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Acta Geoturistica **V**olume **10 (**2019), number **1**, 1-11

Assessing the speleotourism potential together with archaeological and palaeontological heritage in Risovača cave (central Serbia)

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Abstract

The region of Central Serbia is not considered a typical karst region, however one cave near the city of Aranđelovac holds very authentic and diverse speleotourism potential. Risovača cave represents a unique speleological geosite because it possesses additional archaeological and palaentological heritage which complements the existing speleotourism offer. The cave's full utilization for tourism purposes can surely contribute to local or regional tourism development. In this paper we analyzed the speleotourism potential of the Risovača cave by applying the M-GAM (Modified Geosite Assessment Model). The aim of this paper is to emphasize the speleotourism potential and explore the possibilities for further speleotourism development in the area of Aranđelovac. The results indicate that, as a speleological geosite, Risovača cave has great potential for tourism development which still remains to be fully utilized. Research results identified the current problems for speleotourism development as well as potential solutions that can lead to an increase in tourist numbers as well as economic benefits for the local community.

Key words*: Risovača cave, M-GAM, speleotourism, archaeological heritage, palaeontological heritage, Serbia*

Introduction

Speleological objects represent significant symbols of geological and geomorphological processes throughout the world; therefore, they are immensely attractive for a vast number of tourists. This form of tourism is called speleotourism and it has exceptionally unique identity in the tourism world.

Caves like Postojna (Slovenia), Mammoth Cave (United States), Nerja (Spain) and Jenolan (Australia), reach 500 000 visitors annually (Lobo, 2015). Visitation to the underground karst areas, listening and learning about the cave jewelry formations makes speleotourism one of the most interesting and authentic forms of tourism. Furthermore, it is mandatory for speleotourism to be educational, particularly with school excursions, field trips or recreational visits. In some cases, caves also have additional values that can be very appealing to tourists. Those values are often archaeological or palaentological remains with extraordinary historical background. Some of the animal remains found in caves gave scientists a better understanding of the ancient fauna. In Naracoorte Caves in Australia there are clues that can help interpret the geological and unique evolutionary history of Australia (Dowling and Newsome, 2006). It is clear that caves have multiple applications and that they can provide local economy growth or regional development by increasing speleotourism activities.

On an international level, the study of Cigna and Burri (2000) is the most complete for this kind of tourism. It presents the economic characteristics and issues related to the planning and management of caves. Other papers worthy of note include that of Doorne (2000), which explores the social carrying capacity during the management of tourist caves, that of Cigna and Forti (1988) presenting a proposal for the development of a cave management plan, and that of Hoyos et al. (1998) expressing concern with the limits of sustainability in the exploitation of the underground environment (Lobo and Moretti, 2009).

Speleotourism can be an essential part of the tourism market, especially when caves have complementary values such as palaeontological or archaeological heritage. While analyzing Serbia's speleotourism potential it can be noted that the foremost speleological values and supplementary archaeological and palaentological values can be found in Risovača Cave, in central Serbia.

The main goal of this paper is to analyze the speleotourism potential and current state of speleotourism development in Risovača cave, with focus on archaeological and palaentological heritage. This geosite best represents the mixture of speleology, culture and history making it a worthy regional tourist destination. Our research was carried out by applying the Modified Geosite Assessment Model (M-GAM) created by Tomić and Božić (2014). The results of the analysis should provide information about the major fields of improvement and identify which areas require more attention and better management in the future in order for this geosite to become a well-known speleotourism destination which would attract a larger number of tourists.

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Study area

Risovača Cave holds very authentic and diverse tourist values in the form of speleological, archaeological and paleontological heritage. This diversity makes it a complex tourist destination with the potential to attract a larger number of visitors with different interests.

The cave is located near the city of Aranđelovac, in the north-eastern part of the Risovača hill (273 m), 17 m above the Kubrušnica River (Figure 1) Inside the cave, there are palaeolithic remains of the Neanderthal man, stone tools and steppe fauna represented by Ice age mammoths, leopards, wild horses and bison. This geosite represents the largest cave in the Šumadija region (central Serbia). It is 149.5 m long with one main canal and several side canals. The main canal (Figure 2) is 100 m long, while the side canals are 49.5 m long. The cave entrance is located in a 20 m high limestone section. The entrance is 5.5 m high and 2.8 m wide (Rakić, 1980).

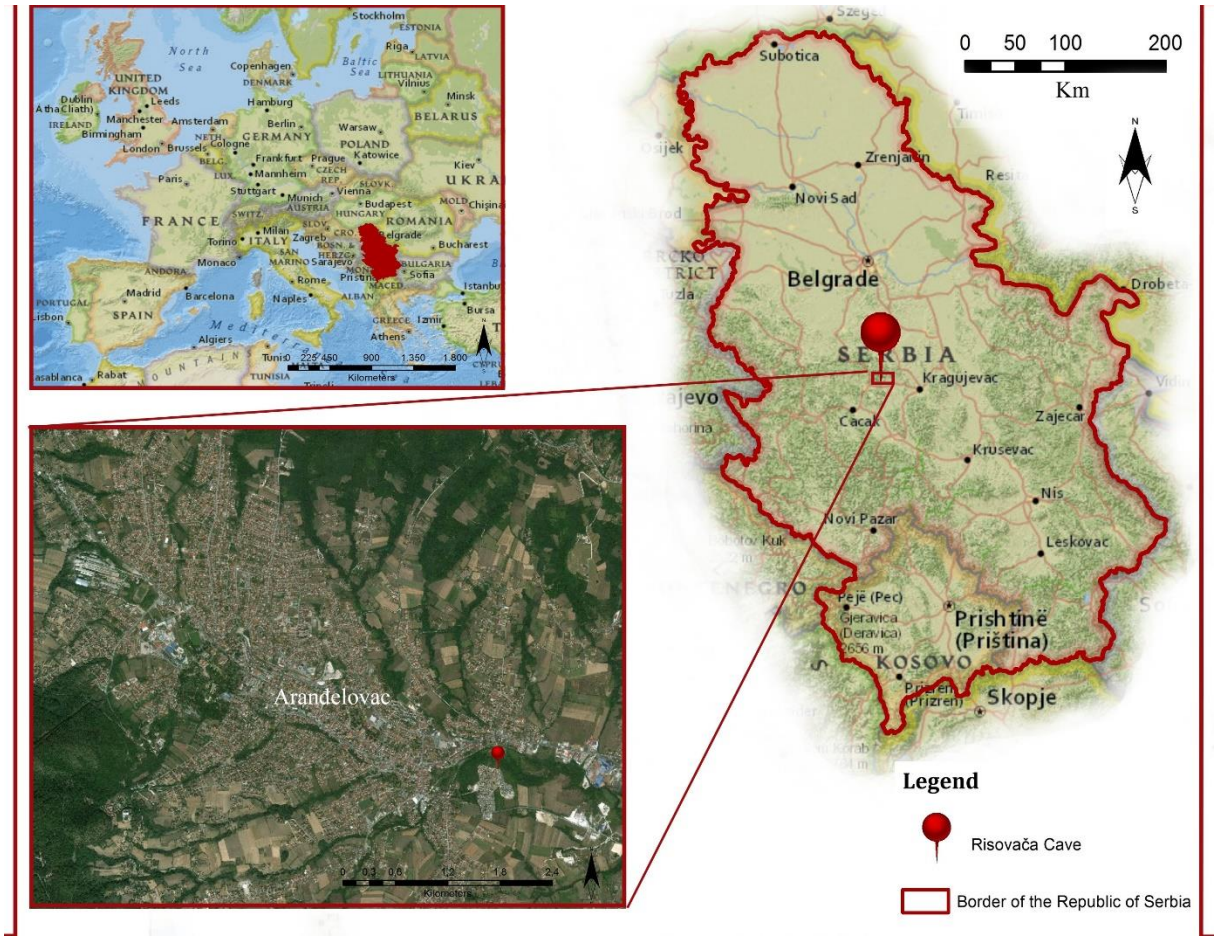

Fig. 1. Location of Risovača Cave

Research and exploration of Risovača cave began in 1953 and was conducted by the Archaeological Institute of the Serbian Academy of Science and Art and the Faculty of Philosophy in Belgrade, under the leadership of professor Branko Gavela, and it lasted, with longer or shorter interruptions, until 1976.

In addition to archaeological research, speleological research was also conducted (from 1975) and led by Radenko Lazarević, scientific adviser of the Institute for Forestry and Wood Industry from Belgrade. These studies especially intensified in the nineties and continued to the present day with the participation of associates from the Geographical Institute "Jovan Cvijić", the Faculty of Geography in Belgrade and speleological groups from Valjevo. In the period from 1995 to 1997 several structural changes which are not typical for classical karst objects were found as well as some morphological irregularities that are inconsistent with evolution schemes of classical karst caves (Wrzak-Tomić and Manecki, 2004).

Long-term archaeological, palaeontological and speleological research in Risovača Cave revealed an abundance of fossilized remains of the Pleistocene fauna, as well as traces of stone artefacts and bones linked to Neanderthal hunters. The fossil remains are believed to be the spoils of human hunters and represent large animals that were hunted for their meat or skin. There are also a few remains of smaller mammals of Holocene age. The

cave was also inhabited by the cave hyena and the cave bear, the latter dominating among the remains (Forsten and Dimitrijević, 1995).

Fig. 2. Main canal of Risovača Cave
(Source: www.bukovickabanja.rs)

Methodology

The methodology of this study is based upon the 'modified geosite assessment model' (M-GAM), developed by Tomić and Božić (2014). This method is based on previous geosite assessment methods developed by different authors (Hose, 1997; Bruschi and Cendrero, 2005; Coratza and Giusti, 2005; Pralong, 2005; Serrano and González-Trueba, 2005; Pereira et al., 2007; Zouros, 2007; Reynard et al., 2007; Reynard, 2008; Erhartič, 2010; Tomić, 2011). It combines the opinion of both sides, tourists and experts, in such a way that neither side is favoured in the assessment process. It has been successfully tested and applied numerous times for the assessment of various geosites (Boškov et al., 2015; Božić and Tomić, 2015; Tomić et al., 2015; Antić and Tomić, 2017, Tičar et al., 2018; Tomić et al., 2018; Vukoičić et al., 2018)

The M-GAM model consists of two key indicators: Main Values and Additional Values, which are further divided into 12 and 15 indicators respectively, each individually marked from 0 to 1. This division is made due to two general kinds of values: main - that are mostly generated by geosite's natural characteristics; and additional - that are mostly human-induced and generated by modifications for its use by visitors. The **Main Values** comprise three groups of indicators: scientific/educational (VSE), scenic/aesthetical values (VSA) and protection (VPr) while the **Additional Values** are divided into two groups of indicators, functional (VFn) and touristic values (VTr). The Main and Additional Values are more detailed presented in table 1. In total sum, there are 12 subindicators of Main Values, and 15 subindicators of Additional Values which are graded from 0 to 1 that define M-GAM as a simple equation:

$$M\text{-}GAM = MV + AV \quad (1)$$

where *MV* and *AV* represent symbols for Main and Additional Values. Since Main and Additional Values consist of three or two groups of subindicators, we can derive these two equations:

$$MV = VSE + VSA + VPr, \quad (2)$$

$$AV = VFn + VTr, \quad (3)$$

Table 1. The structure of Geosite Assessment Model (GAM)

Indicators/Subindicators	Description
Main values (*MV*)	
Scientific/Educational value (*VSE*)	
1. Rarity	Number of closest identical sites
2. Representativeness	Didactic and exemplary characteristics of the site due to its own quality and general configuration
3. Knowledge on geoscientific issues	Number of written papers in acknowledged journals, thesis, presentations and other publications
4. Level of interpretation	Level of interpretive possibilities on geological and geomorphologic processes, phenomena and shapes and level of scientific knowledge
Scenic/Aesthetic (*VSA*)	
5. Viewpoints	Number of viewpoints accessible by a pedestrian pathway. Each must present a particular angle of view and be situated less than 1 km from the site.
6. Surface	Whole surface of the site. Each site is considered in quantitative relation to other sites
7. Surrounding landscape and nature	Panoramic view quality, presence of water and vegetation, absence of human-induced deterioration, vicinity of urban area, etc.
8. Environmental fitting of sites	Level of contrast to the nature, contrast of colors, appearance of shapes, etc.
Protection (*VPr*)	
9. Current condition	Current state of geosite
10. Protection level	Protection by local or regional groups, national government, international organizations, etc.
11. Vulnerability	Vulnerability level of geosite
12. Suitable number of visitors	Proposed number of visitors on the site at the same time, according to surface area, vulnerability and current state of geosite
Additional values (*AV*)	
Functional values (*VFn*)	
13. Accessibility	Possibilities of approaching to the site
14. Additional natural values	Number of additional natural values in the radius of 5 km (geosites also included)
15. Additional anthropogenic values	Number of additional anthropogenic values in the radius of 5 km
16. Vicinity of emissive centers	Closeness of emissive centers
17. Vicinity of important road network	Closeness of important road networks in the in radius of 20 km
18. Additional functional values	Parking lots, gas stations, mechanics, etc.
Touristic values (*VTr*)	
19. Promotion	Level and number of promotional resources
20. Organized visits	Annual number of organized visits to the geosite
21. Vicinity of visitors centers	Closeness of visitor center to the geosite
22. Interpretative panels	Interpretative characteristics of text and graphics, material quality, size, fitting to surroundings, etc.
23. Number of visitors	Annual number of visitors
24. Tourism infrastructure	Level of additional infrastructure for tourist (pedestrian pathways, resting places, garbage cans, toilets etc.)
25. Tour guide service	If exists, expertise level, knowledge of foreign language(s), interpretative skills, etc.
26. Hostelry service	Hostelry service close to geosite
27. Restaurant service	Restaurant service close to geosite

	Grades (0.00-1.00)				
	0.00	0.25	0.50	0.75	1.00
1.	Common	Regional	National	International	The only occurence
2.	None	Low	Moderate	High	Utmost
3.	None	Local publications	Regional publications	National publications	International publications
4.	None	Moderate level of processes but hard to explain to non experts	Good example of processes but hard to explain to non experts	Moderate level of processes but easy to explain to common visitor	Good example of processes and easy to explain to common visitor
5.	None	1	2 to 3	4 to 6	More than 6
6.	Small	-	Medium	-	Large
7.	-	Low	Medium	High	Utmost
8.	Unfitting	-	Neutral	-	Fitting
9.	Totally damaged (as a result of human activities)	Highly damaged (as a result of natural processes)	Medium damaged (with essential geomorphologic features preserved)	Slightly damaged	No damage
10.	None	Local	Regional	National	International
11.	Irreversible (with possibility of total loss)	High (could be easily damaged)	Medium (could be damaged by natural processes or human activities)	Low (could be damaged only by human activities)	None
12.	0	0 to 10	10 to 20	20 to 50	More than 50
13.	Inaccessible	Low (on foot with special equipment and expert guide tours)	Medium (by bicycle and other means of man-powered transport)	High (by car)	Utmost (by bus)
14.	None	1	2 to 3	4 to 6	More than 6
15.	None	1	2 to 3	4 to 6	More than 6
16.	More than 100 km	100 to 50 km	50 to 25 km	25 to 5 km	Less than 5 km
17.	None	Local	Regional	National	International
18.	None	Low	Medium	High	Utmost
19.	None	Local	Regional	National	International
20.	None	Less than 12 per year	12 to 24 per year	24 to 48 per year	More than 48 per year
21.	More than 50 km	50 to 20 km	20 to 5 km	5 to 1 km	Less than 1 km
22.	None	Low quality	Medium quality	High quality	Utmost quality
23.	None	Low (less than 5000)	Medium (5001 to 10 000)	High (10 001 to 100 000)	Utmost (more than 100 000)
24.	None	Low	Medium	High	Utmost
25.	None	Low	Medium	High	Utmost
26.	More than 50 km	25–50 km	10–25 km	5–10 km	Less than 5km
27.	More than 25 km	10–25 km	10–5 km	1–5 km	Less than 1 km

Now that we know that each group of indicators consists of several subindicators, equations (2) and (3) can be written as follows:

$$MV = VSE + VSA + VPr \equiv \sum_{i=1}^{12} SIMV_i \text{ , where } \quad 0 \le SIMV_i \le 1 \text{ ,} \tag{4}$$

$$AV = VFn + VTr \equiv \sum_{j=1}^{15} SIAV_i \text{ , where } \quad 0 \le SIAV_j \le 1 \text{ .} \tag{5}$$

Here, $SIMV_i$ and $SIAV_j$ represent 12 subindicators of Main Values (i = 1,...,12) and 15 subindicators (j = 1,...,15) of Additional Values.

As it was mentioned before, M-GAM focuses not only on the expert's opinion but also on the opinion of visitors and tourists regarding the importance of each indicator in the assessment process. Visitor inclusion in the assessment process is done through a survey where each respondent is asked to rate the importance (*Im*) of all 27 subindicators (from 0.00 to 1.00) in the M-GAM model (Table 2). The importance factor (*Im*) gives visitors the opportunity to express their opinion about each subindicator in the model and how important it is for them when choosing and deciding between several geosites that they wish to visit. After each respondent rates the importance of every subindicator, the average value of each subindicator is calculated and the final value of that subindicator is the importance factor. Afterwards, the value of the importance factor (*Im*) is multiplied with the value that was given by experts (also from 0.00 to 1.00) who evaluate the current state and value of subindicators (Table 2).

This is done for each subindicator in the model after which the values are added up according to M-GAM equation but this time with more objective and accurate final results due to the addition of the importance factor (*Im*). This parameter is determined by visitors who rate it in the same way as experts rate the subindicators for Main and Additional Values by giving them one of the following numerical values: 0.00, 0.25, 0.50, 0.75 and 1.00, marked as points. The importance factor (*Im*) is defined, as:

$$Im = \frac{\sum_{k=1}^{K} Iv_k}{K} \tag{6}$$

Where Iv_k is the assessment/score of one visitor for each subindicator and K is the total number of visitors. Note that the *Im* parameter can have any value in the range from 0.00 to 1.00.
Finally, the M-GAM equation is defined and presented in the following form:

$$M\text{-}GAM = MV + AV \tag{7}$$

$$MV = \sum_{i=1}^{n} Im_i * MV_i \tag{8}$$

$$AV = \sum_{i=1}^{n} Im_j * AV_j \tag{9}$$

As it can be seen from the M-GAM equation, the value of the importance factor (*Im*), which is rated by visitors (for each subindicator separately) is multiplied with the value given by experts (also separately for each subindicator). This is done for each subindicator in the model. Therefore, the values of M-GAM sub-indicators are always equal or less than *GAM* values.

In their research about different geotouristic segments, Božić and Tomić (2015) conducted a survey and calculated the importance factor for each subindicator in the M-GAM model. The values of the importance factor in this paper have been adopted from the mentioned paper.

Based on the assessment results, a matrix of Main (X axes) and Additional Values (Y axes) is created (Figure 3). The matrix is divided into nine fields represented with Z(i,j), (i,j=1,2,3). Depending on the final score, each geosite will fit into a certain field. For example, if a geosite's Main Values are 7 and additional are 4, the geosite will fit into the Z_{21} field.

Results and discussion

Current speleotourism activities in Serbia are largely based on a few active speleological objects that are open for tourists and these are located mostly in eastern Serbia with a few also in the western part of the country. Major barriers for further development of speleotourism in Serbia are low quality guide service, inefficient cave management and promotional activities as well as inadequate lighting and infrastructure inside the caves (Tomić et al., 2018). Speleotourism in Serbia was mostly initiated by cave enthusiasts and explorers. Subsequently, the management was left to local residents. Various cave management organizations in Serbia had different visions in which direction their tourism should be developed. Few have been thinking about investing in cave infrastructure improvement or better tour guide service, while most of them were working more on improving the complementary offers, such as: restaurants, hotels, souvenir shops etc. (Petrović, 2006).

Table 2. Subindicator values given by experts for the analyzed geosite

Main Indicators/subindicators	Values given by experts (0-1)	Im	Total value
MAIN VALUES			
I Scientific/educational values (VSE)			
Rarity ($SIMV_1$)	0.25	**0.89**	0.22
Representativeness ($SIMV_2$)	0.50	**0.79**	0.39
Knowledge on geo-scientific issues ($SIMV_3$)	0.50	**0.45**	0.22
Level of interpretation ($SIMV_4$)	1.00	**0.85**	0.85
II Scenic/aesthetic values (VSA)			
Viewpoints ($SIMV_5$)	0.25	**0.79**	0.19
Surface ($SIMV_6$)	0.00	**0.54**	0.00
Surrounding landscape and nature ($SIMV_7$)	1.00	**0.95**	0.95
Environmental fitting of sites ($SIMV_8$)	1.00	**0.68**	0.68
III Protection			
Current condition ($SIMV_9$)	0.75	**0.83**	0.62
Protection level ($SIMV_{10}$)	0.75	**0.76**	0.57
Vulnerability ($SIMV_{11}$)	0.50	**0.58**	0.29
Suitable number of visitors ($SIMV_{12}$)	0.75	**0.42**	0.31
ADDITIONAL VALUES			
I Functional values			
Accessibility ($SIAV_1$)	1.00	**0.75**	0.75
Additional natural values ($SIAV_2$)	0.50	**0.71**	0.35
Additional anthropogenic values ($SIAV_3$)	1.00	**0.70**	0.70
Vicinity of emissive centres ($SIAV_4$)	0.25	**0.48**	0.12
Vicinity of important road network ($SIAV_5$)	1.00	**0.62**	0.62
Additional functional values ($SIAV_6$)	1.00	**0.59**	0.59
II Tourist values			
Promotion ($SIAV_7$)	0.50	**0.85**	0.42
Annual number of organised visits ($SIAV_8$)	0.50	**0.56**	0.28
Vicinity of visitors centres ($SIAV_9$)	0.00	**0.87**	0.00
Interpretive panels ($SIAV_{10}$)	0.75	**0.81**	0.60
Annual number of visitors ($SIAV_{11}$)	0.50	**0.43**	0.21
Tourism infrastructure ($SIAV_{12}$)	0.50	**0.73**	0.36
Tour guide service ($SIAV_{13}$)	0.75	**0.87**	0.65
Hostelry service ($SIAV_{14}$)	1.00	**0.73**	0.73
Restaurant service ($SIAV_{15}$)	1.00	**0.78**	0.78

The vicinity of Bukovička spa has a crucial influence on the tourist traffic of the Risovača cave. Also, the archaeological remains are very attractive for tourists, since they are confirming the existence of pre-historic cultures south of the Danube and Sava rivers. This is the reason why the cave is protected on a national level as a monument of nature (Lazarević, 1987).

The level of rarity of caves in Serbia is generally low. The majority is concentrated in eastern and western Serbia, but in the case of central Serbia speleological geosites are considered a regional phenomenon. The representativeness of the cave is moderate. The analyzed geosite includes numerous complementary archaeological and palaeontological values, but it does not have many unique speleological values, the like of which exist in eastern Serbia. The scientific community was very committed to the exploration of Risovača cave during the last century, but in recent times the knowledge on geo-scientific issues of this cave can only be found in regional scientific publications. This is considered as an overly negative factor. It is necessary to raise awareness about the knowledge on geo-scientific issues of Risovača cave and the possibilities for geotourism or

speleotourism development through scientific publications. The potential for speleotourism development is also presented in the level of interpretation. Risovača cave is considered as a geosite with good examples of geological processes that can easily be explained to a common visitor. This acknowledgement is important for speleotourism development because it shows that the cave can be visited by many different profiles of tourists with different interests. High scientific and educational values of the Risovača cave give it an advantage that can help this geosite to achieve a better position on the tourism market.

Alongside the subindicators related to the protection values of the cave, the subindicators for aesthetic values have the highest sum of all grades in M-GAM. Since the cave is located on a small hill that is near the city of Aranđelovac, the geosite itself is a very attractive viewpoint. In this area there are also a couple of small lakes, the Bukovička spa is located within the same municipality and the Kubrušnica River flows in the immediate vicinity of the cave. Therefore, the environmental surrounding, landscape and nature are highly rated in the assessment process. Furthermore, the protection values are also very well rated as the cave is protected on a national level as a natural monument. The current protection status of the cave allows further scientific exploration and speleotourism development.

Looking at the grades for additional values, we can notice that they are also generally high. Four subindicators from functional values and two from tourist values are evaluated with the highest score and only one subindicator from additional values was evaluated with the lowest score. The nearby city of Aranđelovac is the main reason behind this. The cave is easily accessible and has a parking lot for bicycles, cars and buses. Additional anthropogenic and functional values are mainly located in the nearby city. The museum of Aranđelovac holds all archaeological and palaentological heritage found inside the Risovača cave making it an additional attraction and visitation to both locations is usually implied.

Table 3. Overall ranking of the analyzed cave by the M-GAM

Geosite name	**Main values**		**Additional values**		**Field**
	VSE+VSA+VPr	Σ	VFn+VTr	Σ	
Risovača Cave	1.68+1.79+1.79	5.26	3.13+4.03	7.16	Z_{22}

Current promotional activities are mostly regional. The cave is promoted at national tourism fairs and on the internet by the Tourist Organization of Aranđelovac. These activities need to be modernized and improved by implementing marketing strategies first throughout Serbia and then in the European tourism market. The current number of visitors is not very high. The annual number of organized visits is not higher than 24, and the cave is visited by a maximum of 10.000 tourist per year. In order to increase this, further investment in the tourist infrastructure and the overall current offer is required. Although there is a continuous need for improvement, some parts of the cave are well presented. Interpretative panels and tour guide service possess high quality and they are very educational. Risovača cave tour guide service has exceedingly positive reviews on social media. This indicator is very important for cave management because it creates a good image and attracts more visitors. Furthermore, it was rated by visitors as one of the most important subindicators in the M-GAM model (Božić and Tomić, 2015).

The overall ranking of the Risovača Cave according to M-GAM is shown in table 3. The total sum of the Main Values is 5.26, while the total sum for Additional Values is 7.16. These results position the Risovača Cave in the Z_{22} field of the M-GAM matrix. The seemingly overall high Additional values of this geosite are primarily caused by the immediate vicinity of the city of Aranđelovac. Therefore, further improvements are still necessary in order to attract a larger number of tourists in the future.

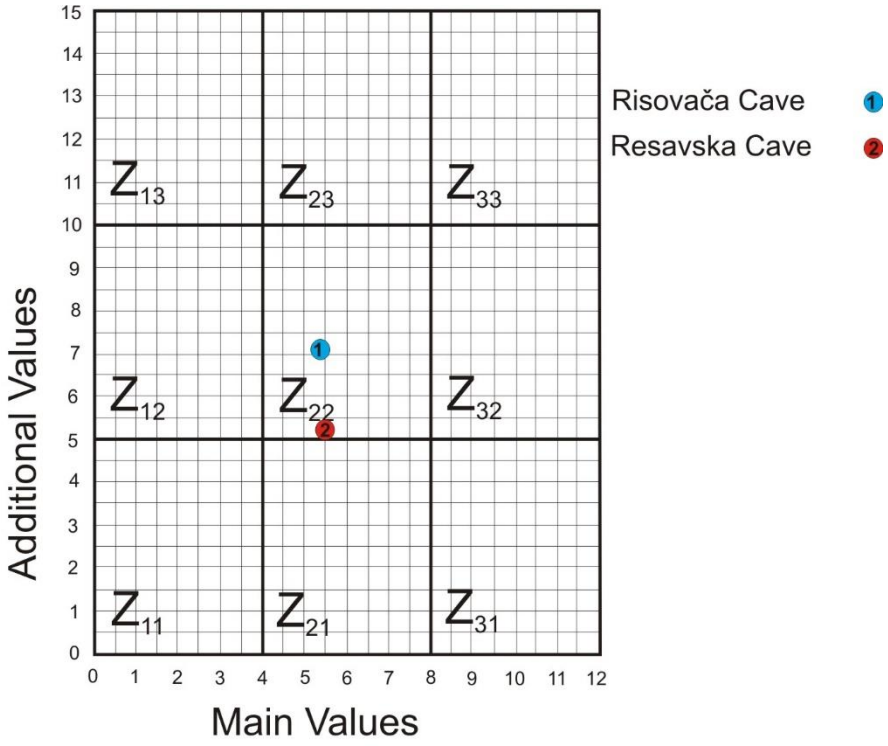

Fig. 3. Position of Risovača and Resavska Cave in the M-GAM matrix

In their paper about speleotourism in Eastern Serbia, Tomić et al. (2018) analyzed six speleological geosites by applying M-GAM. Resavska cave, one of the most popular caves in Serbia, had the highest ranking. The Main values of the cave were 5.52 and the Additional values were 5.27, meaning that it was positioned in the same field of the M-GAM matrix as Risovača cave in this paper (Figure 3). However, Risovača cave has slightly higher scores for Additional values and very similar results for the Main values. The main reason for such high Additional values is the vicinity of Aranđelovac. Because of this, Risovača cave has much higher values of such subindicators as functional values or hostelry and restaurant service. This, together with accessibility and closeness to emissive centres gives it a slight advantage over Resavska Cave. However, if we take into account that Resavska Cave has higher aesthetic values, is bigger and its tourist infrastructure is much better, this makes it more popular with a larger number of visitors.

Conclusion

The geosite assessment of the Risovača cave has shown that this speleological object represents the nucleus of speleotourism in central Serbia. However, its speleotourism potentials are not fully utilized. The additional archaeological and palaeontological heritage in the cave can have much greater influence on future tourism development. Considering that archaeological heritage found in the cave proves the existence of prehistoric cultures in this area, the promotional activities of Risovača cave should be raised at least to a national level. The application of various marketing strategies on the national level would help in attracting a larger number of tourists with diverse interests. By successfully applying M-GAM we can conclude that the Main and Additional values of the cave are more than sufficient and suitable for further speleotourism development and investment. Future focus should mainly be on promotional activities and infrastructure improvement. The vicinity of the city of Aranđelovac has a major impact on Additional values. Nevertheless, the current state of tourism (number of visitors and tourism income) at Risovača Cave is not equivalent to its potential. In the future, the management of Risovača Cave could also benefit from exploring more developed cave tourism complexes which exist in Western Europe (i.e. Lascaux Cave) and implement some of the management processes and tourist arrangements.

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