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Evaluation of geoheritage models – analysis and its application on the loess profiles in Vojvodina region

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Abstract

The touristic value of geoheritage sites has an important role in the decision of the tourists to visit certain destination. Also, the same site can help the people working in tourism to decide about the investments in certain geosite. In order to avoid subjectivity in assessing the value, several quantitative evaluation methods of objects are created, which criteria don't differ too much. Mostly scientific values, representativeness, wholeness as well as tourist equipment are being evaluated. Evaluation models aim to draw attention to the current conditions and the potential every evaluated geosite has. this paper presents an analysis of the chosen quantitative models of geoheritage evaluation, where their effectiveness is checked by the evaluation of three loess - paleosol profiles in Vojvodina, from the Geoheritage List of Serbia. The differences between the models are influenced by the degree of accuracy in the assessment, where for some models, the criteria is not clear when assigning the ratings.

Keywords: *geoheritage, evaluation models, loess profiles*

Rezumat. **Evaluarea modelelor de geo-patrimoniu – analiză și aplicare pe profilele de loess din regiunea Voivodina**

Valorea turistică a geositurilor de patrimoniu are un rol important în decizia turiștilor de a vizita o anumită destinație. De asemenea același sit poate ajuta actorii din turism să decidă despre investițiile ce trebuie făcute în anumite geosit-uri. Pentru a evita subiectivitatea în evaluarea valorilor au fost create metode cantitative de evaluare a obiectivelor, neexistând prea multe criterii de diferențiere. Sunt evaluate valorile științifice, reprezentativitatea, integritatea precum și infrastructura turistică.. Modelele de evaluare au ca scop atragerea atenției spre situația curentă și potențialul fiecărui geosit analizat. Lucrarea prezintă o analiză a modelelor cantitative de evaluare a patrimoniului geologic, iar eficiența lor este verificată prin evaluarea a trei profile de loess din Vojvodina, ce fac parte din Lista Patrimoniului Geologic al Serbiei. Diferenţe între modele este influențată de gradul de acurateţe al evaluării, pentru unele modele criteriile nefiind foarte clare când se atribuie valorile.

Cuvinte-cheie: *geo-patrimoniu, modele de evaluare, profile de loess*

Introduction

Natural resources, unlike anthropogenic ones, have the possibility of uprading in order to attract tourists. Rarity and representativeness, as well as educative and aestetic values contribute to tourist value of a certain natural resource.

The geoheritage study has practical significance in the effective protection of geoheritage, the local ecological environment, the popularization of earth science and the promotion of local economy in the way of sustainable development.

Over the past two decades, there have been several attempts to evaluate the geological heritage, but in different contexts, such as, for example, environmental impacts (Rivas et al. 1997, Coratza & Giusti 2005), the formation of geological heritage list of objects (Serrano & González-Trueba, 2005), tourism promotion (Pralong, 2005), or the management of National parks (Pereira et al., 2007).

In order to reduce subjectivity, many quantitative methods have been developed, and are largely based on several criteria, of which three are the most important: rarity, representativeness and integrity (Grandgirard, 1999).

Methods and Models have the role of drawing the attention to the current situation, but also to the possibility that each geosite has, in order to make the planning process easier for the managers and the tourism supply could be properly formed on those localities which possess a chance for development.

The subject of this paper is a comparative overview and evaluation of quantitative methods of ranking the objects of geological heritage in the case of middle Pleistocene loess-paleosol sequences in Vojvodina.

Geological and geomorphological framework

Loess profiles are unique terrestrial records of paleoclimatic and paleoecological conditions. The most complete loess profiles are located in China and in Europe, specifically in the valley of the Danube. In Serbia, loess profiles are in the form of five mutually separated loess plateaus, whereby it is possible to follow the paleo- climatic conditions up to a million years ago (Markovi et al., 2001, 2003, 2004, 2008, 2011) (Fig. 1). Based on the research and proven scientific and educational significance

that the loess - paleosol sequences have, the last years have been devoted to geoconservation and protection of these geosites. Particularly are significant works of Gray (2004, 2008a, 2008b), Hose (2008), who set the base of geoconservation, as well as the work of Lukić et al (2009) and Vasiljević (2011a, 2011b). In order to make the significance of loess - palaeosol sequences of Vojvodina widespread, authors like Marković et al., 2001; Hose, 2008; Jovanović & Zvizdić, 2009; Jovanvić & Gaudenji, 2009; Vasiljević et al., 2011a; Vasiljević et al., 2011b; Vujičić et al., 2011. note certain loess- paleosol sequences as an opportunity for geotourism development.

It is not possible for all the loess profiles to be renovated and used as geosites, or even if it were possible, it would not be economically viable. Firstly, it is necessary to quantitatively and qualitatively assess the loess profiles, as well as their potential importance for geotourism.

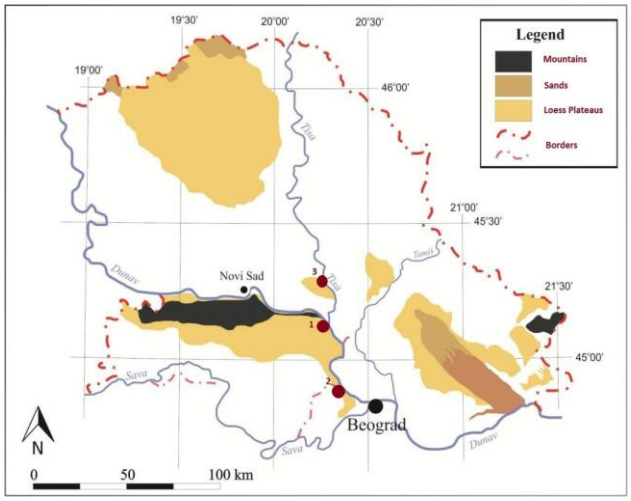

Fig. 1: The geographical position of investigated loess geosites in the Republic of Serbia (1-Čot, 2-Batajnica (Danube), 3-Feudvar)

The most promising loess profiles, when the possibility of the development of geotourism based on loess profiles is being estimated, are the loess profile in Stari Slankamen (especially loess profile Čot), loess profile Batajnica and loess profile of Stara Ciglana Ruma and Titel Hill.

Methodology

It is possible to find a large number of methods to quantitatively assess the geological heritage objects and these methods can mostly be found in foreign literature.

The first methods have been developed in the seventies of the twentieth century by Linton (1968), Leopold (1969). Some have suggested morphometric measurements, while the other methods are more subjective.

There is a rich literature devoted to geotourism (generally by geologists and geomorphologists) by which the attractiveness of many geotourism objects are assessed. Many attributes such as type and age of geological formations (including geomorphological factors and nature influenced formations), geographical location, etc. are considered in the assessment process as well as transport accessibility, tourism infrastructures, economic and many other factors (Bruschi & Cendrero, 2005).

The methods of evaluation of the geological heritage vary in relation to the criteria taken during the evaluation, but most methods include representativeness, rarity and integrity, while the ecological, scientific, educational and cultural values are taken into account depending on the purpose of the study (not cited at references. Precise analysis of geological heritage requires an integrated process, which includes analysis of scientific aspects, tourism and management.

Acceptance of subjectivity in the assessment (based on the opinion of experts) is an inevitable part in the overall evaluation process that is presented on the basis of defining a series of successive steps to facilitate the establishment of clearly stated criteria. These steps include:

- Identification of criteria;
- Definition of indicators to measure each criterion;
- Establishing a range of values for each indicator;
- Confirmation.

Five models of evaluation will be presented in this paper, and they will be well analyzed in the case of medium-Pleistocene loess profiles of Vojvodina. Such a comprehensive comparison should provide a clear view of the advantages and disadvantages of quantitative evaluation methods.

This paper deals with the comparison of five different methods of evaluation, in order to reduce the factor of subjectivity:

1. The Assessment of the Attractiveness (Value) of Geosites (Rybár, 2010);
2. The Dynamic Model of the Assessment of Attractions of Geosites in the Tourism Market (Hadžić et al., 2010);
3. Method of Evaluation of Scientific and Additional Value of Geosites (Reynard, 2005);
4. The Preliminary Model of Valorization of Geosites (Gam) (Vujičić et al., 2011);
5. The Assessment of Values of the Loess Profiles (Jovanović & Zvizdić, 2009).

The models were selected based on their compatibility to apply to specific types of objects of geological heritage. It has been taken into account that the models are different, so the advantages and disadvantages of each model can be noticed.

The methods were tested on loess profiles, as well as on geosites of the same kind and similar features.

Results

The comparative analysis includes only the quantitative part of each method, while the introductory parts, such as the basic information, are presented in the original papers listed in References.

The assessment of the attractiveness (value) of geosites

In order to assess the attractiveness of the sites of geotourism a model has been formed by Fisher (Rybár, 2010), where he estimates the value of objects, helping the tourists to decide whether to visit certain destination or not, by valuing the individual elements of each tourist site. In this way, geotourists receive information about the degree of attractiveness, the number of visitors, as well as the scientific significance of the sites and object that they want to visit.

Table 1 shows the parameters that are being measured (graded), as well as the system in which the evaluation is being done. In order to avoid subjectivity, an explanation has been given for each evaluation.

Table 1The results of evaluation of loess profiles in Vojvodina region

CRITERIA/SITE	GL_1 **Čot**	GL_2 **Bata-jnica**	GL_3 **Feudvar**
Main geological characteristics	6	6	5
Uniqueness	8	5	4
Access to the site	7	5	8
Scientific publications	8	8	8
Terms of observation	5	5	5
Safety	8	8	8
Availability of information on the Internet	8	5	2
Visual value of the site	8	6	6
Additional services	0	0	0
Site in the field of tourism	8	0	0
Sum	66	48	46

Source: Rybar, 2010

Each of the parameters is being evaluated according to the enclosed principle, and the final summation may amount to a maximum of 80.

If the geosite received the ratings that exceed 40 (i.e., a half), it is considered that the site worths a visit, and that meets most of the criteria that are important for geotourists. If the site has not reached 40 points, it is not recommended to geotourists, or does not possess great value (Rybár, 2010).

This quantitative model of evaluation of objects of geological heritage is quite simple, but extremely fair, considering that the precise guidelines that are being used to evaluate are provided to be realistic, without excessive subjectivity of the assessor.

The model covers all the essential elements to be taken into account when deciding on the choice of destinations and can very easily be applied to the loess profiles.

As seen in the table, all three geosites have gone through the process of evaluating all ten criteria, respectively, in order to calculate their sum. All three geosites crossed the threshold of 40 points, which means that each of them represents a site that is worthy of attention of geotourists. Loess profile Čot received the highest number of points (66), making it the best ranked geosite among the examined loess profiles.

The dynamic model of the assessment of attractions of geosites in the tourism market

As a starting point of the planning process of tourism marketing, it is necessary to develop a model of tourism evaluation of geosites.

This model would not only satisfy the curiosity of tourists, but would clearly define destination (site) as well, in order to distinguish it from similar territories. The model was presented at the conference Geotrends 2010 by Hadzic et al. (2010).

The value and importance of geosites is being determined by the evaluation of three main indicators: scientific value, added value and need for protection, which is associated with the level of degradation and vulnerability.

This model also provides the ability to compare geosites based on the final results of the evaluation (Hadzic et al., 2010).

Table 2 presents all the indicators and sub-indicators which are being evaluated. The importance of each sub-indicator has been assessed by scores from tourists ranging from 0 to 1, where 0 is very bad, and 1 is the best score the geosite can get. This score is then being individually multiplied by the grade given by the expert, in the range from 1 to 5. The sum of all these assessments gives a final judgment on a particular geosite which is the subject of interest.

This model, when compared to the previous one, is much more extensive, since there are more sub-indicators to be taken into account in the process of evaluation of geosites.

In addition, this model includes a review of tourists in the evaluation process.

Each of the three loess profiles has undergone the evaluation process according to this model, and the results were somehow different compared to the previous model.

Table 2: Results of evaluation of geosites according to criteria

GEOSITE	GL_1	GL_2	GL_3
	Čot	Batajnica	Feudvar
SCIENTIFIC VALUE	35.25	30. 5	32
Rarity	5	3	5
Wholeness	5	5	2. 5
Representativeness	3	1. 5	3
Diversity	2. 25	1. 5	3
Other geological characteristics	5	5	5
Scientific knowledge	5	4. 5	4. 5
Educational interest	5	5	5
Rarity on a national level	5	5	4
ADDITIONAL VALUES	36.5	22.5	37.2
Scientific value	5	4	5
Ecological value	2.4	2.8	3.6
Experiential component	4.5	2	1.5
Representativeness of the geosite	1.5	1.6	2.8
Connection with the works of art	0.3	0.1	4.5
Connection with the economic development of the local communities	3.0	1.2	1.2
The possibility of organizing cultural events	0.2	1	5
Interpretative value	1.6	1.8	1.6
Additional natural and cultural values	5	3	5
Quality of management	2.5	0.6	0.2
Equipment and technical support on the geosite	1.2	0	0.4
Accessibility	4	1.2	2.4
Visibility	5	3.2	4
Sum	71.75	53	69.2

Source: Hadžić et al., 2010

According to this model, loess profile Čot has received the highest rating, while the profile of Batajnica received the lowest ratings. The reasons for this may be various.

Firstly, the subjectivity in this model is reduced by the fact that one part of the overall assessment opinion consists of opinions made by tourists. On the other hand, the guidelines for assessment have not been specified correctly in this model, unlike the previous one, where a clear description of what is meant has been provided for each assessment.

Also, the range of assessment that the tourists give is not specified and ranges from 0 to 1, where there are a large number of options, and the failure of central tendency can easily be made. Thus, the lack of this model certainly lies in the ambiguity estimation that is provided for each sub -indicator.

Certainly, the boundaries between scientific significance have not been clearly defined in this model, as well as other values, such as the ecological value or the protection of geological heritage sites.

The experiential component is not a stand-alone indicator, but is located within the additional value of the geosites, although it should represent a special indicator that would include sub- indicators: interpretative value, representativeness, visibility, etc.

Method of evaluation of scientific and additional value of geosites

The model of evaluation of scientific and additional values of geosites has been proposed in the paper by Reynard and Associates (Reynard et al., 2007). This model uses a table divided into six parts, each with a number of sub- criteria (Table 3), whereby the right evaluation was carried out in the third and fourth part of the table. The quantitative values are reported by grade from 0 to 1, where 0 indicates that the test has no value, and 1 indicates that it has the highest possible value.

The scientific value of geosites can be obtained by adding all four sub-criteria and dividing them by number 4. The same applies to the additional values (ecological, aesthetic, cultural and economic), whose sub- criteria is being added and divided by the number of sub -criteria.

Table 3 shows all the sub -criteria, as well as the estimates obtained in the process of evaluation of the three loess profiles. Cultural value of geosites differs in that its sub- criteria are not being divided with their number, because in most cases it happens that the geosite has only one of the four geosites, and the highest value is being taken for the purposes of evaluation.

The total value of the loess profile is being determined not only by quantitative indicators in Table 3, but also by qualitative descriptions of global and educational importance, the possible threats to the site, as well as management measures related to the destination, i.e. the site.

If we take a look at the table, it is clear to conclude that the loess profile Čot has the largest scientific significance, as well as the added value, followed by the Feudvar loess profile, while the worst ranked is the loess profile in Batajnica.

The combination of qualitative and quantitative evaluation significantly hinders objectivity and reality in the ranking, as well as the subsequent use of the data that has been collected.

Table 3: The results of evaluation of geosites according to criteria

GEOSITE	GL_1	GL_2	GL_3
	Čot	Batajnica	Feudvar
Scientific value	1	0.6	0.75
Wholeness	1	1	1
Representativeness	1	0.5	0.5
Uniqueness	1	0.5	0.75
Paleographic value	1	0.5	0.75
Ecological value	0.4	0.05	0
Ecological impact	0.3	0.1	0
Protection of the site	0.5	0	0
Aesthetic value	0.25	0.13	0.08
Lookouts	0	0	0
Contrasts, vertical development	0.5	0.25	0.15
Cultural value	0.75	0.5	1
Religious value	-	-	-
Historical value	-	-	1
Artistic value	-	-	-
Geohistorical value	0.75	0.5	-
Economic value	0	0	0

Source: Reynard et al., 2007

The preliminary model of valorization of geosites (gam)

In order to assess the value of the loess profiles, the preliminary model of geosites valorization (GAM) proposed by Vujicic et al (2011) has been used. This model shows the valuation of geosites, and should assist in the process of planning and sustainable management of natural resources, as well as the transformation of the natural resources in tourism destinations.

The assessment consists not only of the inventory of sites, but also on the proposal of protection, promotion and monitoring (Pereira et al., 2007). The methodology is based on several existing models and is being presented in two main groups of values (Main Values) and additional (Additional Values), which are divided into indicators and sub - indicators. The first group consists of three groups of values, namely: scientific / educational (VSE), landscaping / aesthetic (VSA) and environmental / conservational (VPR), while the second group, added value, consists of functional (VFN) and tourism values (VTR). If we take all the facts that have been presented so far into account, it can be concluded that there are 12 sub- indicators of the main values and 15 sub- indicators for the additional values (Table 4). All sub- indicators are marked from 0 to 1 (Vujicic et al., 2011).

Based on the proposed inventory of geosites, each individual geosite passes through the evaluation process until the final result is obtained (Table 4). Since the resultant of the model appears at the end of the graph, which consists of nine fields in which the proposed geosites can be classified according to their similarity with the essential characteristics of tourism in terms of main and additional values whose values are presented on the X and Y axes. These fields are marked with Z (i, j) (i, j = 1, 2, 3), on the basis of evaluations which are obtained from the previous evaluation process.

The main lines that create fields for X axe have a value of 4, and for the Y-axis the value of 5. This means that if, for example, the sum of the main values is 7, and an additional 4, the proposed geosite will be place within the field Z21, which indicates an intermediate level of the value of main and low added value (Figure2).

Such a model could be of great importance and could help to protect the natural heritage, and tourism management would have an easier job when it comes to the assessment of the current and future state of the geosites.

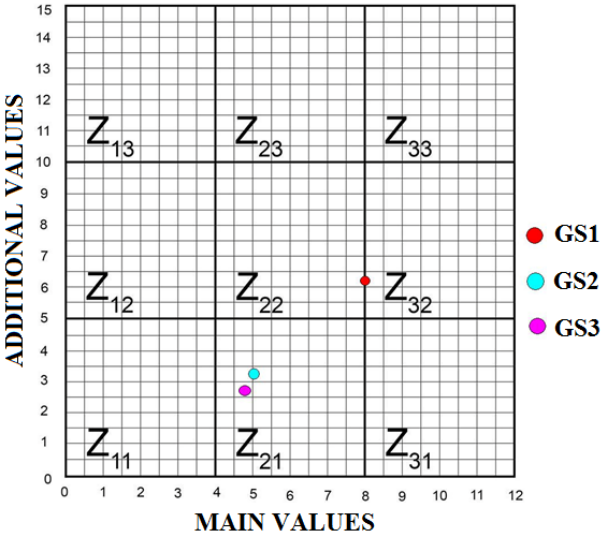

Fig. 2: The layout of geosites according to the GAM model

Table 4: Scheduling the proposed geosites in a specified field of GAM model according to the sum of obtained values

Main Values						GS_1	GS_2	GS_3
Grade	*0*	*0.25*	*0.5*	*0.75*	*1*			
Scientific/Educational values (VSE)						3.75	2	1.75
Rarity	Common	Regional	National	International	The only occurence	3.75	2	1.75
Representativeness	None	Low	Moderate	High	Utmost	1	0.5	0.5
Knowledge on geoscientific issues	None	Local publications	Regional publications	National publications	International publications	1	0.5	0.5
Level of interpretation	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	1	1	0.5
Scenic/Aesthetic values (VSA)						1.25	1.25	1.25
Viewpoints	None	1	2 do 3	4 do 6	More than 6	0	0	0
Surface	Small	-	Medium	-	Large	0	0	0
Surrounding landscape and nature	-	Low	Medium	High	Utmost	0.25	0.25	0.25
Environmental fitting of sites	Unfitting	-	Neutral	-	Fitting	1	1	1
Protection (VPr)						3	1.75	2.5
Current condition	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	0.5	0.25	0.25
Protection level	None	Local	Regional	National	International	075	0	0.75
Vulnerability	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	0.75	0.5	0.5
Suitable number of visitors	0	0 to 10	10 to 20	20 to 50	More than 50	1	1	1
Additional Values						6.25	3.25	2.75
Grade	*0*	*0.25*	*0.5*	*0.75*	*1*			
Functional values (VFn)						3	2.25	1.75
Accessibility	Inaccessible	Low (on foot with special equipment)	Medium (by bicycle)	High (by car)	Utmost (by bus)	0.75	0.5	0.5
Additional natural values	None	1	2 to 3	4 to 6	More than 6	0.5	0.25	0.5
Additional anthropogenic values	None	1	2 to 3	4 to 6	More than 6	0	0	0.25
Vicinity of emissive centres	More than 100 km	100 to 50 km	50 to 25 km	25 to 5 km	Less than 5 km	0.5	0.5	0.25
Vicinity of important road network	None	Local	Regional	National	International	1	1	0.25
Additional functional values	None	Low	Medium	High	Utmost	0.25	0	0
Touristic values (VTr)						3.25	1	1
Promotion	None	Local	Regional	National	International	0.5	0	0
Annual number of organized visits	None	Less than 12 per year	12 to 24 per year	24 to 48 per year	More than 48 per year	0	0	0
Vicinity of visitors' centres	More than 50 km	50 to 20 km	20 to 5 km	5 to 1 km	Less than 1 km	0	0	0
Interpretative panels	None	Low quality	Medium quality	High quality	Utmost quality	0.5	0	0
Annual number of visitors	None	Low (less than 5000)	Medium (5001 to 10 000)	High (10 001 to 100 000)	Utmost (more than 100 000)	0	0	0
Tourism infrastructure	None	Low	Medium	High	Utmost	0.25	0	0
Tour guide service	None	Low	Medium	High	Utmost	0	0	0
Accommodation	More than 50 km	50 to 25 km	25 to 10 km	10 to 5 km	Less than 5 km	1	0.5	0.25
Restaurants	More than 25 km	25 to 10 km	10 to 5 km	5 to 1 km	Less than 1 km	1	0.5	0.75

Source: Vujičić et al., 2011

Based on the sum value, it can be concluded that the loess profile Čot in Stari Slankamen has the highest scores, followed by loess profile in Batajnica, while the Feudvar loess profile got the lowest ratings (Fig. 2). Geosites have a high level of core values in all three cases, i.e. the sites are very representative and possess uniqueness on a global scale, and have a low level of additional value, so the future actions should be directed towards the development of tourist attractions that are in close conjunction with the loess profiles but also to the development of tourism infrastructure.

As it can be seen from the chart, geosite 1 - loess profile Čot is located in the field Z32 and represents the best ranked geosite. Based on this chart, each potential geotourist can easily assess whether the certain geosite is worth visiting. This method of evaluation shows great advantages in comparison to previous models, because the evaluation process is clearly defined, so the errors that can arise due to the subjectivity are reduced to a minimum. The GAM model contains 27 sub-indicators, which means that the evaluation process is very detailed, in comparison to other models. As an advantage, this model emphasizes the ability to adapt to different types of geological heritage sites that are being evaluated.

On the other hand, this model needs to be improved. The opinion of the visitors has to be taken into account. In the paper written by Tomic & Božić (2014), GAM model was modified with respect to the role of spectators or geotourists. However, as these loess profiles are still not enough visited, GAM modified version of the model cannot be taken into account in the evaluation process of loess profiles.

The assessment of values of the loess profiles

The methodology applied for the valuation of certain characteristics of the loess profiles is a customized methodology by Reynard (Reynard et al., 2007), with the division of the internal and external factors according to Čomi (2002). Estimatations range from 1 to 3, wherein the score 1 has highest value, and grade 3 the lowest (Jovanovi & Zvizdić, 2009).

Table 5 shows that all categories that are being analyzed, and due to their large number, the mean value is being taken, in order to constitute a representative indicator.

The indicators are divided into internal and external factors, whereby the internal are being constituted by specific qualities and values that the tourist sites have. External factors are those that greatly affect tourist flows that are directed to geosites and determine their position in the tourism market (Čomi, 2002).

Table 5 shows the evaluation of the value of selected loess profiles in Vojvodina, where it was concluded that external factors were evaluated better than internal, and that the loess profiles received the highest marks because of their proximity to the emissive centre, elements of urbanization and infrastructure. Lower grades were given to the loess profiles based on inherent characteristics and peculiarities.

Table 5: Estimated value of selected loess profile

Category	GL_1	GL_2	GL_3	SUM
INTERNAL FACTORS				
Urbanization	2	2	2	2
Infrastructure				
Urban	1	2	2	1.67
Transport	1/2	1/2	1/1	1.33
Inherent characteristics				
Condition	2	2	2	2
Representativeness	1	1	1	1
Rarity	1	2	2	1.67
Paleographic value	1	1	1	1
Equipment and Services				
Quality	1	2	2	1.67
Quantity	2	2	2	2
The offer /demand	2	2	2	2
EXTERNAL FACTORS				
Accessibility	1	1	2	133
The proximity of the emitting centres	2	1	2	1.67
Specificity				
Ecological value	1	3	1	1.67
Aesthetic value	1/1	1/1	1/2	1.17
Educational value	1	1	1	1
Potential economic value	1	2	1	1.33
OVERALL SIGNIFICANCE	1.33	1.61	1.56	

Source: Jovanović and Zvizdić, 2009

As it can be seen from the table, the loess profile Čot received the highest marks, while the loess profile Batajnica got the lowest. If we take a look at the categories, representativeness and paleogeographic and educational value are best assessed, and the worst is the quality of tourism services on the sites, from which it is possible to conclude that the profiles possess exceptional tourism potential, and it is necessary to take advantage of improving the quality of infrastructure.

When compared to all the other models, this model presented some highlights because it is tailored specifically for loess profiles, while others are generally universal and may have wider application. This, of course, does not mean that the model of estimated value of the loess profile, with certain modifications, could not find its use in the evaluation of other objects of geological heritage.

Discussion - quaternary deposits evaluation

The purpose of the evaluation model of geological heritage sites is to reduce the subjectivity of factors that influence the results, which would be gotten by the descriptive method. Models are being presented in numerical evaluation of certain indicators. Ranking of the models of evaluation does not exist, given that some models prove to be extremely useful in certain situations, while others can be quite useless. Depending on the purpose of the research, the appropriate method is being selected. However, there are methods that are more detailed than the others, and they may prove amenable to the study in most situations.

Methods used in the analysis are based on several different criteria. Most methods of evaluation of sites of geological heritage are divided into scientific and added value. Scientific values usually include uniqueness, completeness and representativeness, and additional values are generally associated with environmental, educational and cultural significance (Table 6).

Table 6: The criteria most frequently used in the analyzed methods

Criteria	Method 1	Method 2	Method 3	Method 4	Method 5
Scientific value	x	x	x	x	x
Education		x		x	x
Uniqueness	x	x	x	x	
Completeness		x	x		
Representativeness		x	x	x	x
Interpretation	x	x		x	
Aesthetic values	x		x	x	x
Surroundings				x	
Protection		x	x	x	x
Level of degradation					
Vulnerability				x	
Economic value		x	x		x
Touristic value	x			x	
Urbanisation		x		x	x
Infrastructure	x	x		x	x
Quantity			x		x
Archaeological value			x		x
Promotion	x				

However, the scientific importance is in the centre of each evaluation model. All the methods, as can be seen from the tables above, show similar results, although many criteria are rather left to subjective assessment. Although the quantitative analysis has been established, subjectivity is an element that cannot be rejected, given that the assessment of the significance of individual elements depends directly from the perception of assessors. This is particularly evident in the evaluation of aesthetic components in most of the models. Therefore, further evaluation of the value is based on the contact with the same site, so the values that are obtained are less accurate.

Loess profile Čot in Stari Slankamen (Fig. 3) was ranked in the category of natural resources of Serbia in 2007. Further activities in the direction of categorization of natural resource, physical protection of sites from degrading factors, regulation or any use for the purposes of tourism has not been conducted. Revealing the secrets of the ice age, the loess profiles of this interesting Srem village are not important only to the scientists, but with using modern ways of presentation they could become attractive to many tourists of special interests. An attractive thematic museum ,,Loessland" is planned to be built here in the future.

In terms of scientific values, which are largely the same for all models, Čot received the most values, which means that in terms of representativeness, uniqueness, integrity, as well as scientific and educational value, this is the top-ranked loess profile. The uniqueness of this profile is reflected in the fact that it is one of only three lower Pleistocene profiles in the world and that at a depth of about 36m is the Paleomagnetic border, which has been discovered only in this profile in the region. Consequently, its large scientific and educational importance is evident, because it represents a unique example for studying and displaying to a wider audience.

When the aesthetic component model is being analysed, it is known that almost all the models include this component, and that it is largely the result of subjective perceptions. Loess profile Čot can certainly impresses every visitor with its magnificence, so the values that this profile received are the highest.

The next component which appears in all models is the environmental impact or the current situation and the existence of adequate protection of the site. In this category, Čot got the highest marks in relation to the other two sites that were evaluated, considering that it is the only loess profile (which is subject to evaluation), which is protected by the state. Since 2007 it has been declared a Natural Monument in the Republic of Serbia, which reduced the certain activities that could lead to its degradation to a minimum.

Another large group of value indicators of geological heritage sites are additional values, which are mainly related to tourism infrastructure, as well as the additional values that support the development of a destination. Loess profile Čot, in addition to its core values, can complement the

tourist offer and other attractions nearby, together with another loess profile in Surduk between Novi and Stari Slankamen, and then the Danube and the Tisza Rivers, Slanača mineral source, Belegiš islands, Zagrada fishing village, as well as the remains of a Roman settlement Acumincum (Accumincum). The number of additional tourist attractions certainly increases the value of the geosite, and extends the length of stay of tourists in the city.

Tourist infra- and supra- structure stand out among other additional values that are exposed to the evaluation process. Generally, in all models, the geosites received significantly worse scores in the terms of equipment of tourism infrastructure, than when it comes to scientific values. This means that the Republic of Serbia, and even local government, still has not recognized the importance of these sites, although there were indications that this could change soon. The Tourist Organization of Indjija, on the initiative of prof. Slobodan Markovic launched the project ,,Loessland" in 2008, for the purpose of tourism promotion of loess profile Čot. This project envisages the construction of a museum next to the loess profile, as well as the opening of a large number of accommodation and catering facilities, the construction of marine access for tourists that would come to Stari Slankamen via Danube, as well as the opening of a tourist information centre. It also envisages the establishment of cooperation with local travel agencies, which would include this site in their offer, as a first step towards the development of geotourism in Serbia.

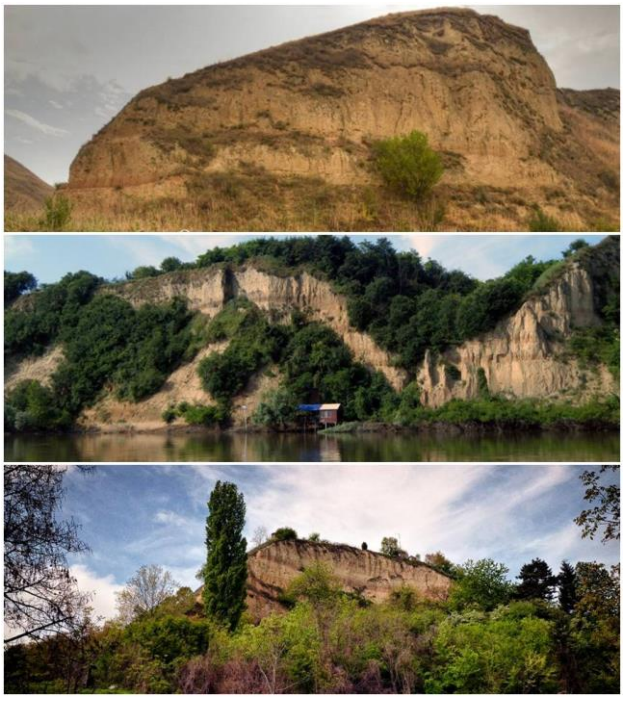

Photo: Jovanovic M.

Fig. 3: Loess profiles (from the top to the bottom) Feudvar, Batajnica – Danube and Cot

However, in the comparison, when it comes to added value, loess profile Čot got the highest marks in relation to the other two geosites, although these values are far from high, speaking in general. Following the chart of GAM models, it is clear that, in the future, more funds need to be invested in infrastructure and promotion of geosites.

All models, except the first one, take the economic value of geosites into account, which represents the amount of the financial resources generated from the visits to the geosites. To date, none of the analyzed loess profiles charges tickets for visitors (there are only few visitors, or no visitors at all). Some models, such as the last one (model which assesses the value of the loess profiles), estimates the economic value on the assumption that the loess profiles are found within the loess geopark, of whose proclamation of some intensive talks have been led over the last years.

If we look at the overall importance of loess profile, we get to the unambiguous conclusion that in all five models, this loess profile is the best ranked, and that it should definitely be the first facility of its kind when it comes to the investment in the geological heritage.

Loess profile Batajnica is located 15 km northwest of Belgrade, on the right bank of the Danube and is recognized as one of the most complete records of paleoclimatic opportunity for the Middle and Upper Pleistocene. Its loess -paleosol sequences are over 40m high with paleolands in which they recorded paleoclimatic and paleoecological changes over the past 620,000 years. Two horizons of tuffits have been identified in this profile, which emphasizes its chrono-stratigraphic importance (Markovi et al., 2009).

At the site of **Batajnica - Danube** (Fig. 3) contemporary geomorphic processes such as leaching, landslides and vertical tear are highly expressed and most intense in late winter and early spring, due to the absence of vegetation. The scientific significance of loess profile Batajnica is reduced when compared to the loess profile Čot, and according to some sub-criteria, in relation to the profile Feudvar on Titel Hill as well. The reason for this certainty lies in the fact that, although it is one of the most complete middle Pleistocene loess profiles in Vojvodina, in many ways it cannot be considered as a unique phenomenon. This loess profile cannot be proud of high grades in terms of representativeness as well. What makes this loess profile stand out is the ability to follow through the direct leaching processes and landslides, and therefore its value is being increased.

When it comes to the protection of this natural resource, for now it all ends on a proposal of protection of loess profile Kapela, while the loess profile Danube still stays without the protection

proposals. It can be expected that a decision on protection of this loess profile will be made in the future, which will prevent future anthropogenic degradation in a certain way. Aesthetically speaking, the loess profiles are integrated into the surrounding environment, and for these sub- indicators it definitely got the highest grades.

In terms of added value, the situation is very bad, as is the case with other analyzed loess profiles. Loess profile Batajnica is the worst ranked by almost all criteria, and in almost all models of evaluation. If we consider the additional tourism values, only the Danube River is in the vicinity of the geosite, and the accessibility of the profile itself is almost impossible. In terms of tourism infrastructure, nothing has been built so far, so it cannot be spoken about the economic value of the loess profile.

The difference between loess profile Batajnica and loess profile Feudvar resulting in additional values is one that relates to roads and emissive areas. Specifically, the E-75 international road passes near the loess profile, while the loess profile Feudvar has an unfavourable position, since it is in the immediate vicinity of the local roads, rarely of regional importance.

In the general ranking, loess profile Batajnica received higher scores compared to loess profile Feudvar in two models (according to the Ribar and the detailed GAM model), while according to the other three models it was in the last place. Given that there are not very big differences between localities Batajnica and Feudvar, positive results can be achieved both of the loess profiles with successful management.

Loess profile Feudvar (Fig. 3) is about 3km away from the village Mošorin. The fossil record indicates that the loess is packed in the middle of the wading environment (Jovanovi, 2012). The presence of the layer of tuffits represents a unique phenomenon in the Republic of Serbia and represents an extremely important geochronological marker for paleogeographic reconstruction of Titel loess plateau, as well as the correlation with loess localities in the Pannonian basin (Horvath, 2001).

At the top of the section are the remains of settlements from the Bronze Age, which highlights the importance of loess profiles for the development of human society (Jovanovic & Zvizdić, 2009).

The scientific value of loess profile Feudvar is certainly high, considering that this profile is one of the most representative loess profiles of Titel loess plateau. As layer of tuffits can be found only on this profile, its value is certainly high. Therefore, the scientific value of loess profile Feudvar should get higher scores in all models in relation to the loess profile Batajnica. However, despite the representation and uniqueness, loess profile could not surpass the loess profile Čot.

Aesthetic and ecological values are not at a high level, because the loess profile is not regulated. The whole area of Titel hill is under the tate protection as a Special nature reserve, although the progress in the prohibition of certain acts in a protected natural area is not regulated, which certainly affects the aesthetic component, as well as the ecological value of loess profile. In addition to anthropogenic pollution, to the construction of embankments on the Tisza river, loess profile has been subject to direct erosion of the river.

When the additional values are being analyzed, the situation is considerably worse than with the previous two sites. In terms of additional tourist values, regardless of whether they are natural or cultural, the loess profile can boast with several lens profiles, archaeological sites and the Tisa river, which has contributed to the overall placement under the state protection.

Access to the site is almost completely disabled and tourist infrastructure consists of information signs that suggest that the site is under the state protection. Even though there is a guardian of this natural resource, little funds are being invested in the promotion of tourism. Management does not seem to recognize that the SRP "Titel hill" has the ability to achieve great economic benefit if it has the proper way of use.

The declaration of Titel hill geopark will happen in the near future, the sites will be used for tourism purposes, although currently, the chances for that are very small.

The final assessment of the site shows a remarkable tourist potential, and a very bad current position in the tourism market.

If the results of the evaluation of loess profiles in Serbia were compared with the results of the evaluation of loess profile in China, no significant difference would be noticed, except for the scientific value and the degree of protection of geosites they require. Loess profiles of China are already known to the wider public and have the outstanding scientific value (they enable the reconstruction of climatic conditions in the past more than 2 million years ago), aesthetic value (impressive creations of nature, different geomorphological forms), educational value and protection (geoconservation) they have extremely high marks in all models of evaluation, given that there is no criterion in which Serbia loess profiles could compete with the Chinese loess.

Conclusions

It is obvious that the purpose of evaluation model of geosites is to help in the process of planning and directing funds into profitable geosites.

However, such models can help in the decision-making process of choosing the destination by tourists. Models of evaluation of sites of geological heritage can assure that the tourists get acquainted with the characteristics of each individual site, where they are offered the possibility of comparison of the sites according to the required characteristics. This way, tourists get help in the decision-making process on the selection of sites they want to visit, because the quantitative indicators are being used to show the detailed characteristics of each locality, and since the qualitative description, the site is no longer sufficient, this method certainly has the potential to live on the tourism market.

The detachment of scientific value from the additional elements show that some simple diagrams can indicate the geosites to the potential tourists, and to enable them to choose the destination they will visit according to their needs and desires. For example, if potential tourists want to visit a particular geosite in order to deepen their knowledge, the graph will look for the best ranked sites according to the geo-scientific values. Conversely, if tourists want to enjoy the natural and cultural values, it will seek for those sites that received the highest scores in terms of complementary tourist values and cultural significance. Also, if accommodation and meals represent an essential component of vacation for some tourists, it will provide them with the opportunity to compare sites (destinations), and choose according to this criterion.

If the results are displayed graphically, thus the orientation of tourists is greatly facilitated, but of tourism workers as well. Most importantly, comparisons that were made are not only the result of subjective opinion of a few tourists, but experts in the field of geotourism, which is certainly more representative and more valid.

It is obvious that not all the values of geological diversity can be used for the purpose of geotourism, mainly the objects of geological heritage of certain values are being exploited (according to various criteria). To select objects of geological heritage it is necessary to make an inventory and evaluation of these facilities as potential geosites. The co-existence of different types of geological heritage and the definition of different terms for more or less the same concept does not facilitate the development of assessment methods.

To confirm the validity of the proposed methods of evaluation of the sites, their application to selected loess profile in Vojvodina has been executed. Almost all the methods showed identical results in the assessment of tourist interest of the three loess profiles. The aim of this paper was to compare selected assessment methods of geosites. Different quantitative methods were selected due to fact that it is possible to compare different criterion on which the models are based.

The results show that using different assessment methods on selected loess profiles gives different results and geosite rankings. Based on this fact, further research in the field of geosite assessment is needed for geotourism planning and management as discussed in this paper.

The results show that all the models have certain values and faults that could be used to measure the component that the management needs. Most of the models (including those not analyzed in this paper) are based on several criteria, and therefore there are no significant differences between geosite evaluation models. However, having in mind that every geosite is different, it is necessary to personalize evaluation models, at least by the type of geosite in order to make a proper insight in the advantages certain geosites have. In the future, evaluation models should be modified to meet these requests. This means that if a certain geosite has high main criteria values, such as representativeness, scientific value, aesthetic, if it is about sensible geological features, such as loess, they could be easily degraded (erosion, illegal construction etc). That is why it is necessary to create the proper mean for geotourism development.

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