

Geomorphosites Assessment in Karst Terrains: Anina Karst Region (Banat Mountains, Romania)

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Abstract This paper presents the assessment of geomorphosites for one of the most important karst regions in Romania, where geomorphological features represent the main touristic attractions due to their density and due to their representativeness for the study area. We used the Pralong method for geomorphosites assessment in the Anina karst region (Banat Mountains). Many geomorphological sites, such as karst springs, caves, gorges and karst plateaus with a high density of karst features, are situated in the study area, sites that will be evaluated as geomorphosites in this article. The present study is important in public awareness of the role of natural features in local development, drawing attention to the local authorities and to the general public regarding the role of geomorphological features in tourism development. For the Anina karst region, it is important that these geomorphosites are appropriately exploited in order to protect the karst landscape, because many studies consider it more important to protect and conserve the geomorphosites, rather than using this geomorphological heritage as a touristic direction.

Keywords Karst · Geomorphological sites · Tourist exploitation · Anina · Romania

Introduction

Geomorphosites include features and processes to which we can assign a value, based on human perceptions, e.g. aesthetic,

historical, cultural, material or non-material, social or economic. The trend in geomorphosite assessment is to raise the level of objectivity (Erhartič 2010). Today, we can observe increasing efforts to popularise science for the general public. Scientific approaches regarding geosites are also successfully spread around the world (Warowna et al. 2013).

Pralong (2005) quoting Panizza and Piacente (1993, 2003) and Quaranta (1993) states that geomorphological sites are defined as those landforms and processes that are have simultaneously values as aesthetic, scientific, cultural/historical and social/economic.

A tool that may be very useful for tourism in areas with many geomorphosites may be the geotouristic map, which represents a cartographic tool that combines information of geological and geomorphologic nature, but also basic touristic information such as sightseeing points, information posters, etc. The aim of this new type of map presenting geological aspects in a more detailed than a tourist map is to help tourists better understanding those landforms that belong to the geomorphological and geological heritage of a territory (Comănescu et al. 2013). Geotouristic maps may help potential customers, people from different domains, e.g. tourists, young people, local residents, old people, scientists etc. This type of map is able to provide the landscape observers with more information on geological and geomorphological processes, including their spatial and temporal scale (Miccadei et al. 2014).

In several studies, the first aim in geomorphosite research is to create a geomorphological map after field surveys and aerial photograph interpretation. The geomorphosite map will be a result of grouping landforms according to their morphogenetic characteristics (Panizza and Piacente 2008). Geomorphosites are prone to reshape as a result of geomorphological processes. Hence, there is a discussion regarding the measures that should be taken to preserve the actual aspect

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of these landforms or to assign values for the processes that are remodelling geomorphosites (Komac et al. 2011).

Natural protected areas (NPAs) are those areas where geomorphosites may very often be seen and where, according to local and regional culture, the relationships between natural systems and social values leading to geomorphosites presenting their own characteristics (Serrano and González-Trueba 2005). Tourist exploitation of caves may have a positive impact from an economic perspective for the local communities. However, open access to caves raises the risk of deteriorating the underground environment due to the lack of regulation of the visits or of an adequate maintenance infrastructure (Cigna 1993).

If Pralong (2005) is studying geomorphological heritage from a tourist perspective, Reynard et al. (2007) have an approach that divides the scientific value and additional values (including ecological value, aesthetic value, cultural value and economic value), but considering that these additional values should be added to the scientific value. Besides the scientific value, geomorphological sites may become tourist resources in order to provide economic effects based on the values of these sites (Pralong 2005). The main problem with geomorphosite studies will be subjectivity due to observer knowledge and experience in implementing the methodology for the assessment (Panizza 2001). The earliest quantitative assessments of landforms go back to the 1970s in the USA, where such studies were developed mainly by scholars (Coratza et al. 2011). There are now many studies and approaches for geomorphosites assessment and geoheritage, e.g. Pralong (2005), Serrano and González-Trueba (2005), Panizza (2009), Erhartič (2010), Pereira and Pereira (2010), Feuillet and Sourp (2011), Coratza et al. (2012), Zgłobicki and Baran-Zgłobicka (2013), Miccadei et al. (2014), Kubalíková and Kirchner (2015).

In Romania, studies regarding geomorphosites are less numerous, but during the last years, we may notice that these approaches for evaluating geomorphological sites and assigning tourist values for some of the most important geomorphological sites in the country had begun, e.g. Toma et al. (2010) with a study on saliferous geomorphosites from East-Transylvanian diaper folds; Comănescu and Dobre (2009) in Ceahlău National Park, Comănescu and Nedelea (2010) in Bucegi Mountains, Băca (2011) with a study on Băile Figa Geosite, Comănescu et al. (2012, 2013), Ilieș and Josan (2007) with a study on geosites from Apuseni Mountains and Necheș (2013), Gavrilă and Anghel (2013) inventorying the geosites in Măcin Mountains.

This paper presents the assessment of geomorphosites for one of the most important karst regions in Romania, where geomorphological features represent the main touristic attractions due to their density and due to their representativeness for the study area. We used the Pralong method for geomorphosite assessment in the Anina karst region (Banat

Mountains), a method that has been applied elsewhere around the world and in Romania.

The Study Area: Anina Karst Region

The area is situated in Banat Mountains, in the centre of the Anina Mountains (Fig. 1), which has the largest and most compact area of carbonate rocks in Romania, namely the Reșița-Moldova Nouă Synclinorium (Orășeanu and Iurkiewicz 2010).

The study area is a folded region, with a Jurassic relief, being characterised by the presence of anticlines and synclines with a regular appearance and a NNE-SSW orientation (Mateescu 1961). Geomorphologically, the Anina karst area presents a variety of relief due to a high diversity of lithology, but also due to its structural aspect (Răileanu et al. 1964). The Anina karst region was previously studied geomorphologically by Sencu (1977) and also speleologically (Sencu 1963, 1964). Based on these studies, he published a tourist guide for the Anina Mountains (Sencu 1978) where the main attractions were karst landforms.

The dominant geomorphological characteristic, which is conditioned by its geological structure, is represented by the existence of long parallel ridges, separated by valleys and karst plateaus (Bucur 1997). An important area of this karst region is part of Semenic—Cheile Carașului National Park, including several natural reserves. Many geomorphological sites, such as karst springs, caves, gorges and karst plateaus with a high density of karst features, are situated in the study area and will be evaluated as geomorphosites in the next section.

The diversity and the complexity of the geomorphological features are considered to be extremely important for geoheritage assessment, and these aspects are evaluated at different reference scales: global, regional or local based on the diversity of geological and geomorphological features. The term ‘geodiversity’ has been proposed, a concept based on the identification of those elements that defines a landscape of a region, referring to those peculiarities that make the territory different from other landscapes in terms of geology (Panizza 2009). The study area includes geomorphological features with a high level of diversity and complexity at a local and regional scale.

Karst terrains are very vulnerable natural systems that may deteriorate due to numerous human activities such as deforestation, agriculture, water exploitation, mining and building. In recent years, tourists and recreational activities have also been added to those that can deteriorate karst environments. It is important that the accessibility of the karst features is appropriate with their conservation (Hoyos et al. 1998).

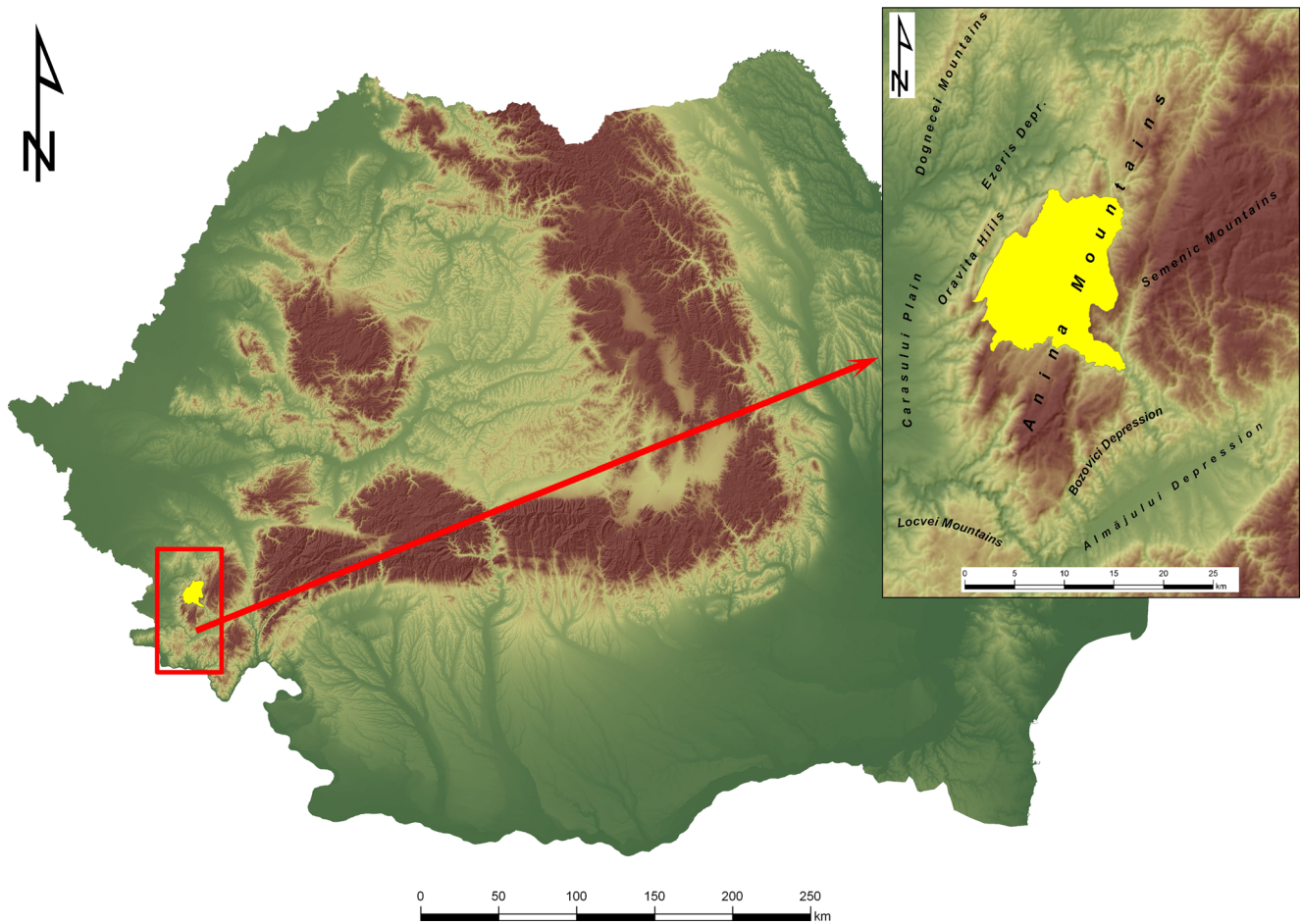


Fig. 1 Location of the study area

The most famous karst features that are present in Anina karst region are represented by a large number of landforms developed on a mature karst terrain e.g.:

- More than 600 caves and vertical shafts (the most important are Buhui Cave, Plopa Cave, The Cave with Water from Gârliștei Gorges, Mărghitaș Cave, Cuptoare Cave, and Cârneală Cave);
- Several gorges sectors: Buhui Gorges, Gârliște Gorges, and Miniș Gorges;
- Suspended karst plateaus: Mărghitaș, Ravnîștea, Colonovăț, and Brădet;
- High density of karst surface landforms as sinkholes, sinkholes valleys, dry valleys, and karrens;
- Several karst springs: Caraș, Bigăr, Certej, Terezia, and Jitin;
- Several hydrographic features such as underground rivers (in Buhui Cave, Cave with Water from Gârliștei Gorges, and Plopa Cave) and waterfall tufa (Bigăr Waterfall);
- Tâlva Zânei or Zânei Hill, as a paleontological site.

All these specific and representative karst landforms can be seen in the Anina karst region. For some of them, there are

nearby trails, but for most of them, tourist paths or tourist information is missing. But this situation can be changed as a result of the open access to those sites. From this large number of karst geosites, we choose to analyse and assess as geomorphosites those that are most representative for the study area according to their natural value, the most visited and well known by tourists and those that present the highest complexity, as a scientific value, because of their uniqueness and due to their extent. The geosites that we evaluated are listed in Table 1, and their geomorphological and geological importance is summarised below. Their spatial location in the Anina karst region is shown by Fig. 2.

The Buhui Cave is the largest cave in the study area and the second largest cave in the Banat Mountains (after Comarnic Cave), and it is crossed by the longest underground river in Romania (2100 m). The cave has four entrances, and it is developed on three levels: fossil, semi-active and the active. The largest halls (Sencu Hall, Bears Hall) present many large speleothems and have also yielded bones of *Ursus speleaus*. In addition, in some sectors of the cave, the stratigraphy of the karst massif can be observed. Certej Spring is situated near to the first entrance to Buhui Cave and represents the most important drinkable water resource in the Colonovăț karst

Table 1 Table of geomorphosites in the Anina karst region

No.	Name	Type
1	Buhui Cave	Punctual
2	Cuptoare Cave	Punctual
3	Buhui Gorges	Areal
4	Mărghitaş Plateau	Areal
5	Caraş Spring	Punctual
6	The Cave from Caraş Spring	Punctual
7	Plopa Cave	Punctual
8	Bigăr Spring and Bigăr Waterfall	Punctual
9	Miniş Gorges	Areal
10	Gârliştei Gorges	Areal
11	The Cave with Water from Gârliştei Gorges	Punctual
12	Straja Peak	Punctual
13	Zânei Hill (Tâlva Zânei)	Areal
14	Certej Spring	Punctual
15	Colonovăţ Peak	Punctual

Plateau and is also a tributary river for the Buhui River. Colonovăţ Peak (812 m) is the highest in the Colonovăţ karst plateau and represents an excellent sightseeing point to observe the relief in the Anina Depression and also the importance of karst topography in the development of Anina town. Cuptoare Cave represents a former fossil gallery of Buhui Cave, blocked by a rock collapse. It is a small cave (135 m), but with several large speleothems (Sencu 1963).

Buhui Gorges are important and attractive due to the large number of caves that are present along them and also due to the karst springs and travertine-petrified springs. The karst springs from Buhui Gorges gather their waters from the Mărghitaş Plateau, a suspended karst plateau without surface water drainage located in the northern part of the Anina karst region—its main geomorphological features are surface landforms such as sinkholes, sinkholes valleys, blind valleys, dry valleys, karrens or karren fields. Straja Peak (715 m) is the highest point in the Mărghitaş Plateau, representing an excellent sightseeing point for observing the surface karst landforms.

Caraş Spring is a very important site due to its uniqueness in the northern part of the study area. The spring is important because it retains water from the Cârneală Plateau, and nearby, there are many small travertine waterfalls. Also nearby is The Cave from Caraş Spring, an active cave that drains a small creek from the Cârneală karst Plateau. The cave presents large halls with impressive speleothems.

Gârliştei Gorges present a high degree of wilderness, with many caves, karst springs and small waterfalls. From the top of the gorges, we can observe the importance of faults in the relief. The largest cave in these gorges is The Cave with Water, having a large entrance (9-m high) and being more than 900-m

long. The most attractive elements of this cave are the large rimstone basins and an underground river. Zânei Hill (Tâlva Zânei) has the highest altitude in the Anina karst region (939 m) and includes an abandoned quarry with Jurassic plant fossils (Popa and Meller 2009). It is also an important geological site due to the fact that vegetation and soil cover are missing on large areas of the slopes. It could also provide an excellent sightseeing point for the entire area,

Miniş Gorges presents very important geological and geomorphological aspects such as steep rock walls, a large number of caves and also karst springs. Two of the most important sites located in the Miniş Gorges are Plopa Cave and Bigăr Spring with the Bigăr Waterfall. Plopa Cave is an active cave from the Ponor-Plopa Caves System with large rimstones at the entrance that are form underground lakes. Plopa Cave is also an extremely important paleontological site as it has yielded some of the oldest human remains in Europe. Bigăr Spring and the homonymous waterfall are a very important site as Bigăr Spring has the highest flow of the springs in Anina karst region, and differences with the suspended karst plateau where the water flows are very large. The Bigăr Waterfall is formed on tufa, with an aspect of a curtain covered with moss. Recently, this waterfall has been considered to be one of the “top 10” in the world, and hence, the numbers of visitors have grown very quickly.

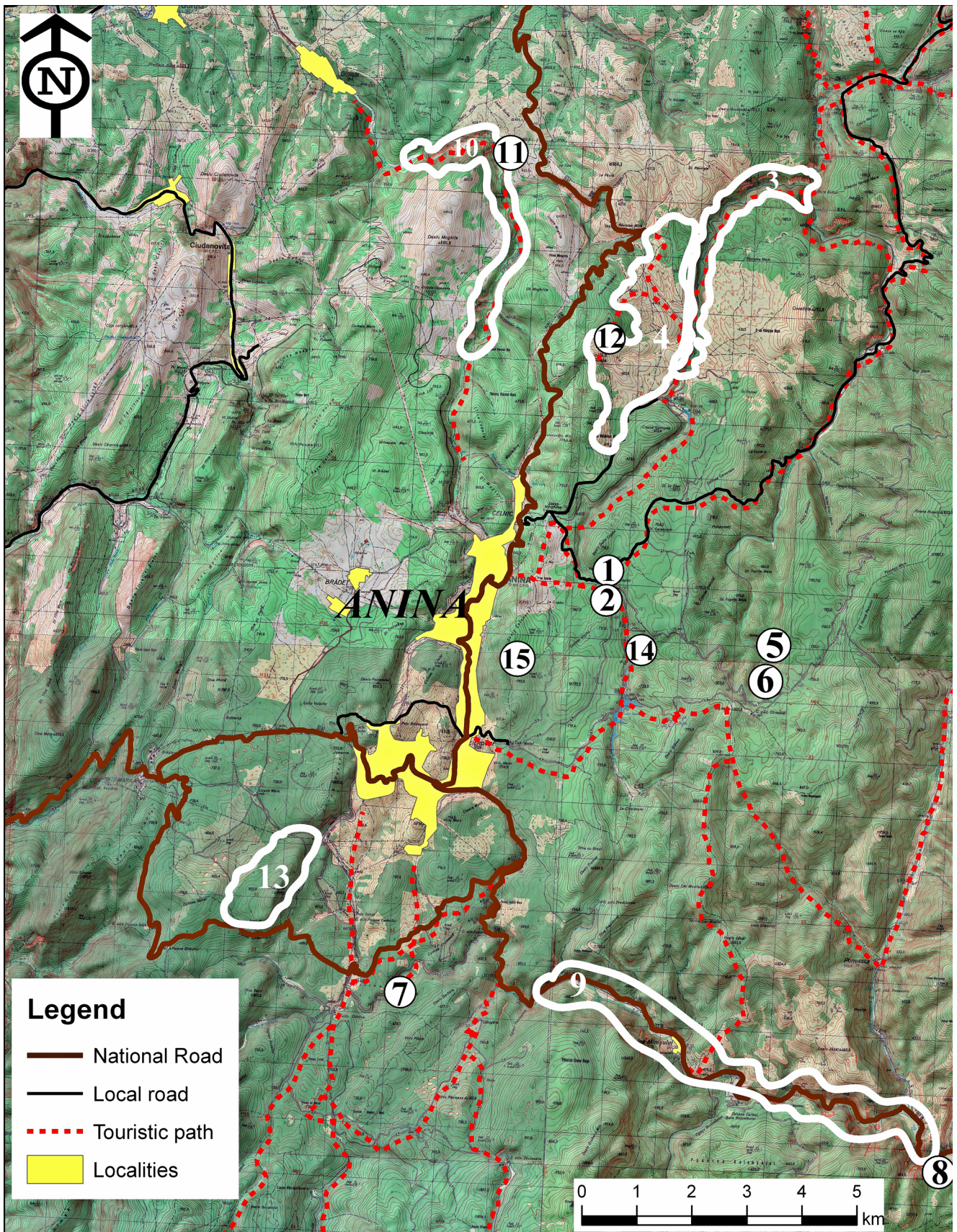
These key sites in the Anina karst region are evaluated in the following section:

Methodology

Geomorphological heritage is characterised by values such as aesthetic, scientific, cultural and ecological (Panizza 2001) as intrinsic values of the sites. These values may be considered as a primary tourist resource and have a potential for tourist development based on geomorphological features (Pralong and Reynard 2005). The touristic value of the geoheritage is given by a human perception regarding geomorphological heritage (e.g. aesthetic, scientific, cultural and ecological values), the capability of geomorphological features to attract tourists, and also by the economic value that could arise from geomorphological heritage exploitation (Pralong 2005).

The first step in geomorphosite assessment for the Anina karst area was the research on existing thematic maps and scientific papers on the geology and geomorphology of the region. The next step was to consider the most relevant

Fig. 2 Location of the evaluated geomorphosites in the study area. 1 ► Buhui Cave; 2 Cuptoare Cave; 3 Buhui Gorges; 4 Mărghitaş Plateau; 5 Caraş Spring; 6 The Cave from Caraş Spring; 7 Plopa Cave; 8 Bigăr Spring and Bigăr Waterfall; 9 Miniş Gorges; 10 Gârliştei Gorges; 11 The Cave with Water from Gârliştei Gorges; 12 Straja Peak; 13 Zânei Hill (Tâlva Zânei); 14 Certej Spring; 15 Colonovăţ Peak



geosites in the study area, from a scientific perspective and also relevance for tourists. Our study on the geomorphosites in the Anina karst region is based on the model proposed by Pralong (2005), evaluating the following values: aesthetic, scientific, cultural or historical and economic. The tourist value is the result of the average of these four values, according to the next formula:

$$V_{\text{tour}} = (V_{\text{sce}} + V_{\text{sci}} + V_{\text{cult}} + V_{\text{eco}}) / 4,$$

where V_{tour} =tourist value, V_{sce} =scenic (aesthetic) value, V_{sci} =scientific value, V_{cult} =cultural value and V_{eco} =social-economic value.

The Pralong (2005) tourist assessment model primarily aims to evaluate the economic values of the geomorphological heritage, without oppressing scenic, scientific and cultural values (Kubalíková 2013).

Based on numerous field visits in the study area, discussions with local people and based on many papers on geomorphosites around the world and in Romania, we assigned points for each value (between 0 and 1) according to Pralong method (2005).

Results and Discussions

The scenic value was determined based on the following parameters: the number of sightseeing points (Sc1); the average distance between the sightseeing points (Sc2); the site area (km²) as compared to other sites of the same type within the area (Sc3); relief intensity (Sc4) and colour contrast (Sc5).

Table 2 The evaluation of the scenic value of geomorphosites within Anina karst region

No.	Name	Scenic value					Total
		Sc1	Sc2	Sc3	Sc4	Sc5	
1	Buhui Cave	0	0.5	1	0.5	1	0.6
2	Cuptoare Cave	0	0.25	0.25	0.5	1	0.4
3	Buhui Gorges	0.5	0.75	0.75	0.75	1	0.75
4	Mărghitaş Plateau	1	1	1	0.75	0.5	0.85
5	Caraş Spring	0	0.25	0.25	0.5	0.25	0.25
6	The Cave from Caraş Spring	0	0.25	0.25	0.5	1	0.4
7	Plopa Cave	0	0.5	0.25	0.5	1	0.45
8	Bigăr Spring and Bigăr Waterfall	0.25	0.75	0.5	0.5	0.5	0.5
9	Miniş Gorges	0.5	0.75	0.75	0.75	1	0.75
10	Gârliştei Gorges	0.75	1	0.75	0.75	1	0.85
11	The Cave with Water from Gârliştei Gorges	0	0.25	0.5	0.5	1	0.45
12	Straja Peak	1	1	0.25	1	0.5	0.75
13	Zânei Hill (Tâlva Zânei)	1	1	0.25	1	0.5	0.75
14	Certej Spring	0.25	0.5	0.25	0.5	0.25	0.45
15	Colonovăţ Peak	0.75	1	0.25	1	0.25	0.65

The evaluation of the scenic parameter indicates that the highest score was obtained for the gorge sectors and the Mărghitaş Plateau, mainly due to the large number of sightseeing points and to the extent of those sites (Table 2).

The scientific value (Table 3) varies between 1 (Buhui Cave) and 0.33 (Colonovăţ Peak). The evaluation of the scientific criteria was carried out based on the following elements: palaeogeographical interest of the site (St1), representativeness (St2), the percent of the site area (St3), the rarity (St4), integrity (St5) and the ecological interest of the site (St6).

We observed that Buhui Cave obtained the maximum value (1) due to its speleothems, palaeontological value, the site area and its ecological interest. In the second place is another cave, Plopa, with its early human remains, but also a site with other elements that give a very high scientific value. In the third place is Zânei Hill, a quarry area, which is not active now, but with a Jurassic flora (Popa and Meller 2009) and also proposed as Geopark (Popa et al. 2010). The lowest values are given to the Straja and Colonovăţ peaks, due to their limited scientific importance.

For cultural assessment (Table 4), we obtained values that vary between 0.55 (for Buhui Cave) and 0 (Caraş Spring, The Cave from Caraş Spring, and Straja Peak). The evaluation was carried out based on five elements: cultural/historical customs (C1), iconographic representations (C2), historical/archaeological relevance (C3), religious/metaphysical relevance (C4) and art or cultural event (C5). The cultural criteria are typically given small scores, influencing in this way the global values for geomorphosites, due to the fact that almost all of these sites are not very well integrated into the cultural life of local communities.

Table 3 The evaluation of the scientific value of geomorphosites within Anina karst region

No.	Name	Scientific value						
		St1	St2	St3	St4	St5	St6	Total
1	Buhui Cave	1	1	1	1	1	1	1
2	Cuptoare Cave	0.5	0.5	0.25	0.25	0.5	0.75	0.45
3	Buhui Gorges	0.25	0.75	1	0.5	0.25	0.75	0.6
4	Mărghitaş Plateau	0	0.75	1	0.75	0.75	0.5	0.65
5	Caraş Spring	0.25	1	0.25	0.75	1	1	0.7
6	The Cave from Caraş Spring	0.5	0.75	0.25	0.5	1	1	0.65
7	Plopa Cave	1	1	0.5	1	1	1	0.9
8	Bigăr Spring and Bigăr Waterfall	0.25	1	0.5	1	1	0.75	0.75
9	Miniş Gorges	0.5	0.75	1	0.75	0.5	0.75	0.7
10	Gârliştei Gorges	0.25	0.75	0.75	0.5	0.25	0.75	0.55
11	The Cave with Water from Gârliştei Gorges	0.5	0.5	0.5	0.5	0.75	1	0.63
12	Straja Peak	0	0.5	0.25	0.25	0.75	0	0.35
13	Zânei Hill (Tâlva Zânei)	1	1	0.5	1	0.75	0.5	0.8
14	Certej Spring	0	0.5	0.25	0.25	1	0.5	0.4
15	Colonovăţ Peak	0.25	0.5	0.25	0.25	0.75	0	0.33

For the last element taken into account in the geomorphosite assessment method proposed by Pralong (2005), economic criteria, we obtained values that vary between 0.85 (for Bigăr Spring and Bigăr Waterfall) and 0.3 (for The Cave from Caraş Spring). For the economic value, five elements were analysed: the accessibility of these sites (E1), natural risks (E2), the annual number of tourists (E3), the official level of protection for the studied sites (E4) and the attraction (E5). We should mention that in our study area, official statistics regarding the number of visitors are almost missing, and because of this, the E3 criteria were

approximated using figures from a larger area for which we had some statistics.

The economic criteria evaluation reveals those sites that are located near or along some important accessibility ways and are more prone to be exploited (Table 5). We observe that the highest score is given to a site that is located very close to a national road (DN57B), Bigăr Spring and Bigăr Waterfall, and also that is widely publicised, becoming a tourist attraction at an international scale visited by a large number of people.

The global evaluation indicates those sites that based on this, assessment method for tourist value could be considered

Table 4 The evaluation of the cultural value of geomorphosites within the Anina karst region

No.	Name	Cultural value					Total
		C1	C2	C3	C4	C5	
1	Buhui Cave	0.25	1	1	0	0.5	0.55
2	Cuptoare Cave	0.25	0.25	0	0	0	0.1
3	Buhui Gorges	0.25	0.25	0.5	0	0	0.2
4	Mărghitaş Plateau	0	0.25	0	0	0	0.05
5	Caraş Spring	0	0	0	0	0	0
6	The Cave from Caraş Spring	0	0	0	0	0	0
7	Plopa Cave	0.75	0.5	0	0	0.5	0.35
8	Bigăr Spring and Bigăr Waterfall	0	1	0.25	0	0.5	0.35
9	Miniş Gorges	0.5	0.75	0.5	0	0.25	0.4
10	Gârliştei Gorges	0.25	0.25	0	0	0	0.1
11	The Cave with Water from Gârliştei Gorges	0	0.25	0	0	0	0.05
12	Straja Peak	0	0	0	0	0	0
13	Zânei Hill (Tâlva Zânei)	0.5	0.5	0.25	0	0.5	0.35
14	Certej Spring	0	0.25	0	0	0	0.05
15	Colonovăţ Peak	0	0.5	0	0	0	0.1

Table 5 The evaluation of the economic value of geomorphosites within Anina karst region

No.	Name	Economic value					
		E1	E2	E3	E4	E5	Total
1	Buhui Cave	0.75	0.25	0.25	0.25	1	0.5
2	Cuptoare Cave	0.75	0.5	0	0.75	0.25	0.45
3	Buhui Gorges	0.5	0.5	0.25	0.75	0.5	0.5
4	Mărghitaş Plateau	0.75	1	0	1	0.5	0.65
5	Caraş Spring	0	1	0.25	0.75	0.75	0.55
6	The Cave from Caraş Spring	0	0.25	0	0.75	0.25	0.3
7	Plopa Cave	0.5	0.25	0	0	1	0.35
8	Bigăr Spring and Bigăr Waterfall	1	1	0.5	0.75	1	0.85
9	Miniş Gorges	1	0.75	0.5	0.75	0.75	0.75
10	Gârliştei Gorges	0.75	0.5	0.25	0.75	0.5	0.55
11	The Cave with Water from Gârliştei Gorges	0.25	0.25	0	0.75	0.5	0.35
12	Straja Peak	0.25	1	0	1	0.25	0.5
13	Zânei Hill (Tâlva Zânei)	0.75	1	0.25	1	1	0.8
14	Certej Spring	0.5	1	0.25	1	0.25	0.6
15	Colonovăţ Peak	0.25	1	0	1	0.25	0.5

to be geomorphosites and should be included in different tourist itineraries. The global values vary between 0.675 (Zânei Hill), 0.6625 (Buhui Cave), 0.65 (Miniş Gorges), 0.6125 (Bigăr Spring and Bigăr Waterfall) and 0.3375 (The Cave from Caraş Spring) (Table 6).

We noticed that those sites that get the highest scores are the most important in the study area, the most well known and the most accessible. These results show that the assessment method is one that is suitable for a touristic assessment of geomorphological features, because in the tourism industry, factors such as accessibility,

marketing and attractiveness are the most important for a geomorphological site,

In Fig. 3, we observe that the average score of the global value is 0.49. Those sites that are above this value are as follows: Buhui Cave, Buhui Gorges, Mărghitaş Plateau, Plopa Cave, Bigăr Spring and Bigăr Waterfall, Miniş Gorges, Gârliştei Gorges and Zânei Hill (Tâlva Zânei).

Using this method for geomorphosite assessment, we aim to be objective and implement a model that has already been used in other areas, but we noticed that certain values lose their specificity for geomorphosites.

Table 6 The evaluation of the global value of geomorphosites within Anina karst region

No.	Name	Scenic value	Scientific value	Cultural value	Economic value	Global value
1	Buhui Cave	0.6	1	0.55	0.5	0.6625
2	Cuptoare Cave	0.4	0.45	0.1	0.45	0.35
3	Buhui Gorges	0.75	0.6	0.2	0.5	0.515
4	Mărghitaş Plateau	0.85	0.65	0.05	0.65	0.55
5	Caraş Spring	0.25	0.7	0	0.55	0.375
6	The Cave from Caraş Spring	0.4	0.65	0	0.3	0.3375
7	Plopa Cave	0.45	0.9	0.35	0.35	0.515
8	Bigăr Spring and Bigăr Waterfall	0.5	0.75	0.35	0.85	0.6125
9	Miniş Gorges	0.75	0.7	0.4	0.75	0.65
10	Gârliştei Gorges	0.85	0.55	0.1	0.55	0.515
11	The Cave with Water from Gârliştei Gorges	0.45	0.63	0.05	0.35	0.37
12	Straja Peak	0.75	0.35	0	0.5	0.4
13	Zânei Hill (Tâlva Zânei)	0.75	0.8	0.35	0.8	0.675
14	Certej Spring	0.45	0.4	0.05	0.6	0.375
15	Colonovăţ Peak	0.65	0.33	0.1	0.5	0.4

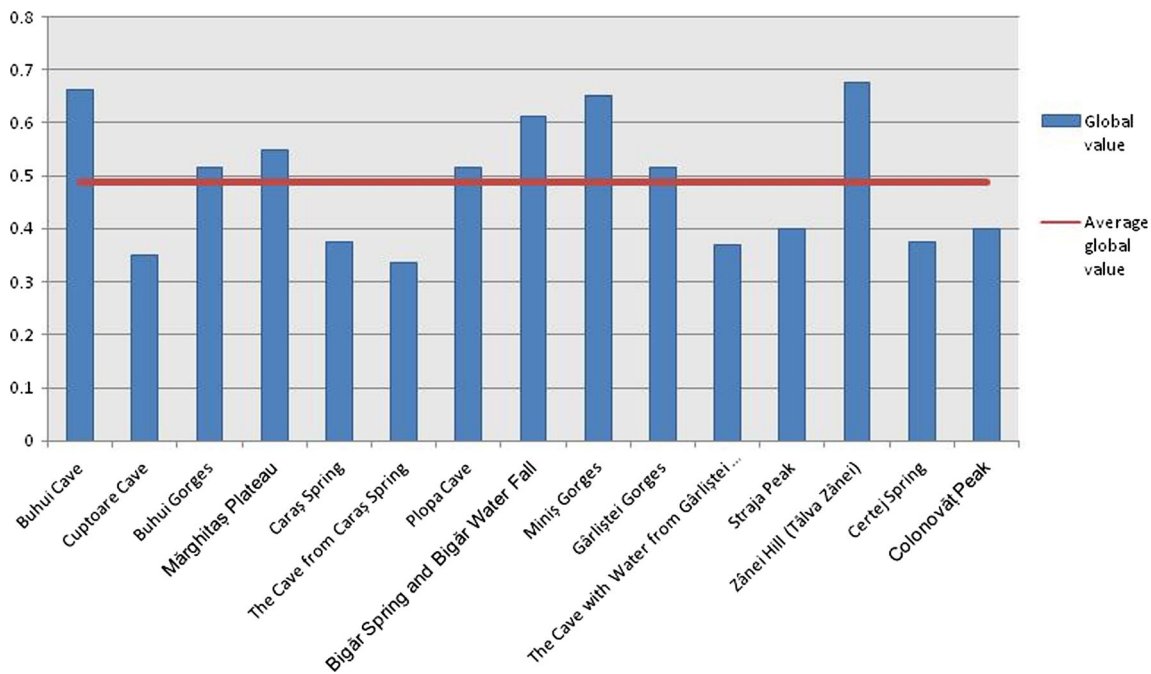


Fig. 3 Global values and average of global value for the evaluated geomorphosites within Anina coast region

The scientific or the scenic values have very high scores, and we think that these values are the most important because accessibility or art/cultural events could be created after the site is established as a geomorphosite. It is easier to build up an infrastructure or create events than to artificially ‘raise’ the natural value of a certain geosite.

Conclusions

The methodology presented in this work could represent a useful tool for the assessment of geomorphosites in karst areas and also for the environmental management of Anina region.

Our results show that the main criteria that are important for tourism (attractiveness, accessibility, tourism promotion, rarity) are given a high score in the geomorphosites assessment in the Anina karst region. The geosites that obtained the highest global value in the evaluation are Zănei Hill, Buhui Cave, Miniș Gorges, Bigăr Spring and Bigăr Waterfall, based on scientific and economic criteria. Conversely, we have, for example Caraș Spring and The Cave from Caraș Spring, sites that are also very attractive, but the accessibility is difficult, and there is no promotion for those geosites.

Based on this observation, we consider that when we deal with geomorphosite assessment, the scientific and scenic values should receive a higher weight due to their importance, considering that cultural events or access routes for those geosites are possible and could be created in time.

In our opinion, a good approach is to try to be as objective as possible, but from this example, we can see that we may lose certain local values, for instance, the longest underground river in the Banat region, the first dam built on karst, the importance of karst springs and underground rivers in human lives or the connection between past mining activities and karst water circulation in the Anina region, that could bring value to the geomorphosites.

To conclude, the results of our assessment can serve as a basis for establishing appropriate management of geomorphological sites as geoheritage in a karst region in Romania.

The present study is important for public awareness of the role of natural features in local development, drawing attention to local authorities and to the general public the role of geomorphological features in tourism development. For the Anina karst region, it is extremely important that these geomorphosites can be adequately exploited in order to protect the karst landscape, because many studies consider that it is more important to protect and conserve the geomorphosites, rather than employing this geomorphological heritage as a touristic resource (Comănescu and Nedelea 2010).

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