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A modified Geosite Assessment Model (M-GAM) and its Application on the Lazar Canyon area (Serbia)

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ABSTRACT: The aim of this paper is to present a modified version of GAM (M-GAM) which should show that the results gained by using this version are more accurate and realistic. The modification is based on the inclusion of tourists and their opinion regarding the importance of indicators in the assessment process. The assessment was done by using both versions of GAM and the results were compared and analyzed afterwards. Both assessment methods were applied on the Lazar Canyon area located in eastern Serbia, a territory which possesses a large concentration of geosites on a relatively small surface area and it has great potential for geotourism development. The study revealed that the inclusion of tourists in the assessment process can have crucial impact on the final results. By introducing the importance factor in the modified model we were able to point out those values which are of paramount importance for tourists. This can be rather useful in the improvement and planning of tourism activities as it exactly shows which of the lower values should receive the most attention in the future based on their significance for tourists.

Key words: Modified Geosite Assessment Model (M-GAM), Evaluation, Assessment, Geotourism, Lazar Canyon

INTRODUCTION

The evaluation of geosites has been developing since the 1990s, in three main domains: within the context of Environmental Impact Assessment (EIA) procedures (Rivas *et al.,* 1997; Cendrero and Panizza, 1999); for the elaboration of geographic knowledge on the geomorphological heritage in the context of land planning (Stürm, 1994; Grandgirard, 1999); and finally, and more recently, in the context of geoheritage promotion (geotourism, cultural heritage in a broad sense) (Panizza and Piacente, 2003a; Reynard, 2008). The Lazar Canyon area (eastern Serbia) possesses several remarkable geosites of scientific importance and with great geotourism potential. This territory must be the object of geoconservation strategies regarding its conservation and management (Vasiljević *et al.,* 2011a; 2011b). In the year 2000, due to its great importance, Lazar's Canyon was put under state protection as a natural monument of the first category with a second degree protection regime (Tomić, 2011).

The majority of the Serbian protected areas are focused on biological objects rather than geological, resulting in a higher number of protected areas based on bio aspects. However, the Lazar Canyon area possesses both geological and biological diversity. Apart from many geosites, there is also a large number of endemic and relict plant spe-cies. The flora diversity of this relatively small area repre-sents approximately 20% of the country's flora. Due to these facts it is easy to see why this area needs conservation and good management in the future. However, this paper will only be focusing on the assessment of geosites in this area and their value for geotourism development.

For the purpose of this paper we singled out three geosites in this area. These sites include the main part of the Lazar Canyon system and also two caves (Vernjikica and Lazar's Cave) (Fig. 1) which have the greatest geotourism potential (Tomić, 2011).

During the last years, several studies have been conducted regarding the assessment and management of geosites and also the definition of geoconservation strategies (e.g. Serrano and Gonzalez-Trueba, 2005; Pereira *et al.,* 2007; Reynard, 2009; Lima *et al.,* 2010; Kavčič and Peljhan, 2010; Coratza *et al.,* 2011; Fassoulas *et al.,* 2011; Pellitero *et al.,* 2011; Moufti *et al.,* 2013). There is also a great number of

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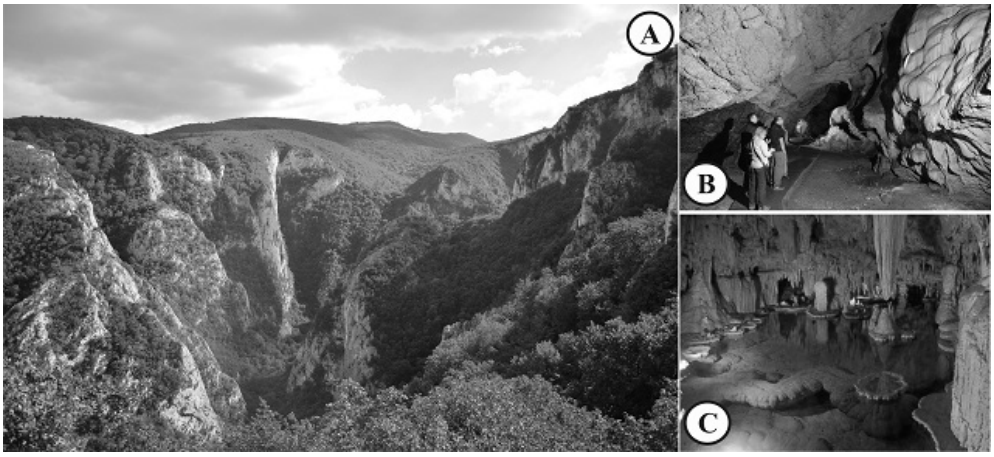

Fig. 1. Three main geosites of the investigated area: A – Lazar's Canyon; B – Lazar's Cave; C – Vernjikica Cave

assessment methods to rank the different values of geosites from a particular territory (Grandgirard and Szepesi, 1997; Panizza and Piacente, 2003b; Gray, 2004; Brilha, 2005; Reynard, 2005; Reis and Henriques, 2009; Tomić, 2011; Vujičić *et al.,* 2011; Rocha *et al.,* 2013).

The present work is based on the Geosite Assessment Model (GAM) by Vujičić et al. (2011), which will be used for the assessment of the three aforementioned geosites in the investigated area. However, the assessment will also be done by using M-GAM, made by the authors of this paper respectively, focusing 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. The aim of this research is to show that the results gained by using the modified version of GAM (M-GAM) are more objective and accurate and that the inclusion of visitors in the modified model should be one of the key elements in the assessment process. The results will then be compared and analyzed.

MATERIALS & METHODS

The Lazar Canyon area is located in the region of eastern Serbia (Fig. 2), within ten kilometers from the town of Bor. This territory is very rich with numerous canyons, caves and pits that are lo-cated on a relatively small area. These geosites are excellent representatives of this area's geodiversity. Geoheritage sites usually include all geological, ge-omorphological, pedological and distinct archaeo-logical values created during the formation of the Earth's crust (Djurović and Mijović, 2006). All of these values are present in the area of Lazar's Canyon which makes this territory excellent for the devel-opment of geotourism in the future. Also, the entire area around the investigated sites is surrounded by highly degraded zones of the Bor mining basin, which gives this protected area even greater significance. For the purpose of this paper we singled out three main geosites in this area. These sites include the main part of the Lazar Canyon system and also two caves (Vernjikica and Lazar's Cave) which have the greatest geotourism potential.

The Lazar River Canyon is one of the deepest, most inhospitable and impassable canyons in Serbia with a length of 4400 meters and an av-erage incline of the longitudinal profile of 44‰. The greatest depth of the canyon is at the Ko-vej site, where on the right side of the valley, the upper edge of vertical cliffs is at 375 meters above the canyon bottom, and on the left side the depth is 330 meters. The canyon bottom narrows in some places between three and four meters and throughout the canyon there is a great num-ber of boulders, rocky towers and cas-cades that occasionally turn into waterfalls. The most prominent rock tower is located at the junc-ture of Mikulj River Canyon and Lazar's Canyon. The height of this tower is 150 meters (Lazarević, 1998).

Lazar's Cave is located downstream, at the end of Lazar's Canyon, 6.70 meters above the La-zar River bed. The total length of the explored part of the cave is 1592 meters of which 1225 me-ters belongs to the dry channels (Vasiljević *et al.,* 1998).

The backbone of the cave's channel system is the main channel with several larger morpho-logical units: Prestona hall with the Cathedral of blocks in the northwestern branch, and a Con-cert hall and the Hall of bats near the end of the north branch. Besides its length, there are sever-al other indicators that show the significance of this cave: Its surface area is 9900 square meters and its volume is around 70000 cubic meters of which the main channel takes about 52000

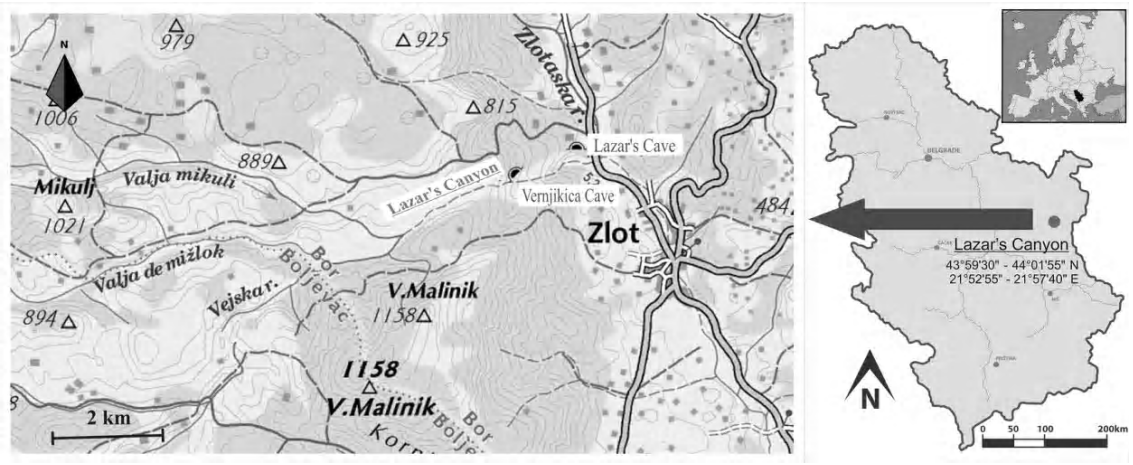

Fig. 2. The position of the Lazar Canyon Area and the three geosites included in the study

me-ters. The cave has very rich ornaments made from calcite and travertine that vary in shape, size and color (Lazarević, 1998). It also has paleontological remains of Ice Age animals as well as 5000 years old archaeological remains of tools and pottery (Vasiljević *et al.,* 1998).

Vernjikica Cave is located in the left side of La-zar's Canyon, below the Kornjet elevation at 545.5 meters above sea level and over 150 meters above the canyon bottom.

The total length of the cave is 1015 meters, its surface area is 13000 square meters and its vol-ume is 260000 cubic meters, calculated for the av-erage height of 20 meters.

The Colosseum hall is the best proof of this cave's megalitic dimensions. The diameter of this rounded room is over 55 meters, and the max-imum height of its dome ceiling is 50.7 meters, while the height difference between the lowest point on the floor and the highest point on the ceiling is 58.7 meters (Lazarević, 1998).

This cave is also characterized by vast amounts of calcite and crystal accumulation, which form extremely diverse and imposing figures like the stalagmite Colossus, which is the symbol and logo of Vernjikica with a height of 11.5 meters.

The assessment methods developed in previous years focused mainly on geosites and their scientific quality, and later additional values (Grandgirard, 1999; Bruschi and Cendrero, 2005; Coratza and Giusti, 2005; Reynard, 2005; Reynard and Panizza, 2005; Reynard *et al.,* 2007; Pereira *et al.,* 2007; Vujičić *et al.,* 2011). Based on some of these methods, a new model was developed by Pralong (2005) specifically for the evaluation of the tourist quality of geomorphosites and their use by the tourism sector. According to this method, the tourist value of a site is determined as the average value of the scenic, scientific, cultural and economic values. In this model, like in many earlier models, one of the main issues concerning the evaluation of a site is objectivity. None of the mentioned methods include information on the needs, views, interests and opinions of tourists that visit geosites which is very important especially when evaluating the tourist potential of a site. Visitor inclusion in the evaluation process is a good way to achieve objectivity. An example of this is given in a report by the Scottish Natural Heritage (GSR, 2006). The report describes a survey conducted among regular visitors (non-experts) and experts thus including the opinion of both ends of the spectrum instead of just one like in most previous models. However, this type of research can be complex and time consuming which means that the development of more simple methods is required for the future selection of the best sites for geotourism (Tomić, 2011).

The methodology of this study is based upon the Geosite Assessment Model (GAM) created by Vujičić *et al.* (2011). This model was assisted by a number of relevant papers (e.g. Hose, 1997; Hose *et al.,* 2011; Bruschi and Cendrero, 2005; Coratza and Giusti, 2005; Pralong, 2005; Pereira *et al.,* 2007; Serrano and González-Trueba, 2005; Zouros, 2007; Reynard *et al.,* 2007; Reynard, 2008) that also dealt with the evaluation of geosites. GAM consists of two key indicators: Main Values and Additional Values, which are further divided into 12 and 15 indicators respectively (Table 1), each individually marked from 0.00 to 1.00. This division is made due to two general kinds of values: main - that are mostly generated by the geosite's natural characteristics; and additional - that are mostly human-induced and generated by modifications for its use by visitors. The **Main Values (*MV*)** comprise of three groups of indicators: scientific/educational (*VSE*),

scenic/aesthetical (*VSA*) values and protection (*VPr*). The **Additional Values (*AV*)** are divided into two groups of indicators, functional (*VFn*) and touristic values (*VTr*) (Vujičić *et al.,* 2011; Petrović *et al.,* 2013). In total sum, there are 12 subindicators of Main Values, and 15 subindicators of Additional Values which are graded from 0.00 to 1.00 that define GAM as a simple equation:

$$GAM = MV + AV, \quad (1)$$

where *MV* and *AV* are signs for main values and the additional values, respectively. As each of the two values *MV* and *AV* are composed of the three and two groups of indicators, two equations can be written:

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

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

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

Indicators/Subindicators	Description
Main values (*MV*)	
Scientific/Educational value (*VSE*)	
Rarity ($SIMV_1$)	Number of closest identical sites
Representativeness ($SIMV_2$)	Didactic and exemplary characteristics of the site due to its own quality and general configuration
Knowledge on geoscientific issues ($SIMV_3$)	Number of written papers in acknowledged journals, thesis, presentations and other publications
Level of interpretation ($SIMV_4$)	Level of interpretive possibilities on geological and geomorphologic processes, phenomena and shapes and level of scientific knowledge
Scenic/Aesthetic (*VSA*)	
Viewpoints ($SIMV_5$)	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.
Surface ($SIMV_6$)	Whole surface of the site. Each site is considered in quantitative relation to other sites
Surrounding landscape and nature ($SIMV_7$)	Panoramic view quality, presence of water and vegetation, absence of human-induced deterioration, vicinity of urban area, etc.
Environmental fitting of sites ($SIMV_8$)	Level of contrast to the nature, contrast of colors, appearance of shapes, etc.
Protection (*VPr*)	
Current condition ($SIMV_9$)	Current state of geosite
Protection level ($SIMV_{10}$)	Protection by local or regional groups, national government, international organizations, etc.
Vulnerability ($SIMV_{11}$)	Vulnerability level of geosite
Suitable number of visitors ($SIMV_{12}$)	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*)	
Accessibility ($SIAV_1$)	Possibilities of approaching to the site
Additional natural values ($SIAV_2$)	Number of additional natural values in the in radius of 5 km (geosites also included)
Additional anthropogenic values ($SIAV_3$)	Number of additional anthropogenic values in the in radius of 5 km
Vicinity of emissive centers ($SIAV_4$)	Closeness of emissive centers
Vicinity of important road network ($SIAV_5$)	Closeness of important road networks in the in radius of 20 km
Additional functional values ($SIAV_6$)	Parking lots, gas stations, mechanics, etc.
Touristic values (*VTr*)	
Promotion ($SIAV_7$)	Level and number of promotional resources
Organized visits ($SIAV_8$)	Annual number of organized visits to the geosite
Vicinity of visitors centers ($SIAV_9$)	Closeness of visitor center to the geosite
Interpretative panels ($SIAV_{10}$)	Interpretative characteristics of text and graphics, material quality, size, fitting to surroundings, etc.
Number of visitors ($SIAV_{11}$)	Annual number of visitors
Tourism infrastructure ($SIAV_{12}$)	Level of additional infrastructure for tourist (pedestrian pathways, resting places, garbage cans, toilets etc.)
Tour guide service ($SIAV_{13}$)	If exists, expertise level, knowledge of foreign language(s), interpretative skills, etc.
Hostelry service ($SIAV_{14}$)	Hostelry service close to geosite
Restaurant service ($SIAV_{15}$)	Restaurant service close to geosite

Indicators/Subindicators	Description				
	Grades (0.00-1.00)				
	0.00	0.25	0.50	0.75	1.00
$SIMV_1$	Common	Regional	National	International	The only occurence
$SIMV_2$	None	Low	Moderate	High	Utmost
$SIMV_3$	None	Local publications	Regional publications	National publications	International publications
$SIMV_4$	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
$SIMV_5$	None	1	2 to 3	4 to 6	More than 6
$SIMV_6$	Small	-	Medium	-	Large
$SIMV_7$	-	Low	Medium	High	Utmost
$SIMV_8$	Unfitting	-	Neutral	-	Fitting
$SIMV_9$	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
$SIMV_{10}$	None	Local	Regional	National	International
$SIMV_{11}$	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
$SIMV_{12}$	0	0 to 10	10 to 20	20 to 50	More than 50
$SIAV_1$	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)
$SIAV_2$	None	1	2 to 3	4 to 6	More than 6
$SIAV_3$	None	1	2 to 3	4 to 6	More than 6
$SIAV_4$	More than 100 km	100 to 50 km	50 to 25 km	25 to 5 km	Less than 5 km
$SIAV_5$	None	Local	Regional	National	International
$SIAV_6$	None	Low	Medium	High	Utmost
$SIAV_7$	None	Local	Regional	National	International
$SIAV_8$	None	Less than 12 per year	12 to 24 per year	24 to 48 per year	More than 48 per year
$SIAV_9$	More than 50 km	50 to 20 km	20 to 5 km	5 to 1 km	Less than 1 km
$SIAV_{10}$	None	Low quality	Medium quality	High quality	Utmost quality
$SIAV_{11}$	None	Low (less than 5000)	Medium (5001 to 10 000)	High (10 001 to 100 000)	Utmost (more than 100 000)
$SIAV_{12}$	None	Low	Medium	High	Utmost
$SIAV_{13}$	None	Low	Medium	High	Utmost
$SIAV_{14}$	More than 50 km	25–50 km	10–25 km	5–10 km	Less than 5km
$SIAV_{15}$	More than 25 km	10–25 km	10–5 km	1–5 km	Less than 1 km

where *VSE*, *VSA*, *VPr*, *VFn* and *VTr* are scientific/educational (*VSE*), scenic/aesthetical (*VSA*), protection (*VPr*), functional (*VFn*) and touristic (*VTr*) values, respectively.

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

$$MV = VSE + VSA + VPr \equiv \sum_{i=1}^{12} SIMV_i \ ,$$

where $0 \le SIMV_i \le 1$, (4)

$$AV = VFn + VTr \equiv \sum_{j=1}^{15} SIAV_i \ ,$$

where $0 \le SIAV_j \le 1$ (5)

Here, $SIMV_i$ and $SIAV_j$ present 12 subindicators ($i = 1,\ldots,12$) for the Main Values and 15 subindicators ($j = 1,\ldots,15$) for Additional Values (Hrnjak *et al.,* 2013). In accordance with the original definition of GAM (Vujičić *et al.,* 2011), each of the subindicators can only receive one of the following numerical values: 0.00, 0.25, 0.50, 0.75 and 1.00, marked as points.

For the purpose of this paper we made a modified version of GAM (M-GAM) in order to achieve more objective results. The modification is based on the following facts:

A geosite can present a synthesis of several elements: socio-cultural, historical, scenic, archaeological, educational, scientific, fun, psychological and artistic (geosites and landscapes have always been source of inspiration of painters, sculptors, writers and musicians). Geotourists have

Table 2. Values given by experts and visitors for each subindicator in the GAM model

Main Indicators / Subindicators	Values given by experts (0.00-1.00)			*Im*	Total		
I Scientific/Educational values (*VSE*)	GS_1	GS_2	GS_3		GS_1	GS_2	GS_3
1. Rarity ($SIMV_1$)	0.75	0.25	0.50	0.95	0.71	0.23	0.47
2. Representativeness ($SIMV_2$)	0.75	0.25	0.25	0.70	0.52	0.17	0.17
3. Knowledge on geo-scientific issues ($SIMV_3$)	1.00	0.75	0.75	0.66	0.66	0.49	0.49
4. Level of interpretation ($SIMV_4$)	0.75	0.75	0.75	0.84	0.63	0.63	0.63
II Scenic/Aesthetic values (*VSA*)							
1. Viewpoints (each must present a particular angle of view and be situated less than 1 km from the site) ($SIMV_5$)	0.75	0.00	0.00	0.83	0.62	0.00	0.00
2. Surface (each considered in quantitative relation to other) ($SIMV_6$)	1.00	0.50	0.50	0.58	0.58	0.29	0.29
3. Surrounding landscape and nature ($SIMV_7$)	1.00	1.00	1.00	0.91	0.91	0.91	0.91
4. Environmental fitting of sites ($SIMV_8$)	1.00	1.00	1.00	0.87	0.87	0.87	0.87
III Protection (*VPr*)							
1. Current condition ($SIMV_9$)	1.00	0.75	0.75	0.92	0.92	0.69	0.69
2. Protection level ($SIMV_{10}$)	0.75	0.75	0.75	0.78	0.58	0.58	0.58
3. Vulnerability ($SIMV_{11}$)	0.75	0.75	0.75	0.67	0.50	0.50	0.50
4. Suitable number of visitors ($SIMV_{12}$)	1.00	0.75	0.75	0.58	0.58	0.43	0.43
I Functional values (*VFn*)							
1. Accessibility ($SIAV_1$)	1.00	1.00	1.00	0.75	0.75	0.75	0.75
2. Additional natural values ($SIAV_2$)	1.00	1.00	1.00	0.66	0.66	0.66	0.66
3. Additional anthropogenic values ($SIAV_3$)	0.25	0.25	0.25	0.67	0.16	0.16	0.16
4. Vicinity of emissive centres ($SIAV_4$)	0.00	0.00	0.00	0.71	0.00	0.00	0.00
5. Vicinity of important road network ($SIAV_5$)	0.50	0.50	0.50	0.74	0.37	0.37	0.37
6. Additional functional values ($SIAV_6$)	0.25	0.25	0.25	0.69	0.17	0.17	0.17
II Touristic values (*VTr*)							
1. Promotion ($SIAV_7$)	0.00	0.00	0.00	0.71	0.00	0.00	0.00
2. Annual number of organised visits ($SIAV_8$)	0.25	0.50	0.00	0.56	0.14	0.28	0.00
3. Vicinity of visitors centre ($SIAV_9$)	0.00	0.00	0.00	0.74	0.00	0.00	0.00
4. Interpretative panels (characteristics of text and graphics, material quality, size, fitting to surroundings, etc.) ($SIAV_{10}$)	0.25	0.25	0.00	0.87	0.21	0.21	0.00
5. Annual number of visitors ($SIAV_{11}$)	0.25	0.25	0.00	0.58	0.14	0.14	0.00
6. Tourism infrastructure (pedestrian pathways, resting places, garbage cans, toilets, wellsprings etc.) ($SIAV_{12}$)	0.25	0.25	0.00	0.70	0.17	0.17	0.00
7. Tour guide service (expertise level, knowledge of foreign language(s), interpretative skills, etc) ($SIAV_{13}$)	0.00	0.25	0.00	0.74	0.00	0.18	0.00
8. Hostelry service ($SIAV_{14}$)	0.50	0.50	0.50	0.73	0.36	0.36	0.36
9. Restaurant service ($SIAV_{15}$)	0.25	0.25	0.25	0.76	0.19	0.19	0.19

different profiles with respect to their motivation (Hose, 1994; Pralong, 2006) for the visit of a geosite: some are interested in specific fields of the Earth sciences and possess excellent knowledge in these fields while others are motivated by a large socio-cultural or artistic interest. The sites with the highest scientific values are not necessarily the best from the point of view of tourists who are interested very much in socio-cultural meanings of a geosite. For example, such geosites as mining outcrops or loess sections are unlikely to

attract much more than academic interest on their own. They need to possess good quality interpretation and educational activities in order to spark an interest among visitors from the non-scientific community and those who want to become actively involved during their visit. Hence, the importance of the subindicators in the model should be strongly related to the specific need of a specific segment of geotourists. The structure and size of tourist segments is changeable over time. It may be that in certain periods of time visitors of a geosite are mostly interested in the scientific value of a geosite, but later on, a large part of visitors can belong to a segment of tourists who are mostly interested in the socio-cultural meaning of a geosite.

Hence, the market value of a geosite (estimated by the number of visitors) depends on many variables. This is why the value of a geosite should be a product of both expert opinion and visitors' opinion also. One way of achieving this is to include the visitors/tourists in the assessment process. Visitors should play an important role in the assessment process and determine how important each subindicator is for them because, after all, they are the ones that will make the final decision to visit or not to visit a certain geosite.

For the purpose of this paper, this was done through a survey where each respondent was asked to rate the importance (*Im*) of each from the 27 subindicators (from 0.00 to 1.00) in GAM (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. 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 was done for each subindicator in the model after which the values were added up according to the already mentioned 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 $SIMV_i$ and $SIAV_j$ 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:

$$Im = \frac{\sum_{k=1}^{K} Iv_k}{K}, \qquad (6)$$

where 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 modified GAM equation is defined and presented in the following form:

$$M - GAM = Im(GAM) = Im(MV + AV). \qquad (7)$$

As it can be seen from the *M-GAM* equation, the value of the importance factor (*Im*) is multiplied with the value that was given by experts (*GAM*). This was done for each subindicator ($SIMV_i$ and $SIAV_j$). Therefore, the values of *M-GAM* sub-indicators are always equal or less than *GAM* values.

As it was said before, there have been many assessment methods over the years but M-GAM seems to be one of the most accurate and objective ones as it considers not only the views and opinions of experts but also the views of visitors whose needs and interests have a significant impact in determining the value and potential of a geotourism destination. Provided the assessment of some subindicators (for example scenic value) is only done by experts, the final result could be very subjective and include only the opinion of the scientific community whereas the non-scientific segment of tourists is completely ignored. Thus, a survey among visitors is a good way to avoid such a problem.

RESULTS & DISCUSSION

In order to assess the current use and geotourism potential of our study area and to see which values should be the focus of future improvements we used the previously explained model. A survey was conducted among the visitors of the Lazar Canyon area in July and August of 2013. The questionnaire consisted of 27 questions/ subindicators and each visitor was asked to rate the importance (*Im*) of every subindicator on a five point Likert-type scale by rating it from zero to one (0 = not at all important; 0.25 = not very important; 0.50 = neutral; 0.75 = somewhat important; 1.00 = very important). A total of 96 visitors filled out the questionnaire. Tables 3 and 4 and figure 3 show us the final results of the assessment acquired by using both versions of GAM.

When analyzing the first group of subindicators (*VSE*) we can see how the ranking of importance for some of them, done by tourists, can considerably change the final results of the assessment. For instance, *Rarity* ($SIMV_1$) was rated by tourists as a

Table 3. Overall ranking of the Lazar Canyon area geosites by using GAM

Geosite Label	Values				
	Main		Additional		Field
	VSE+VSA+VPr	Σ	*VFn+VTr*	Σ	
Lazar Canyon – GS_1	3.25 + 3.75 + 3.50	10.50	3.00 + 1.75	4.75	Z_{31}
Lazar Cave – GS_2	2.00 + 2.50 + 3.00	7.50	3.00 + 2.25	5.25	Z_{22}
Vernjikica Cave – GS_3	2.25 + 2.50 + 3.00	7.75	3.00 + 0.75	3.75	Z_{21}
Mean	-	8.58	-	4.58	-

Table 4. Overall ranking of the Lazar Canyon area geosites by using M-GAM

Geosite Label	Values				
	Main		Additional		Field
	VSE+VSA+VPr	Σ	*VFn+VTr*	Σ	
Lazar Canyon – GS_1	2.52 + 2.98 + 2.58	8.08	2.11 + 1.21	3.32	Z_{31}
Lazar Cave – GS_2	1.52 + 2.07 + 2.20	5.79	2.11 + 1.53	3.64	Z_{21}
Vernjikica Cave – GS_3	1.76 + 2.07 + 2.20	6.03	2.11 + 0.55	2.66	Z_{21}
Mean	-	6.63	-	3.20	-

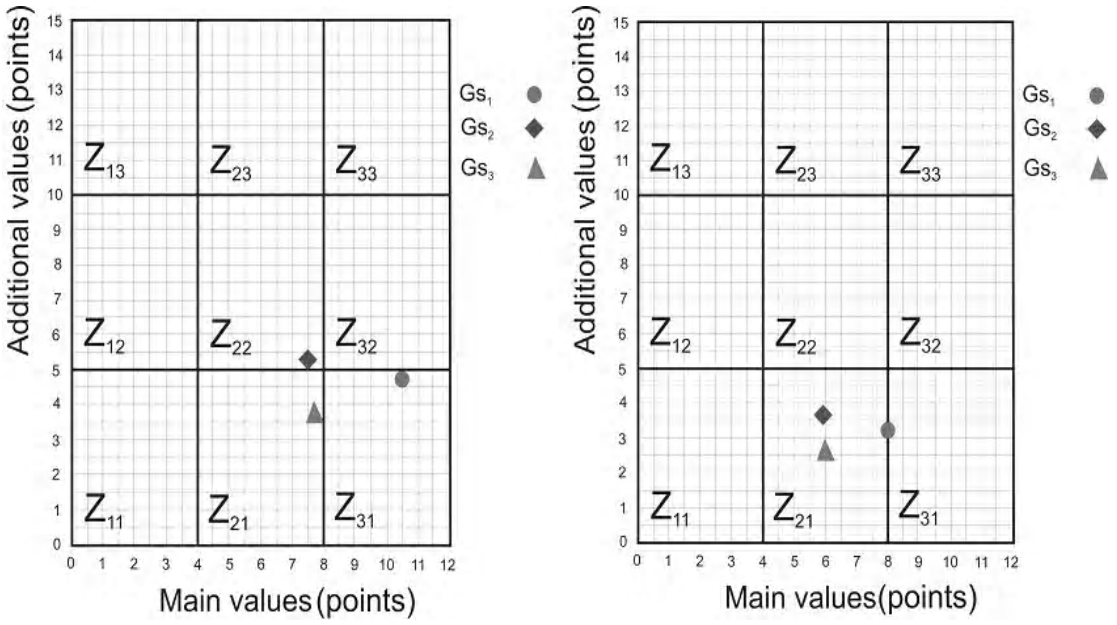

Fig. 3. Position of the assessed geosites in the GAM and M-GAM matrix

factor of great importance (*Im* = 0.95), which means that this subindicator plays a significant role when choosing the place tourists will visit. In addition, when the marks given by experts are multiplied with importance (*Im*) rated by tourists, we get quite similar results, so there is no significant change. However, when looking at the subindicator *Knowledge of geoscientific issues* ($SIMV_3$), which was chosen by experts as an important factor to be included in the assessment, it doesn't seem to be of same importance for tourists (*Im* = 0.66). We can see how this affects the final results (Table 2) where values given by experts, when

multiplied with importance given by tourists produce lower values.

Scenic and aesthetic values seem to be quite important to tourists when choosing their destination. This especially refers to subindicators such as *Viewpoints* ($SIMV_5$), *Surrounding landscape and nature* ($SIMV_7$), as well as *Environmental fitting of the sites* ($SIMV_8$), so the difference between results after their judgment is not so radical. However, *Surface* ($SIMV_6$) is not a very important factor to them, as we can see from the fact that they marked it with 0.58 and it changed the results significantly.

The protection values (*VPr*) for all three geosites seem to be on an enviable level, as all subindicators were marked high (from 0.75 to 1.00). These quite high marks given by experts shouldn't be taken as completely realistic for the assessment since some of the subindicators have a very small significance among tourists and don't really affect their decision when choosing the site they will visit. This especially refers to the subindicator *Suitable number of visitors* ($SIMV_{12}$), which was highly marked by experts, but it doesn't significantly affect tourists ($Im = 0.58$), so the final marks should objectively be much lower, as we can see in Table 2.

In addition, not all of the functional values are also of the same importance for tourists. Here, once again, we can see how this fact can radically change the final result. For instance, notwithstanding the fact that there is plenty of *Additional natural values* ($SIAV_2$) (as we can see from the highest mark given by experts) in the near surroundings of all three geosites, it doesn't seem to be extremely important to tourists ($Im = 0.66$) in comparison with some other subindicators such as *Accessibility* ($SIAV_1$) ($Im = 0.75$) which also gained the highest mark from experts (1.00). By using the modified GAM version (M-GAM), we get a more realistic assesment, as we can conclude from the fact that the importance of this subindicator is marked as 0.75 by visitors, so the final mark can't be 1.00, but it has to be lower (0.75) if we also take into account the opinion of visitors.

Touristic values seem to be quite important to tourists, as importance for most of them varies from 0.71 to 0.87 (such as interpretative panels, promotion, hostelry and restaurant services). However, here we can also notice some exceptions such as *Annual number of organised visits* ($SIAV_8$) ($Im = 0.56$) as well as *Annual number of visitors* ($SIAV_{11}$) ($Im = 0.58$) which experts considered to be important for the assesment but the tourists' opinion didn't match with their opinion. This is one more proof that we cannot rely solely on the opinion of experts, which are considered to be just one of the tourist segments that visit geosites, and the exclusion of other segments and their opinion gives less objective and accurate results in GAM then in the modified version (M-GAM) where other segments beside experts are also included in the assessment.

By comparing the final results gained by both models we can obviously see the noticable difference in their final marks, and how it affected their position in the GAM matrix (Figure 3). The matrix consists of main and additional values, where these values are presented via X and Y axes respectively. The matrix is divided into nine fields (zones) that are indicated by Z(i,j) (i,j=1,2,3) based on the grade they received in the previous evaluation process. Major grid lines that create fields, for X axe have value of 4 and for Y axe of 5 units. This means that, for example, if the sum of main values is 7 and of additional values is 4, the geosite would be in the Z_{21} field of the GAM matrix which indicates a moderate level of main values and a low level of additional values (Vujičić *et al.,* 2011).

The biggest difference between the final results gained by these two methods can be noticed in the assesment of Lazar's Cave. The immence influence of tourist's opinion on the final result can obviously be seen from the fact that in the GAM model the main values and additional values have a mark of 7.5 and 5.25 putting this geosite in the Z_{22} field of the matrix which means that it has moderate main and additional values. On the other hand, the results gained by using M-GAM were somewhat different. The main values and additional values were 5.79 and 3.64 respectively, positioning Lazar's Cave in the Z_{21} field of the matrix. This means that the site's additional values, ranked as moderate in GAM, changed to low in the modified version thus changing the position of the geosite in the matrix. From this we can see that in M-GAM, the indicators have lower values as a result of including tourist opinion about importance of given factors valued by experts.

The other two geosites, the Lazar River Cayon (Z_{31}) and Vernjikica cave (Z_{21}) kept their position in the same field of the matrix, but as we can see from figure 3, they significantly changed their position within that same field in the matrix. The values gained by using M-GAM are much lower for both Lazar River Canyon and Vernjikica Cave in comparison with the results gained by GAM. The reason for this is once again the lesser importance of some subindicators for tourists that were included in the assessment.

CONCLUSIONS

The principle aim of this research was to create a modified version of GAM and to compare the two assessment methods (GAM and M-GAM) and their final results in order to try and show that the results gained by using the modified version are more objective and realistic. This is based on the fact that not all indicators can have the same weight, as it was presented in GAM, since tourists, when making decisions whether to visit or not visit a site, give more or less importance to different indicators.

Thus, this is the crucial thing which must be considered in geosite assessment. However, it was ignored in many other previous geosite assessment models as almost none of them included tourists' opinion in the assessment process. Their inclusion is necessary mainly because experts, who give their opinion, are considered to be just one of the market segments that visit geosites and their assessment, done from a scientific perspective can be rather subjective since they could draw more importance to some indicators which, as research showed, are of less importance for an average tourist. On the other hand, expert opinion combined with those of regular tourists leads to more objective and accurate results.

The original version of GAM aims to indicate the current state of main and additional values for a geosite and it can indicate which subindicators already have high values and also those with lower values which haven't reached their maximum potential yet. However, some of the subindicators with lower values are perhaps not so important for tourism development. By introducing the importance factor, rated by tourists, in the modified model we reduce our field of focus and draw our attention only to those values which are of paramount importance for tourists. This means that we should base future improvements first and foremost on those values which still haven't reached a high level but are significant for tourists.

Finally, we can conclude that the assessment results gained by models which exclude visitors from the assessment process can give us quite a blurry and deceptive picture of the current geosite situation in terms of their engagement in tourism purposes. On the other hand, by including the opinion of tourists, as it has been done in M-GAM, we can get a more clear and realistic picture which can be rather useful in the improvement and planning of tourism activities for the analyzed geosites.

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