

GIS ANALYSIS OF AN AREA REPRESENTATIVE FOR THE ROMANIAN HARDLY ACCESSIBLE MOUNTAIN REGIONS WITH A COMPLEX AND HIGH-VALUED TOURISTIC POTENTIAL

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Abstract: The crucial importance of mountain regions in the socioeconomic and environmental cohesion policies is underlined by key documents in Romania as well as in the European Union. However, the lack of a unique definition or set of criteria used to delineate the mountain regions, in order to analyze their characteristics constitutes a barrier to the elaboration of a common strategy for their development. This study has created a methodology based upon the Geographical Information Systems to select a Romanian hardly accessible mountain region with a complex and high-valued touristic potential and determine its characteristics. The approach consisted of the identification of all hardly accessible mountain regions with a complex and high-valued touristic potential, followed by the choice of a representative site and its spatial analysis based on the values of specific indices. The results indicate that the selected area exhibits accessibility, environmental, demographic, and economic problems in most administrative units. Tourism trends suggest reduced accommodation, food, and entertainment opportunities, an increase in the number of tourists, but a decrease of the average duration of stay, and reduced usage of the touristic facilities. Based on these findings, the outstanding touristic potential of Romanian hardly accessible mountain regions appears to be insufficiently valorized, calling for actions on behalf of the authorities.

Keywords: GIS, mountain region, tourism, regional development, accessibility

1. INTRODUCTION

Among the goals of the European Union related to territorial cohesion, mountain regions represent a priority (European Commission, 2001). Furthermore, the proposed European Constitution shows that mountain regions, in conjunction with territorial and socioeconomic cohesion, are crucial objectives of European regional development. Most regional European policies address mountain regions; 95% of these areas receive funds either for development or socioeconomic conversion (Popescu, 2008). The interests of mountain regions are promoted in the EU by cooperative association (*e.g.*, Euromontana), networks of multi-sectoral professional organisms, and some INTERREG programs (*e.g.*, Interreg IIIB: Carpathian Project, Parks&Economy, Ruraltour, Shining Mountains, Development of a Sustainable Tourism or the Alpine Space Programme). The mountain regions received special interest also due to their vulnerability to

environmental threats due to their special characteristics: inclusion of fragile ecosystems, harsh climate, isolation, political and economic isolation, etc., underlined in Agenda 21. The sustainable development of these regions had been agreed by the adoption of the Convention on the protection and sustainable development of the Carpathians in Kyiv, 2003.

In Romania, mountain regions differ from other regions due to natural disadvantages (*i.e.*, elevation, climate, slope, low soil fertility, reduced access to the communication routes and markets), and structural disadvantages (*i.e.*, ageing active population, migration trends, restricted jobs, distances from decisional centers, and insufficiently developed infrastructure). The Program of the Romanian Government aims to align the trends of tourism with the regional and international offers, and increase the quality of services; another goal is to develop spatial development policies contributing to socioeconomic cohesion of administrative units and regions,

increased competitiveness, and the conservation of natural and cultural diversity. In order to implement these goals, specific instruments aim to develop sustainable tourism, based on in-depth knowledge of the ecosystems and environmental carrying capacity with respect to tourism, and identify areas with a complex and high-valued touristic potential.

The identification of mountain regions is based on their definition. However, this is not unique, as different documents propose a variety of criteria, synthesized in table 1.

The Euromountains project resumed precedent definition, but used in addition an index of temperature contrast equal to 0.25. The project included only North-European areas, high elevation areas, areas with a very diverse topography, or with extreme climate conditions, as well as any possible combinations (Price, 2007).

In the south-eastern Europe, the definitions of the mountain region (Table 2) are mainly based on elevation, occasionally on other criteria (Buttoud,

2001; Price et al., 2004).

The availability of modern technologies has made possible a more precise and consistent characterization of European mountain regions. Among them, Geographical Information Systems (GIS) represent decision support systems involving the integration of spatially referenced data in a problem solving environment (Cowen, 1988). A 2000 study used information from the GTOPO30 database, produced by the United States Geological Survey in 1996 in conjunction with the Geographical Information Systems (GIS) to develop two new criteria: (a) the slope, computed based on a raster using the values of the eight adjacent cells, and (b) the local elevation range (LER), again computed in a raster based on the minimum and maximum elevation and their difference at a certain distance from each cell. The two criteria resulted into a new definition: a level difference over 300 m within a 7 km radius from considered milestone.

Table 1. Definition of mountain regions in different documents. The table indicates the definition and its interpretation, as well as the source.

Definition	Source
Areas characterized by limited possibilities of using the land and high costs of works due to: (a) the existence of different climate conditions, <i>i.e.</i> , at elevations over 600-800 m; (b) presence of steep slopes, <i>i.e.</i> , with a gradient of 1-5 per km ² ; or (c) any combination of (a) and (b).	European Council Regulation 1257/1999
Physical, environmental, socioeconomic and cultural region where disadvantages derived from elevation and other natural factors must be accounted for in conjunction with socioeconomic constraints, and spatial and environmental imbalance. Climate analysis should consider the latitude and geographical position in addition to elevation. Physical aspects must include the landform, soil type, and other factors in addition to the slope. Socioeconomic disadvantages include the low density of population, isolation due to large distances from cities and other economic and political centers, and the dependence on agriculture.	Euromontana, 2004
Elevation, slope and the environmental gradients generated are key components of mountain regions, but their combination is problematic; elevation alone excludes old and low mountains, and includes high elevation areas with little landform and environmental variation. The following classes are proposed: (a) elevation between 300-1000 m and elevation variation over 300 m; (b) elevation between 1000-1500 m and slope over 5° or elevation variation over 300 m; (c) elevation between 1500-2500 m and slope over 2°; (d) elevation between 2500-3500 m; (e) elevation between 3500-4500 m; and (f) elevation over 4500 m.	Blyth et al., 2002

Table 2. Definition of mountain regions by country

Country	Minimum elevation (m)	Other criteria
Bulgaria	600	
The Czech Republic	700	
Poland	350	
Romania	700	Elevation between 300-350 m with slope over 15%
Slovakia	600	
Slovenia	600	Elevation below 600 m if over half of agricultural parcels have slopes over 25%
Albania	650	
Croatia	650	
Norway	600	
Former Yugoslavia	500	

The application of this definition had produced a new classification of mountain regions, including: (a) regions with elevations over 2500 m (oxygen threshold; also, all ecosystems are characteristic to mountain regions); (b) regions with elevations between 1500-2499 m and slopes over 2° (prevents high elevation fields and plateaus from inclusion); (c) regions with elevations between 1000-1499 m with slope over 5° or LER > 300 m (slope introduced to prevent plateaus from inclusion); and (d) regions with elevations between 300-999 m and LER > 300 m (Blyth et al., 2002).

This study will create a methodology utilizing the GIS technology in conjunction with other software to select a Romanian hardly accessible mountain region with a complex and high-valued touristic potential and underline, through spatial analyses, its characteristics. The result may be used by decision factors to develop special policies in line with the European and international strategies providing for a sustainable development of these regions, and will contribute to the knowledge of the status of mountain regions at the level of the European continent.

2. MATERIALS AND METHODS

The identification of mountain regions involved the following steps:

1. The selection of areas situated at elevations over 600 m, according to the Romanian Law of the Mountain, was based on the Digital Elevation Model (DEM) of the terrain using ArcGIG 9.2. This step also involved the transformation of the raster file into the shape (shp.) format using the 3-D Analyst. The final selection represented the mountain region.

2. The ArcGIS selection of the administrative units that intersect the mountain region defined in step 1 and cities situated at distances of 60 km or less from it.

3. The identification of territories situated at high elevation was based on the selection of administrative units with elevation over 800 m. The 701 units constituting the mountain region represent approximately 22.1% of all administrative units in Romania, and out of these 89 (12.7%) are urban.

4. The assessment of the touristic potential of administrative units was based upon specific criteria. Based upon the scores, administrative units were given a status reflecting the touristic potential of their resources: very high, good, fair, and low. The end result of this stage was the selection of 426 units.

5. The identification of hardly accessible administrative units with a complex and high-valued touristic potential required a spatial definition of hard access. In our study, the hardly accessible units were

those accessible only via local (county or communal) routes, and those situated at large distance from the closest representative centers and accessible via national routes in a precarious technical condition. This step involved a ranking of access from high to low: (a) European highway; (b) main national highway; (c) secondary national highway, county or communal highway for units situated in the hill or mountain region; (d) lower rank highway and position in a cul-de-sac; (e) low rank highway and large distance from higher rank routes. At the end, 162 units (32.3% of all units situated at high elevations) were selected.

6. The final selection of hardly accessible administrative units situated at elevations over 800 m with a complex and high-valued touristic potential was based on the grouping in clusters of at least three units from those identified in stage 5. This stage excluded singular isolated units, even though meeting all criteria specified below. The rationale consisted of the fact that a regional policy can be applied only to a large and compact area.

As a result, 16 hardly accessible mountain regions with a complex and high-valued touristic potential, including 131 units (out of which 7 are cities), were selected (Fig. 1).

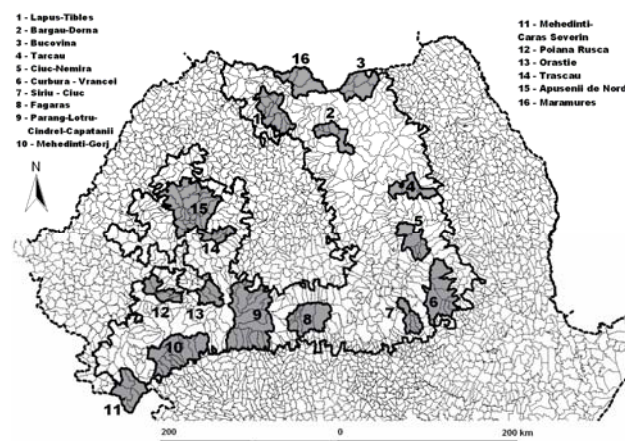


Figure 1. Hardly accessible areas consisting of grouped administrative units with a complex and high-valued touristic potential situated within the mountain region in Romania.

For the next analyses, the site selected from these regions included five administrative units belonging to the region of development south-west Oltenia, two of which belong to Vâlcea county (communes Voineasa and Mălaia) and three to Gorj county (communes Baia de Fier and Polovragi and the city Novaci). These communes are part of the massif Parâng - Lotru - Cindrel - Căpățâni (Fig. 2).

The methodological process involved several additional steps in the selected region:

7. Position on the digital map forests, lakes, roads, rivers, and update the situation of the administrative units based on satellite imagery.

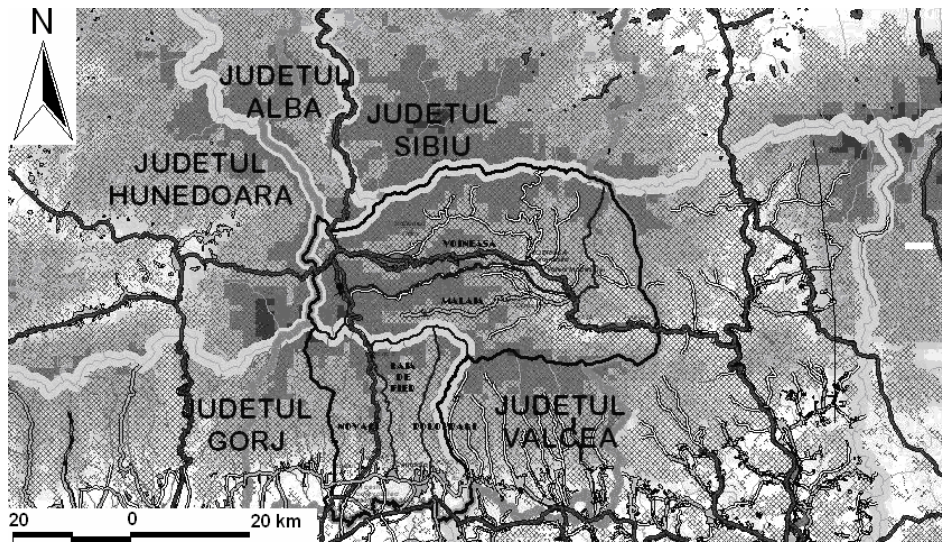


Figure 2. Delineation of the scope of the project.

8. Integrate Global Positioning System (GPS) data on roads, elevation, accommodation units, ski paths, and the situation of the administrative units. GPS data were collected using a TRIMBLE Pathfinder in conjunction with ARCPAD. The precision was 5 m.

9. Add data from scanned military topographic maps (scale: 1:25000). Data included elevation curves, which were used in conjunction with GPS data to create the DEM. The limitation was due to the age of military maps, produced in 1960. Corrections were based on satellite imagery, aerial photography, and GPS data.

10. Convert all data to the Stereo 1970 system.

11. Georeferencing: adjust coordinates until the error is less than 5 m in all corners of a raster.

12. Spatial join all scanned rasters.

13. Clip the joined raster by the shape of the pilot region, obtained in step 6.

14. Merge all datasets to produce the final database, which can be displayed as a map (Fig. 3).

15. ArcView GIS 3.2 spatial analyses based data on the indices presented in Table 3, provided by specialized agencies: physical data were derived from scanned topographic maps; other data were provided by the Tourism Research Institute, National Institute of Statistics, and other specialized agencies.

3. RESULTS AND DISCUSSION

This study aimed to identify common characteristics of the administrative units situated within an area representative for Romanian hardly accessible mountain region with a complex and high-valued touristic potential, in order to propose a strategy for the sustainable development of such

areas.

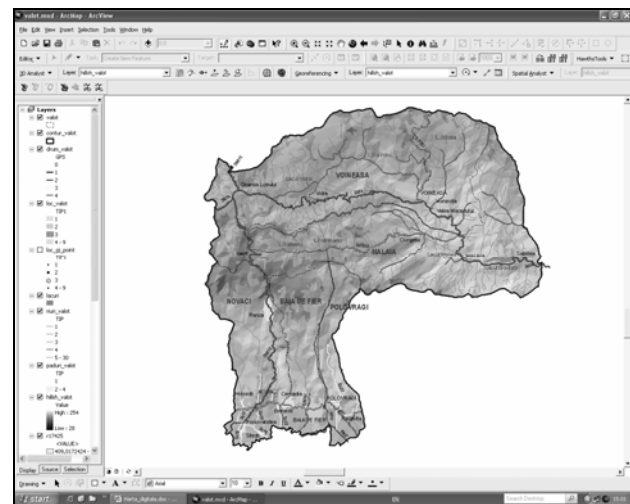


Figure 3. The final map of the scope of the project (screenshot).

The analyses focused on the categories presented in table 3 and indicated that:

1. The quality of the transport infrastructure is poor; even though there are high-rank roads (national), as well as county, communal or forestry roads, the area is far from the European highways and railroad. In addition, their technical condition is not good. Some portions of the national highways require modernization or fixing. Moreover, climate conditions block part of the roads during the cold season.

2. Demography (Fig. 4): ageing population appears to be more numerous within the investigated area than in Romania (16.5% compared to 14.77%). However, the young population is also more numerous (16.2% compared to 15.45%). Despite of it, ageing represents an issue within the area as in Romania, with alarming values in Baia de Fier and Mălaia.

Table 3. Selected indices used in the analysis of hardly accessible administrative units with a complex and high-valued touristic potential from the mountain region. Values represent averages for all administrative units within the scope of the project.

Category (1)	Index (2)	Values (3)
Physical	Landform	
	Average elevation	480 m
	Climate	
	Number of days with snow, snow thickness	6.2 mo./60 cm
	Temperature	
	Annual average temperature	4 ^o C
	Land cover and use	
	Total surface	1238.3 km ²
	Agricultural area	
	Arable land (% of agricultural area)	9.1%
	Permanent crops (% of agric. area):	1.8%
	Vineyards and nurseries	0.3%
Orchards and nurseries	0.8%	
Permanent pastures	89.8%	
Forests by type: broadleaf, conifers, mixed	1.1%	
Demography	Total population	17,054
	Density of population	13.8‰
	1992-2006 and 2002-2006 population	+14%/-7%
	Population by age groups	
	Population by age groups	<i>Fig. 4</i>
	Ageing	16,5%
	Age dependence	488‰
	Natural variation and migration	
	Growth in last 3 years (rate per 1000 people)	-3.3%
	Migration in last 3 years (rate per 1000 people)	-7.4‰
	Work resources	
	Population by working age	67.2%
	Employees per 1000 people	132.5‰
	Number and percentage of employees by activity type	43.4% primary
	Active population	5,963
	Number of small and medium enterprises	297
Industry units	351	
Agricultural area		
Size	25,975 ha	
Agricultural potential	1.56 ha/person	
Forested area		
Size	123,507 ha	
Forestry potential	5.32 ha/person	
Infrastructure	Transport	
	Highway - total length	212 km
	Airport access (distance to closest airport)	92-121 km
	Town infrastructure	
	Potable water distribution	2,605 m ³ /day
	Potable water distribution to consumers	303,000 m ³ /yr
	Household potable water distribution	240,000 m ³ /yr
	Sewerage	0.95 m/person
	Natural gas distribution	None
	Touristic infrastructure	
	Accommodation	
	Number of units	103
	Number of seats	3,302
	Food	
	Number of units	36
Number of seats	2,731	
Tourist circulation		
Number of tourists arrived	18,986-22,619	
Number of tourists staying over night	95,175-72,221	
Duration of stay	5,0-3,2 days	
Occupation %	16,6%-9,9%	
Environment	Number of protected areas	5

Note: Further computations were performed using Excel and Visual FoxPRO 8.

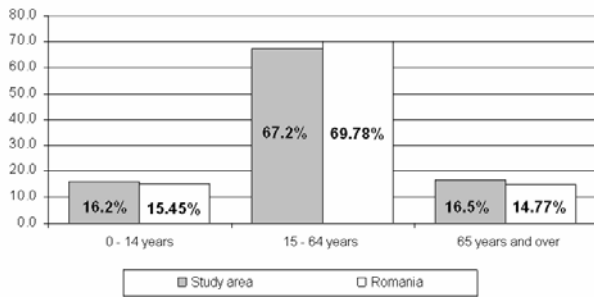


Figure 4. Comparison between the age distribution of population within the scope of the project (yellow) and Romania (orange).

3. Energy is produced by accumulations of waters; other works on the courses of water include underground energy derivations and flood protection works. The latest are insufficient, and floods represent a serious hazard.

4. Numerous units receive potable water in a centralized system, even though water supplies are lower than the average per country. Water supply systems need to be rehabilitated. Furthermore, water treatment stations are rare, resulting into pollution over the admissible thresholds. The main problem is the lack of sewerage system, impacting both surface and underground waters.

5. The economy is based on traditional jobs. Most people are shepherds; however, after 1989 some started breeding also cattle and goats. Husbandry represents a way to valorize the pastures that cover large territories. In addition to husbandry, agriculture relies on cultivating potatoes, corn, vegetables and fruitful trees. People in poor units also collect forest products and mushrooms. In addition to agriculture, water-based energy production represents a main industrial branch that had changed the mountain landscape. Services rely on commerce practiced by small centers concentrated in the center, but also interlaced with residential areas, across the roads. The number of small and medium enterprises increased after 1990. Economic opportunities include the development of apiculture, specialized husbandry (snails, ostriches, pheasants, peacocks, rabbits etc.), and collection of forest products. Overall, the well developed activities are energy production, wood processing industry, tourism, agriculture (particularly husbandry), and silviculture.

Since the touristic potential represents the main asset of these regions, separate analyses are focused on indices specific to tourism.

1. Accommodation (Fig. 5): with respect to comfort, overall most units are included into the low comfort classes. Approximately 70% have 1 or 2 stars, and 15% 3 or 4 stars. Unclassified units represent 15.7% of the total, but for example in Novaci their

percentage increases to 50.8%. In the north of the studied areas, most units have 1 or 2 stars (Voineasa – 88.8%, Mălaia – 61.2%), while in the south most have 3 stars (70.9% in Baia de Fier, 75% in Polovragi; and 31.8% (64.6% of classified units) in Novaci).

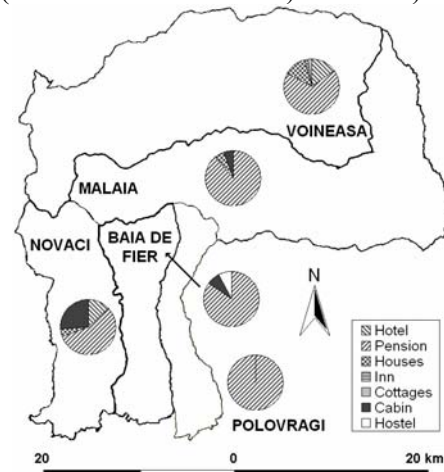


Figure 5. Accommodation units by type.

2. Most food and dining units (Fig. 6) have overall 1 or 2 stars (over 60%), but since 26.4% of them are situated within unclassified accommodation units, it is clear that the low class units are dominant. This situation is due to the large number of units in Voineasa (1.193 – 43.7% of the total per area), and to the old and inflexible structure of accommodation. 81.4% of food and dining units are restaurants (classical, hunter's or pension); only 7.1% are daily bars, 5.9% buffet bars, 3.7% brasseries, and 1.9% cafeterias.

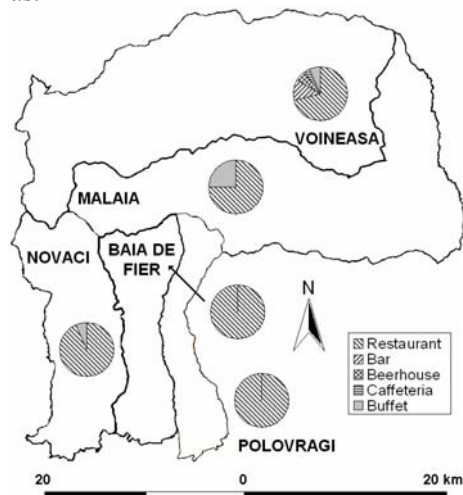


Figure 6. Food and dining units by type.

3. Food and dining places were also analyzed in conjunction with accommodation (Fig. 7). The ratio of the two is 0.83, less than the range 1.2-1.5 required for a satisfactory coverage of the needs of tourists. The values are higher in Polovragi (2.35), Râncea (1.36), and Obârșia Lotrului (1.13), and low

in Voineasa (0.67), Mălaia (0.69), Vidra (0.38), Baia de Fier (0.99, excepting for Râncă), and Novaci (0). These results suggest that there is a need to increase the number and quality of food units.

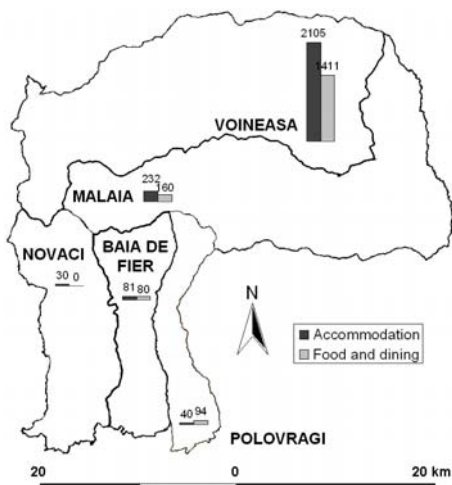


Figure 7. Number of accommodation, food and dining units.

4. With respect to the number of tourists (Fig. 8), the general trend is positive; the number increased by 19.1% between 2005-2007, especially in Polovragi (77.2%) and Voineasa (17.2%), but dropped down in Mălaia (by 36.8%). The situation is due to a decrease of the number of nights spent in Voineasa (by 27.6%, but nights spent here represented 79.6% of the total per area in 2007), and Mălaia (54.7%) - Fig. 9.

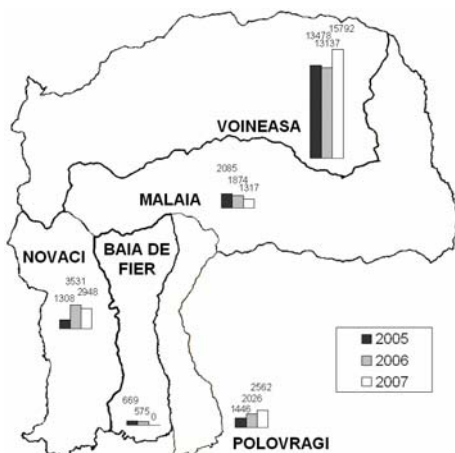


Fig. 8. Number of tourists between 2005 and 2007.

5. The average stay (Fig. 10) had decreased during 2005-2007 from 5 to 3.2 days; this is due to less tickets being distributed by the National Agency of Retiring Aid and Social Insurances for Voineasa, since in this case the duration of stay exceeds the average. In 2005, these tourists represented 19.1%, but only 8.1% in 2007. Another possible explanation would be reduced entertainment opportunities. Average stay reduced in

Voineasa from 5.9 to 3.6 days, in Mălaia from 4.4 to 3.1 days, in Polovragi from 1.7 to 1.5 days, and in Baia de Fier from 2.1 to 1.6, but increased in Novaci from 2.1 to 2.3 days between 2005 and 2006. The decrease of the average stay in Voineasa created a paradoxical situation: the number of tourists increased by 17.2% while the number of nights spent dropped down by 27.6%. There are also differences between the average stay of Romanian tourists (5.1 days in 2005 and 3.2 in 2007) and of foreign tourists (1.9 to 1.5 days). This is most likely due to the fact that Romanian students came for vacation or treatment, while foreigners came to visit specific objectives (Polovragi Monastery and cave, Cheile Oltețului, Muierilor Cave).

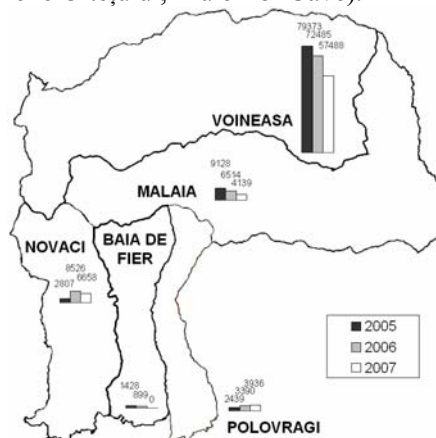


Figure 9. Number of nights spent in touristic facilities between 2005 and 2007.

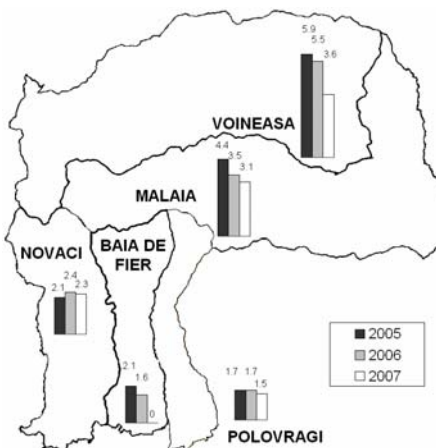


Figure 10. Average stay in touristic facilities between 2005 and 2007.

6. The level of occupation of touristic facilities (Fig. 11) is overall low and decreased between 2005-2007 from 16.6% to 9.9%, less than the average per country (36.0%) or counties Gorj and Vâlcea (26.1% and 47.9%). Similarly, it decreased in the north, in Voineasa and Mălaia, to 12.1% respectively 10.8%, in Novaci to 3.3% in 2007) and Baia de Fier (4.6% in 2006). The highest values are found in Polovragi (31.8% to 42.2%).

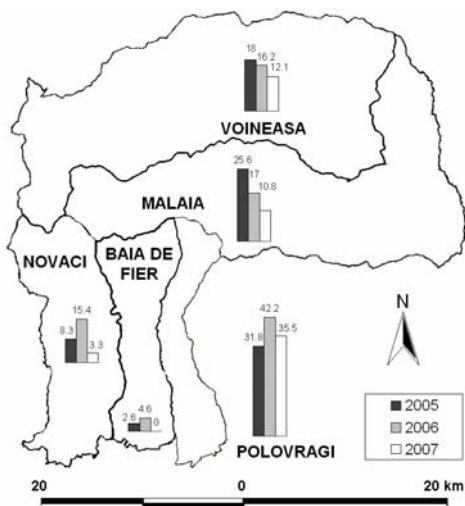


Figure 11. Occupation of touristic facilities between 2005 and 2007.

The limitations of the study are due to defining the mountain region mainly based on altitude, provided that some Romanian mountain areas have elevations below 100 m. (e.g., the Danube Defile, Herculane).

4. CONCLUSIONS

Overall, the pilot area (consisting of Lotru and Oltet valleys) benefits upon a rich touristic potential, with outstanding natural and cultural objectives insufficiently valorized. The infrastructure shows an explosive development, partially based on non-reimbursable European funds. The new buildings do not always comply with the spatial planning regulations. Some areas benefit upon ski and cable transport facilities; not all are approved by the authorities or are functional. Entertainment does not provide for many opportunities, resulting into a seasonal tourism; some places are preferred in the cold season while others attract more tourists during the warm one. Conference centers could increase the overall number of tourists, bypassing seasonality.

Existing accommodation units are ageing and lack modernization. This situation resulted into the decrease of average stay and of the number of foreign tourists. Moreover, more units have low comfort levels, are old and inflexible to the new challenges. Nevertheless, the overall number of tourists increased especially in areas with special landscapes. Despite of it, the average stay dropped down due to less tickets being distributed by the National Agency of Retiring Aid and Social Insurances and reduced entertainment

opportunities. Differences between the average stay of Romanian and foreign students are due to the fact that Romanians come for vacation and treatment, while foreigners spend 1-2 days visiting specific objectives. Finally, the capacity is insufficiently utilized, and its trend is descendant.

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