	14	25	surface lift	600	✓	✓

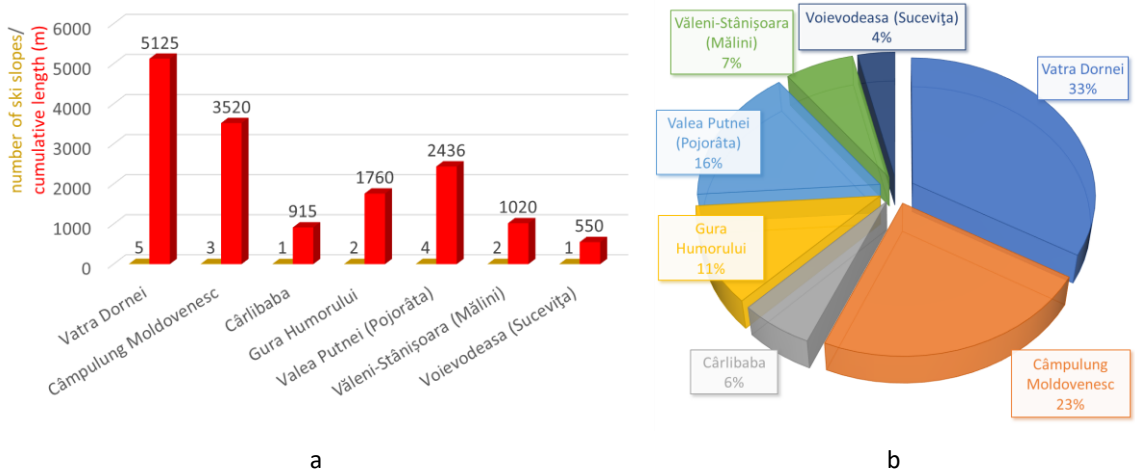


Figure 4 Details of the main ski slopes in Suceava County: a. the number and cumulative length per settlement of the 18 selected ski slopes in Suceava County; b. their length share of their total length.

The facilities for winter sports in Suceava county face a trend recorded globally for similar facilities, in similar climatic conditions: a tendency of environment warming, a quasi-continuous reduction in the amount of solid precipitation, an alternation of the thermal periods that are specific to winter with time intervals having a higher, even positive temperature. These changes determine, especially for resorts located at altitudes below 1000 m, great risks regarding the possibility of capitalizing on the infrastructure for skiing. Certain locations can compensate for these aspects through the favorable effects caused by the thermal inversion phenomenon that can ensure the favorable temperature for the production of artificial snow, but this phenomenon also has disadvantages because, on the slope, above the bottom part of the depression, the air temperature can rise to a level that does not support the operation of the snow cannons - especially when the temperature becomes positive.

Starting from the general realities recorded by climate trends at the global level, we must accept that we will face unfavorable prospects for the ski slopes in the county. Investments for the development of ski slopes must be focused on favorable areas, which guarantee, from a climatic point of view, minimum conditions that ensure operation of at least 90-100 days per season. Of all locations where there are ski facilities, only Mestecăniș, Cârlibaba, Rarău and Dealul Negru-Vatra Dornei are located in favorable areas, from an altitudinal and climatic point of view. The mentioned ski slopes are, however, not completely safe from current risks.

Identifying the right places for a ski slope should be a priority for the establishment of investment strategies in the field of winter sports and it seems that we have to go beyond the paradigms imposed by traditions - namely the setting up in consecrated resorts. Political decisions that often alter the placement of facilities in suitable locations must be eliminated. Any location choice must be supported by specialized studies - morphological, climatic, on the impact on the natural environment, on the social impact - and these studies are the prerogative of geographers. They are specialists who can cover the most important chapters in a pre-feasibility or feasibility study.

For Suceava County, the most suitable areas for skiing, from a geographical point of view, are those located on the northern slopes of the Suhardului and Călimani Mountains, respectively in the Bistrița Mountains. The identification of the most suitable locations requires geographical

studies based especially on the identification of favorable geomorphological characteristics and on the measurements of various meteorological parameters (temperature, precipitation, thickness of the snow pack, atmospheric dynamics, meteorological phenomena) which reveal with as much accuracy as scientifically possible today the exact natural potential of the studied places. Given that, at the national level, there is fierce competition for the development of ski slopes, a competition that most often generates a chaotic development, at the level of Suceava county a long-term strategy should be established that takes into account the development of a sustainable ski slope, even if it requires the "invention" of a new tourist resort.

The choice of locations for the construction of ski slopes was not always a rational one in the last decades, which is why the layouts face various dysfunctionalities both for objective and subjective reasons. Consequently, some of the facilities have closed, some operate occasionally or randomly, and others have relatively short functioning intervals during the ski season.

Choosing a suitable place for setting up a ski slope requires a correct and objective assessment, and this is done with appropriately chosen specialists. Unfortunately, most evaluations of this type are carried out superficially, often under time pressure or only from the office, without consulting specialists, among whom perhaps the most suitable to provide objective analyzes are geographers.

The design and layout of the ski slopes must take into account several factors and we will list them according to their importance, but not exhaustively:

- the terrain morphology, respectively the ability to offer suitable spaces for ski runs - altitude, exposure, slopes;
- the climate, respectively the evolution of the air temperature in the cold season on altitudinal profiles, the amounts of precipitation, the direction of the dominant wind, the occurrence of meteorological phenomena such as the frost phenomenon, the thermal inversion, the cyclonic manifestations, etc.;
- the land ownership regime;
- the existence of water resources to ensure the stocks necessary for the production of artificial snow;
- the accessibility and position in relation to population concentrations;
- the accommodation capacity and leisure infrastructure;
- the existence of similar ski slopes nearby, which can influence the diffusion of customers.

4. Conclusions

The current climatic trends, visible as mild winters, mean that many of the ski facilities no longer function (Poiana, Putna), are open occasionally (Mălini, Voievodeasa) and have short ski seasons (the ski slopes Șoimul in Gura Humorului and Bucovina in Câmpulung Moldovenesc) or of medium duration (Cârlibaba, Rarău). The functionality of some facilities is flawed by other aspects too:

- the one related to the property regime - the Dealul Negru ski slope is blocked on the lower sector by the location of property boundary fences, the difficult accessibility;
- the lack of accommodation facilities - Floria ski slope in Neagra Șarului;
- the non-homologated status - the ski slopes La Istrati and Pața in Câmpulung Moldovenesc.

An important aspect in increasing the number of skiers is the existence of an initiation infrastructure, which technically must be separated from the default ski slopes. In recent years, there has been a concern in this regard by setting up some perimeters equipped with cable transport – baby ski lift, but more recently also on the conveyor belt: Bucovina-Câmpulung, the beginner ski slopes in Dealul Negru, the Parc 1 ski slope in Vatra Dornei. Also, future facilities should take into account the technical evolution of a skier: the initiation stage must be followed by the stage of fixing and consolidating the technique and, for this aspect, the infrastructure of the ski facilities should be focused on the easy ski slopes (blue rank) - these ski slopes currently represent only 17% of the length of all ski slopes in the county.

From our point of view, the development of new ski facilities in the county should take into account a season of at least 90-100 days and easy ski slopes with lengths of at least 1000 meters. The average length of the functional slopes in all categories of difficulty in the county is 851 m, or even lower - 733 m - if we exclude the Dealul Negru ski slope, which de facto has not been fully functional for several seasons.

The tourist resort status that 25 territorial administrative units in Suceava county have obliges most local administrations, especially where there are no facilities for the winter season, to carry out specific studies to evaluate the possibility of transforming spaces for skiing, as an additional form of leisure that must enrich the tourist offer of the destination.

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