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OPPORTUNITIES FOR DEVELOPING WINTER TOURISM IN CEAHLAU MOUNTAIN IDENTIFIED BY USING GIS

BY

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Abstract. The study identifies the most suitable areas for developing winter tourism in Ceahlau mountain using GIS techniques by taking under consideration parameters like altitude, slope, exposure, land use and distance from human settlements.

After researching for the ideal conditions for winter tourism in the mountain area, were created the next maps that need to be overlapped in order to identify most opportune zones in our case study: the hypsometric map, slope map, slope's exposure map, the land use map and the distance buffer from human settlements. The conclusions are to be reached after applying the operations of addition and multiplication of grades for each parameter.

Key words: GIS, development, tourism, maps.

1. Introduction

The global average percent of tourists that visit mountain resorts for practicing ski or other winter sports is approximately 70%, the rest of them being purely "contemplative" ones. In Romania, the situation is totally different: the touristic infrastructure in general (and the one destined to winter sports in particular) is a rare concept. For example, Ceahlau Mountain – the well-known and impressive mountain from Eastern Carpathians – has only 3 touristic chalets and just a single ski slope in Durau mountain resort.

In the last period of time the number of tourists going to Ceahlau has increased and the touristic potential imposes immediate adaptation to present

demands. It arises the question: *is Ceahlau Mountain suitable for winter tourism? And if it is, what are the most opportune areas for creating the infrastructure for winter sports?*

The objective of this study is to find the answer to these questions by using the references, the materials and the methods, and also GIS analysis based on topographic maps at 1 : 25000 scale. The expected result of research will be identified through map interpretation.

2. Background

Ceahlău Mountain is located in Romania, in the Central part of Eastern Carpathians, more precise at the intersection of 47 degrees North latitude parallel and the 26 degrees East longitude meridian.

Next valleys represent the limits with the neighbours: to North – valley of Bistricioara, to South – valley of Bicaz, to East – valley of Bistrita and valleys of Bistra, Pintic and Jidan's to the West. The mountain is made of a system of radial disposed peaks that vary between 1,000 and 1,300 metres and that converge towards the two highest points: Ocolasul Mare (1,907 m) and Toaca (1,904 m).

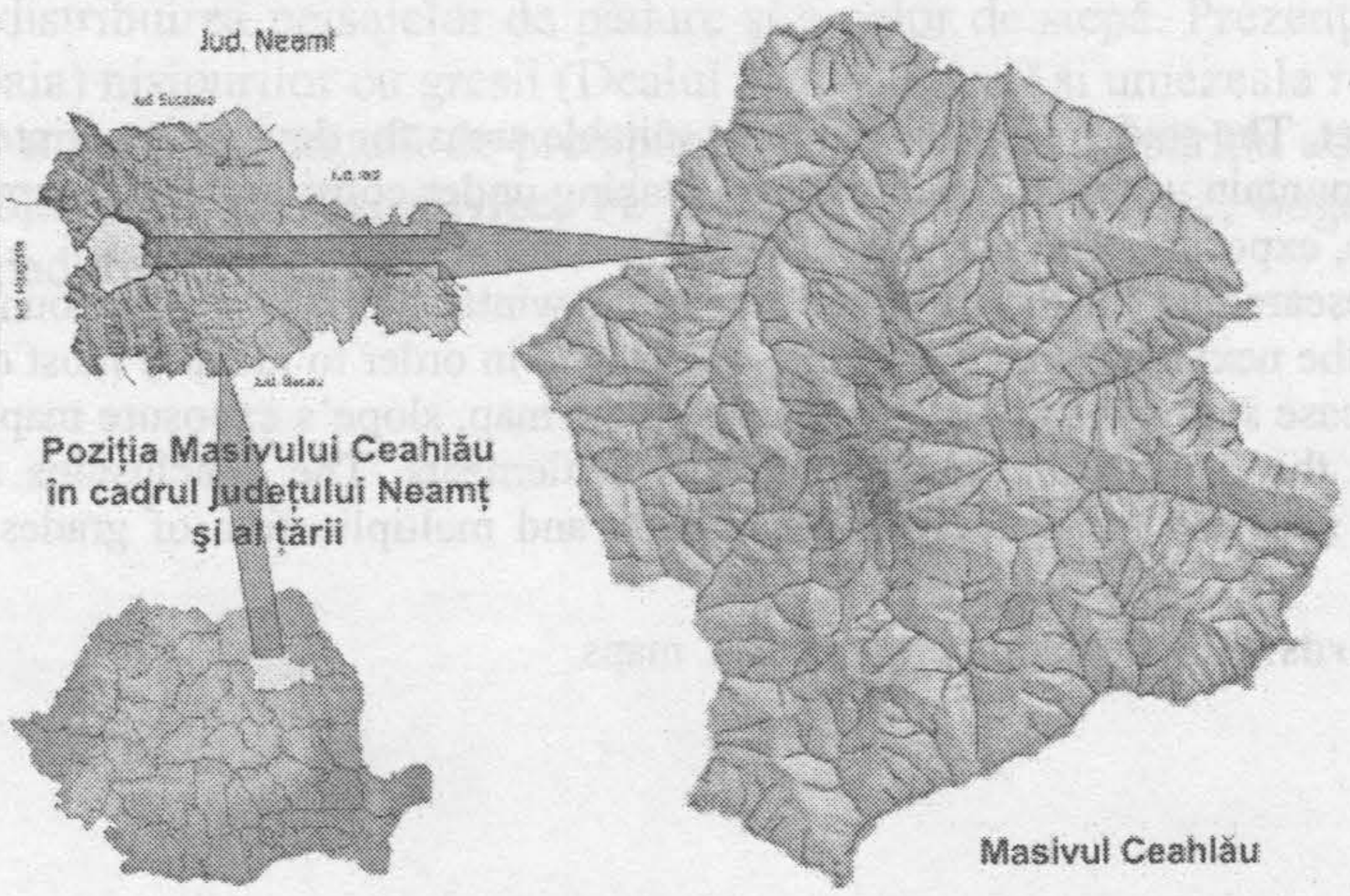


Fig. 1 – Localization of area of study.

Ceahlău Mountain (also known as Kogaion or Pion), considered the holly mountain of Antiquity, can be seen in conditions of clear weather from a distance of almost 350 km – from Danube Delta. It is one of the pillars of Romanian spirituality, being a holy mountain, a true Olimp for Romanians, that drives man towards nature.

Actual touristic activity consists in the specific *attraction*, *accessibility* and the *infrastructure* of Ceahlău Mountain.

The attraction can be translated into touristic potential of a dual origin: natural and anthropic – it is one of most appreciated mountain in Romania

receiving the name of "touristic massive". It is not the highest mountain in Moldova and not even the largest, but it is delimited by deep valleys that give it greatness.

Larix deciduas ssp. carpatica is quite common in Ceahlau, and so are other vegetal or animal species. In 1955 was created Ceahlău National Park that covers 7742.5 ha of the mountain, with the purpose of protecting ecosystems and for relaxing.

As for *the accessibility*, Ceahlău Mountain is accessible from 4 main directions: Piatra Neamț and Bacău on National Road 15 and County Road 155F, Transilvania through Gheorghieni, Lacu Roşu and Cheile Bicazului on National Road 15C and County Road 155F, Vatra Dornei on County Road 17B, then National Road 15 and County Road 155F, from Târgu Neamț on Național Road 15B and County Road 155F. The accessibility of the 7 touristic paths in Ceahlau is average.

The touristic infrastructure is poor and quite old. It consists of 3 touristic chalets: Izvorul Muntelui (at 797 m), Fantanele (1,220 m), Dochia (at 1,750 metres of altitude), and 7 authorized tourisctic tracks. The types of tourism identified for Ceahlău Mountain are: for visiting Durău mountain resort and surroundings plus ascending the mountain, climatical tourism (Durău is known to be an area with a pleasant microclimate fit for neurological affections), transit tourism from Transilvania (through Toplița) and from Moldova (through Borsec) and the agrotourism that is developing in adjacent localities . Most of the flux of tourists that come to visit Ceahlău are concentrated to Durau mountain resort and their safety is assured by Salvamont Service Neamț.

3. Determinant Conditions for Winter Tourism

The factors that influence the development of winter tourism can be percept from two views: geographical and economical; generally, the natural factors belong traditionally to geography and the anthropic ones belong to economy (or human geography).

From the natural factors: *climate conditions* and *the relief* are most important and they condition each other, so the absence of either one of them excludes the possibility of winter tourism.

The anthropic factors that can influence winter tourism are: *human settlements* and *ways of communication*. Their favorability is inverse/counter proportionate to the distance towards them, so a bigger distance means a small favorability.

The determinant climatic parameters for the development of winter tourism are solid precipitations, the number of days with snowpack, the thickness of the snowpack and so on. In the next table we find the specific parameters of the Ceahlău Mountain's topoclimate (source: Ceahlău National Park's Management Plan).

Table1

Climatic Parameters for Ceahlău Mountain Area

No. crt.	Parameter	Value	
		Ceahlău Toaca	Ceahlău Sat
1	Air temperature, [°C]:		
	1. annual mean	0.7	7.2
	2. january's mean	–12.4	–8.3
	3. july's mean	13.2	23.4
	4. absolute maximum/registration date	25.0/04.07.1998	24.5/10.01.1968
	5. absolute minimum/restration date	28.2/06.02.1965	24.5/10.01.1968
2	Annual number of days:		
	6. with frost (temp. minimum ≤ –10°C)	66.6	27.0
	7. of winter (temp. maximum ≥ 0°C)	127.4	40.4
	8. of freezing (temp. minimum ≤ 0°C)	193.0	133.2
	9. of summer (temp. maximum ≥ 25°C)	1	39.4
	10. tropical (temp. maximum ≥ 30°C)	0	2.6
3	Air's relative humidity, [%]	83	77
4	Wind speed frequency, [%]:		
	11. 0…2 m/s	12.7	59.0
	12. 3…5 m/s	24.9	36.4
	13. 6…10 m/s	25.3	4.6
	14. 11…15 m/s	17.0	0.3
	15. 16…20 m/s	17.3	0.0
	16. > 20m/s	8.2	0.0
5	Total nebulosity, annual mean (in tenths from 0…10)	7.0	6.2
6	Amount of precipitation, [mm]:		
	17. annual mean	738.4	617.8
	18. rainiest month's mean/month	107.5/06	104.3/07
	19. driest month's mean/month	33.5/11	26.6/01
	20. maximum in 24 h/registration date	54.5/17.08.2002	55.9/08.06.1969
	21. rain	100	112.2
	22. snow	108.8	50.6
7	Thickness of the snowpack, annual mean, [cm]	11.3	4.7

After analyzing the data results that the climate conditions from Ceahlau Mountain are suitable for winter tourism. With an average air temperature of 0.7°C at the peak (7.2°C in the village) and with an absolute average temperature of 28.2°C, the winter season (days with a maximum air temperature below or equal to 0°C) reaches 127.4 days in the high mountain area and only 40.4 days in the village. Another important indicator is the number of days with freezing (days with a minimum air temperature below or equal to 0°C): at the peak 193 days and in the village 133.2. The thickness of snowpack as a multiannual mean value measures 11.3 cm at the peak and 4.7 cm in the village.

As for the climate, the opportune areas for winter tourism are the medium heights going up towards the peak, but not the high altitudes where the blizzards take place and sylvan vegetation is missing.

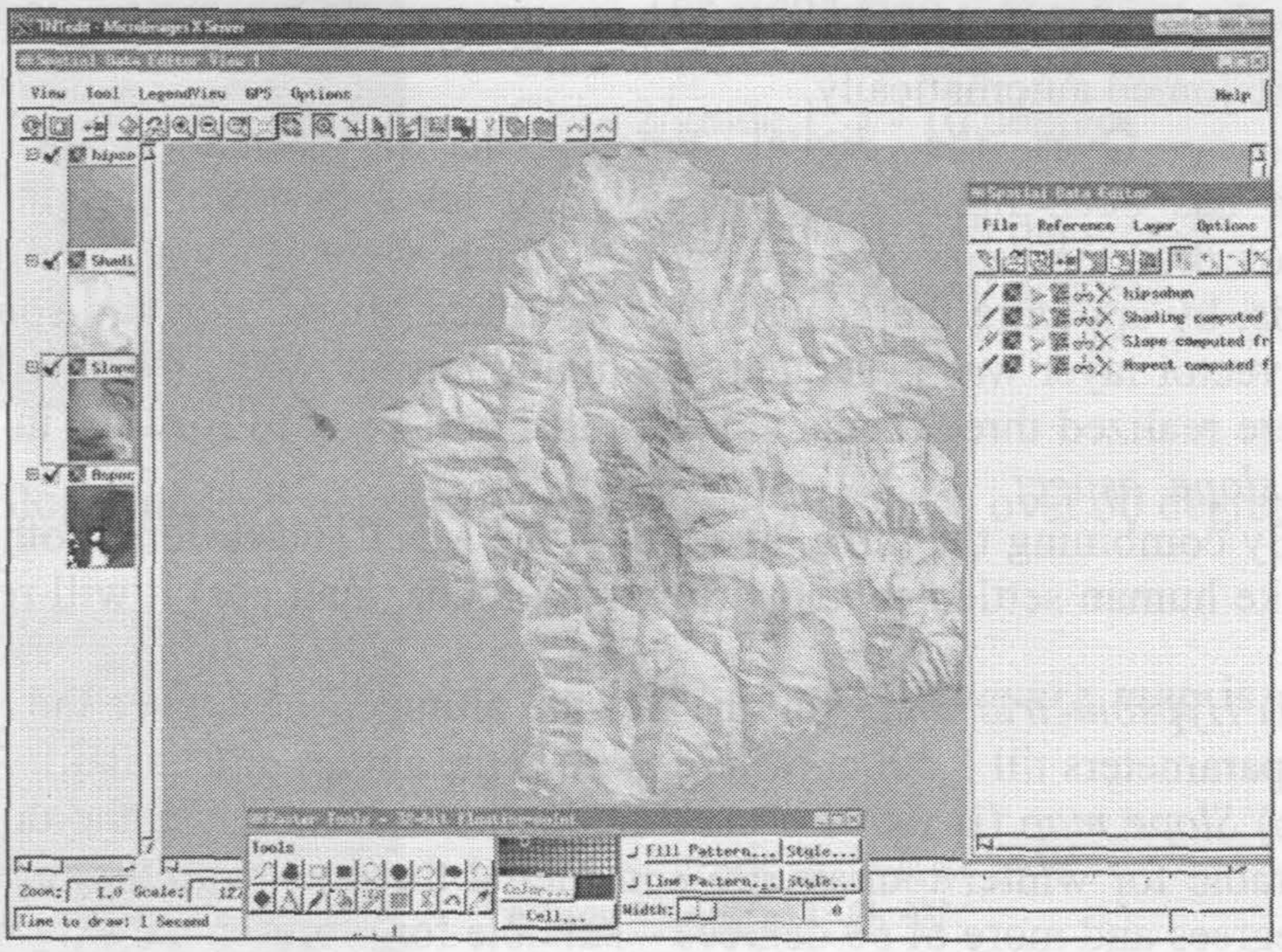


Fig. 2 – The MNT of Ceahlău Mountain.

The relief: Ceahlău Mountain appears as a unique presence in the scenery of Eastern Carpathians, standing out through altitude and massiveness. The actual aspect owes to the massive pack of 500 m high Cretacic conglomerates with increased resistance. The slopes have in Ceahlău values from very small to great abruptness, which's base is made of structural glacis of periglacial age.

The relief is very fragmented and slopes have approximately equal proportions between cardinal points, but identifying the opportune areas for winter tourism is quite hard using old-fashion techniques.

As for the anthropic factors, human settlements from Ceahlău Mountain area have a decisive role in tourist activity because they have the potential of becoming winter sport resorts. Any previous infrastructure that might exist can be modernized. These last two parameters will be will be later analyzed using the GIS techniques.

4. Materials and Methods

The laboratory research stage of research coincides with the GIS analysis, that has the advantage of applying the criteria analyzed to the hole area of study, at the end giving the possibility of the interpretation of data and the comparison of found results with the expected one.

The main materials used are the topographic maps at scale of 1 : 25,000

which, after working with the professional software Micro Images TNT Mips 6.9 led to obtaining the digital terrain model (MNT) and the other maps needed.

First of all, the 8 topographic maps were imported to GIS software and then they were georeferenced into the coordinate system Gauss-Kruger with a Krassovsky 1938/1940 reference ellipsoid. Using the georeference points all 8 maps were joined automatically.

Over the digital topographic representation of Ceahlau Mountain has been made a vector layer of level curves through "stretch" method of drawing lines and polygons, which were assigned the Z value; afterwards, by applying the operation of "Surface Modelling" and some filters over the vector layer was generated the digital terrain model (MNT). Based on MNT were realized three thematic layers that will be used forward in analysis: *shading, slope, aspect.*

By combining the three layers with the MNT and different other vector layers (like human settlements, hydrography, roads, land use) it will result next maps:

a) *Hypsometric map* (the higher the altitude, the higher the values of climatic parameters till 1,400m, where there is the abrupt of Ceahlău);

b) *Slope map* (is rather a classification criteria because the only slopes not favorable for winter tourism are considered the ones with an angle of less than 3 degrees and more of 50 degrees – suitable for professional ski only);

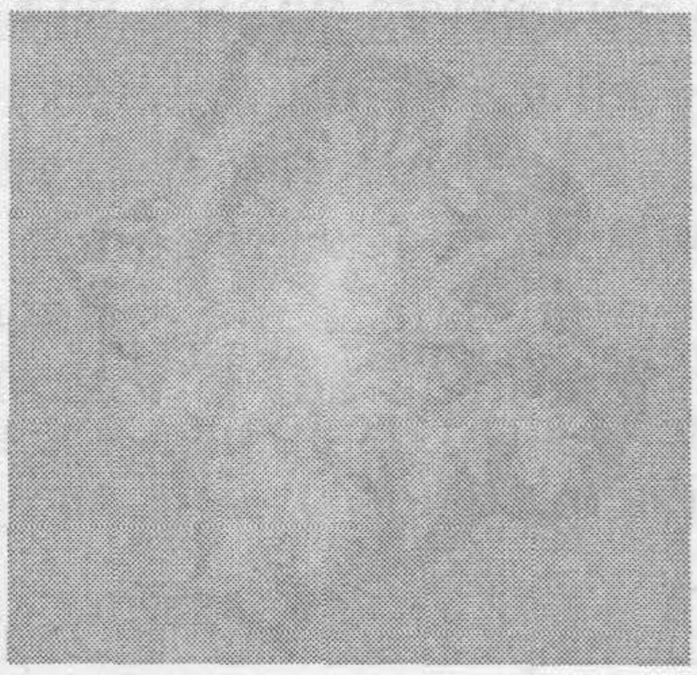
c) Slope's exposure map (influences directly the temperature or duration of snowpack);

d) Land use map (was made using the data of Corine Land Cover 2000 program; the most opportune areas are the ones with coniferous forest, the mixt forests and the deforestated ones);

e) Distance buffer from human settlements map (using the GIS software were automatically generated some buffers at distances of 500, 1000, 1500, 2000 and more than 2000 m from human settlements).

5. Research Results

Once made, these five maps are to be classified and given grades according to the favorability they have for winter tourism. The last class is considered to be most favorable, and receives the biggest grade.



The *hypsometric map* is classified in:
Class 1/grade 0: <800 m
Class 2/ grade 1: 800…1000 m
Class 3/ grade 2: 1000…1200 m
Class 4/ grade 3: 1200...1400 m
Class 5/ grade 4: > 1400 m

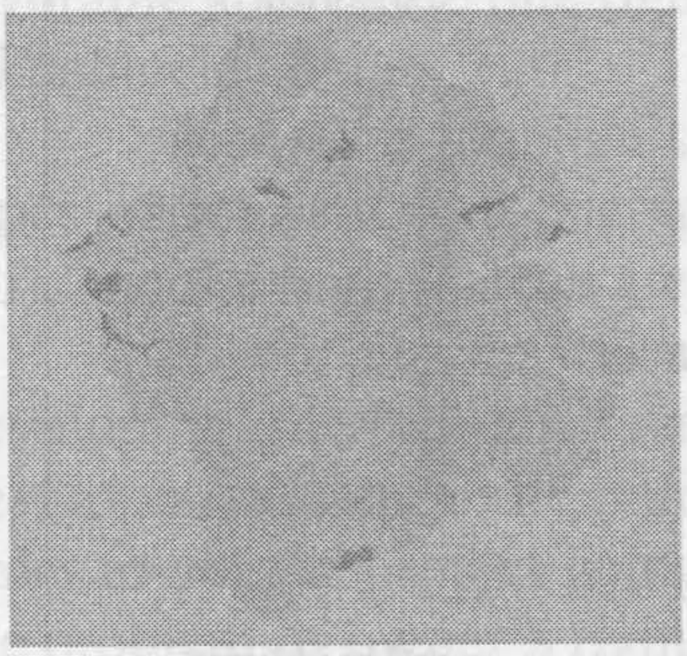
The areas under 800 m altitude and the upper plateau of Ceahlau Mountain received 0 grade because they are totally not favorable.

The ***slope map*** is classified in 5 classes:
Class 1/grade 0: <5 and >50 degrees
Class 2/grade 1: 5 - 10 degrees
Class 3/grade 2: 10 - 20 degrees
Class 4/grade 3: 20 - 30 degrees
Class 5/grade 4: 30 - 40 degrees

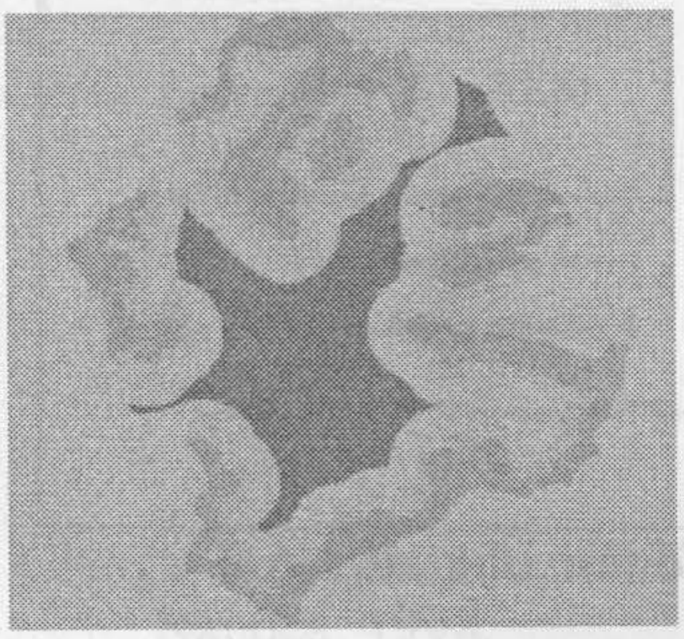
Slopes under 5 degrees (river valleys) and those over 50 degrees are not favorable!

The ***slope's exposure map*** is classified in next 5 classes:
Class 1/grade 1: S
Class 2/grade 2: S-E şi S-W
Class 3/grade 3: E, W
Class 4/grade 4: N-E şi N-W
Class 5/grade 5: N

North is the most favorable cardinal point and the grades decrease towards South.



The *land use map* is classified in:
Class 1/grade 0: areas covered with water, stones and human settlements;
Class 2/grade 1: agro-industrial areas, complex agriculture;
Class 3/grade 2: pastures, natural meadows, savine and broad-leaved forests;
Class 4/grade 3: coniferous and mix forests.



The ***distance buffer from human settlements*** is classified in 5 classes:
Class 1/grade 1: > 2000 m
Class 2/grade 2: 1500…2000m
Class 3/grade 3: 1000…1500 m
Class 4/grade 4: 500…1000 m
Class 5/grade 5: < 500 m

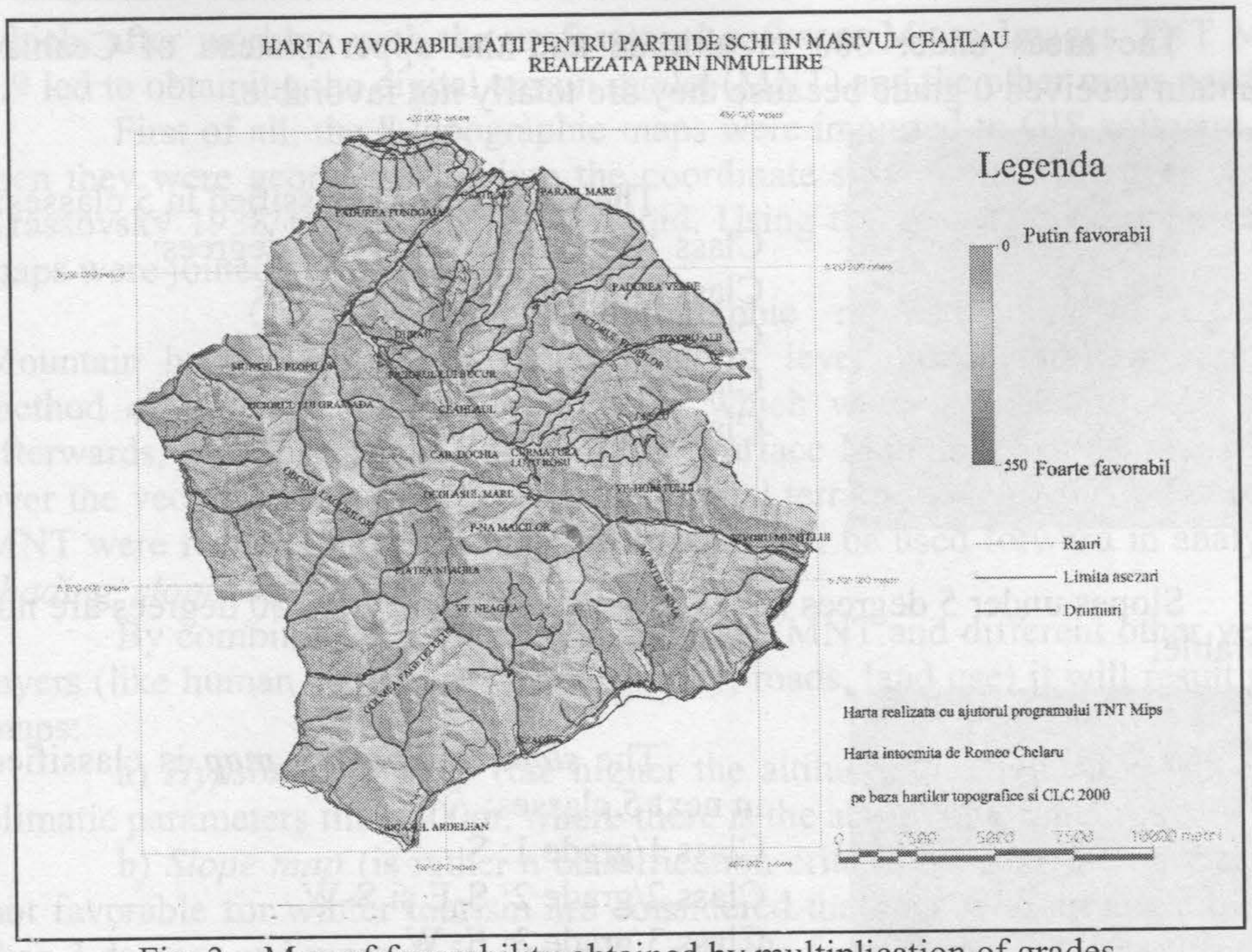


Fig. 3 – Map of favorability obtained by multiplication of grades.

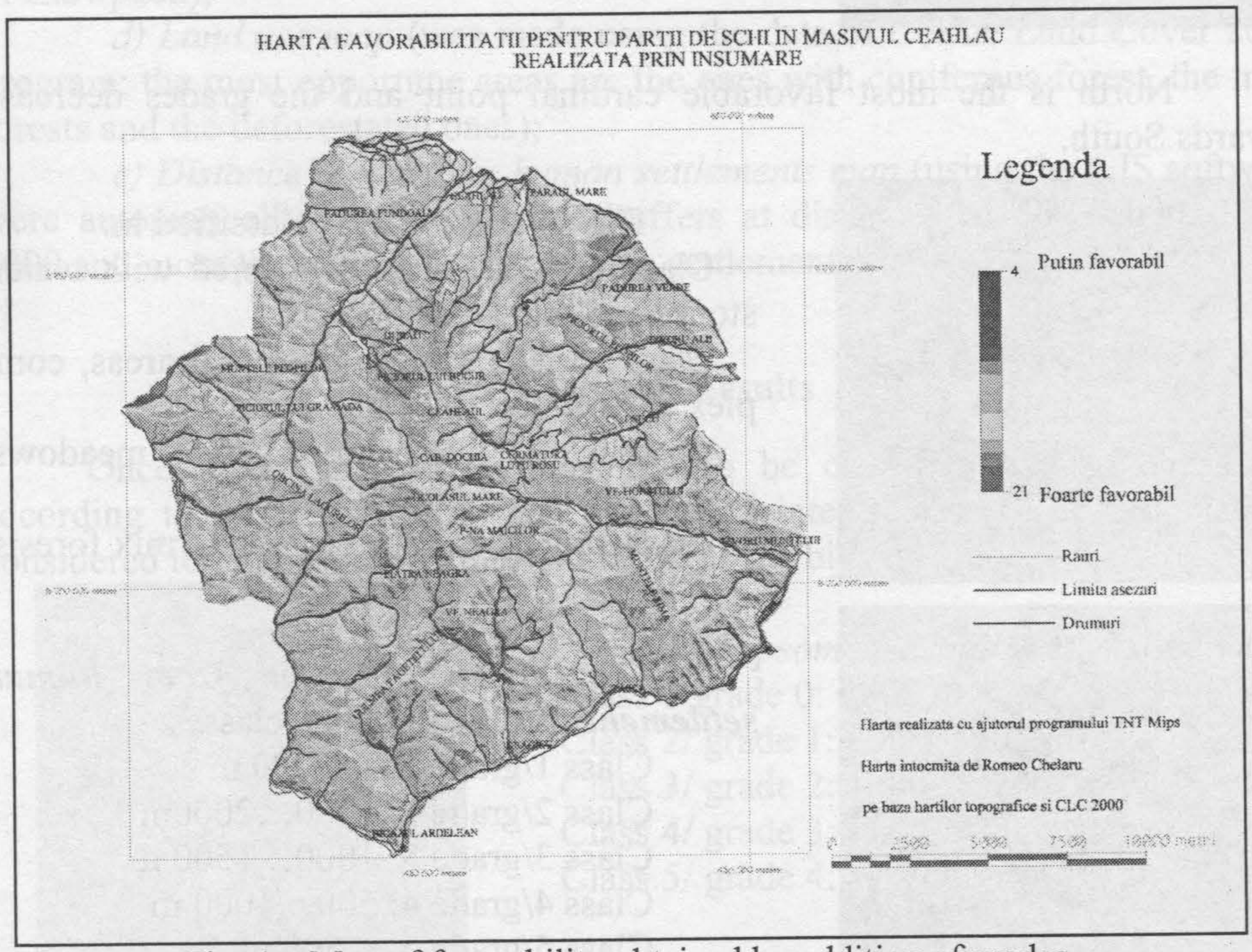


Fig. 4 – Map of favorability obtained by addition of grades.

By applying simple operations of ADDITION and MULTIPLICATION to the grades corresponding to same class from all 5 maps will result the main maps for GIS analysis.

The two maps are quite similar: the general fragmented aspect of Ceahlau Mountain apparently does not recommend it for winter tourism, but there are hole areas that comply to the ideal conditions: *the most opportune area seems to be the one near Durău resort* (Durău as forest, Fântânele chalet, and "Picioarele" his Ghironte, Odăii, his Bucur, or Şchiopului going to the base of mountain abrupt); also a favorable area is the one at the East of Ocolaşul Mare peak. In the west side, the settlements of Poiana, Bradul, Pintic or Teleac have a great potential of becoming a mountain resort and being able to sustain the winter tourism activity for the neighbor areas (Plopilor Mountain, Piciorul Arsitei, Piciorul Suricului, Piciorul Tarsoase, Piciorul Păltinişului, on the valley of Bista Mică, Pâraul Caprei, Pâraul Frânturilor and so on). On the east side good values has the mountain in the south of Izvorul Muntelui chalet.

4. Conclusions

The closest conditions to the ideal model for the favorability of winter tourism in Ceahlău Mountain have the next values for the analyzed parameters:

a) Altitude between 1000 and 1400 meters;
b) Average slopes without abruptness;
c) Slope's exposure predominantly to the North;
d) Forest vegetation (that acts like a barrier for strong winds):
e) As for the distance to human settlements, it is clear that the most favorable area is the one right near them (the example of Durau mountain resort – Fântânele chalet)

Ceahlău Mountain's winter touristic potential is represented by two types of tourism: the one specific to average altitude areas (slopes for alpine ski), and the high plateau area, suitable for extreme skiing.

In conclusion, Ceahlău Mountain has an important potential for developing the winter tourism and one of the explanations for it's poor development can be the immense value of investments that have to be made in order to get the project going. On another side, another restraining factor can be the problem of owner's right for the area.

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OPORTUNITĂŢI DE DEZVOLTARE A TURISMULUI HIVERNAL ÎN MASIVUL CEAHLĂU IDENTIFICATE PRIN TEHNICI SIG

(Rezumat)

Studiul de faţă îşi propune să identifice cele mai oportune zone pentru dezvoltarea turismului hivernal din Masivul Ceahlău utilizând tehnicile SIG şi luând în considerare parametri precum altitudinea, panta, expoziţia, utilizarea terenului şi distanţa faţă de aşezările umane.

În urma cercetării condiţiilor ideale pentru dezvoltarea turismului hivernal în aria montană au fost create următoarele hărţi care vor fi suprapuse cu scopul de a identifica cele mai oportune zone din aria studiată: harta hipsometrică, a pantelor, a expoziţiei versanţilor, a utilizării terenului şi bufferul distanţei faţă de aşezările umane. Concluziile studiului sunt obţinute în urma aplicării operaţiunilor de însumare sau înmulţire a notelor acordate fiecărui parametru.