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Đurđa Miljković*, Sanja Božić, Ljupče Miljković, Slobodan B. Marković, Tin Lukić, Mlađen Jovanović, Dajana Bjelajac, Đorđije A. Vasiljević, Miroslav D. Vujičić, and Branko Ristanović

Geosite Assessment Using Three Different Methods; a Comparative Study of the Krupaja and the Žagubica Springs – Hydrological Heritage of Serbia

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Abstract: Hydrological heritage is a relatively new concept in the field of geosite assessment. The principal aim of this study is to apply M-GAM (Modified geosite assessment model) for comparative analysis of the Krupaja spring and the Žagubica (Mlava) spring, located in Homolje area, in Eastern Serbia. According to the classification of geosites of Institute for Nature Conservation of Serbia, these sites are on the list of protected sites ("hydro(geo)logical" heritage sites) of extraordinary national importance; however, they still have not gained necessary recognition in Serbia. Thus, their assessment according to different target groups should provide a clearer picture of their current condition. As M-GAM considers that not all indicators for evaluation of geosites are of the same importance, this paper applies two methods for comparing and determining the importance of indicators and subindicators in the model (Analytical-hierarchy process (AHP) and descriptive statistics conducted by SPSS). Also, it is assumed that different target groups will give different importance to some indicators in the model, which would result in various evaluation scores for the same geosites. The paper also provides a comparative analysis of the assessment carried out by two different target groups – potential geotourists and geoexperts. The results obtained by AHP and descriptive statistics are quite similar, which confirms the reliability of respondents' answers and the results gained. The analyzed sites are differently positioned in the evaluation matrix, and implications are further discussed in the paper.

Keywords: Hydrological heritage, Geotourism, M-GAM, Analytical-hierarchy process, Descriptive statistics, the Krupaja spring, the Žagubica spring

1 Introduction

Geoheritage is a relatively contemporary concept in nature conservation although it has roots far back in history [1], derived from the concept of nature protection. Therefore, it is not surprising that there is a need for contribution in various segments - theory, methodology, but also direct protection (geoconservation) and promotion of geosites (geotourism). So far, many authors have defined the term and the concept of geoheritage. The first time it was distinguished from geodiversity was at the Malvern International Conference in 1993 [2]. According to McBriar [3], geoheritage encompasses the diversity of minerals, rocks and fossils, landforms and other geomorphological fea-

***Corresponding Author: Đurđa Miljković:** Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia, E-mail: djurdja.miljkovic@dgt.uns.ac.rs
Sanja Božić, Ljupče Miljković, Mlađen Jovanović, Dajana Bjelajac, Đorđije A. Vasiljević, Miroslav D. Vujičić, Branko Ristanović: Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia
Slobodan B. Marković: Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia
and South Ural State University (National Research University), Prospekt Lenina, 76, 454080 Chelyabinsk, Russia
Tin Lukić: Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia
and University of Belgrade, Faculty of Geography, Studentski Trg 3/3, 11000 Belgrade, Serbia

tures that illustrate the effects of present and past effects of climate and Earth forces. Also, Geological World Heritage in Global Framework (2005) [4] uses the definition by Dixon [5, p. 3], in which geoheritage is defined as "those components of natural geodiversity of significant value to humans, including scientific research, education, aesthetics and inspiration, cultural development, and a sense of place experienced by communities". Moreover, geoheritage is considered to be the concept that comprises existing cases of geodiversity, identified as having conservation significance [6]. Specifically for Serbia, the objects of heritage include all geological, geomorphological, hydrological, pedological that were formed in the process of formation of the Earth's crust and its morphological shaping as well as special archaeological values [7, 8].

Besides being important for the scientific community, geoheritage has potential to be promoted and interpreted to the general public [9]. This phenomenon is defined as geotourism, initially pointed out by T. Hose [10]: "The provision of interpretive and service facilities to enable tourists to acquire knowledge and understanding of the geology and geomorphology of a site (including its contribution to the development of the Earth sciences) beyond the level of mere aesthetic appreciation" [10, p. 17]. According to T. Hose [11] geotourism should ensure geoheritage conservation for future use by academics, tourists and casual recreationalists.

1.1 Overview of hydrological heritage and its protection in Serbia

Hydrological heritage, a segment of geoheritage, has not been sufficiently recognized in Serbia. There is no Inventory of hydrological heritage of Serbia and official hydrological research group, as a part of Serbian National Council for Geoheritage, which would be responsible for its creation. However, several authors in Serbia focused on the definition, concepts, problems, protection, and perspectives of hydrological heritage [12–18]. Simić [15] has defined hydrological heritage as a segment of the hydrological diversity of an area, which among the abundance of other water phenomena and sites stands out with its value, which can be reflected in the environmental, resource, scientific, educational, sociocultural and aesthetic terms. The Inventory of Serbian geoheritage sites includes approximately 650 sites [19]. The Institute for Nature Conservation of Serbia has so far protected around 80 geoheritage sites [7]. Among these, 12 are hydrogeological sites, including the Krupaja and the Žagubica springs. According to the classification of geosites of Institute for Nature Conservation of Serbia, these sites are on the list of protected sites ("hydro(geo)logical" heritage sites) of extraordinary national importance; however, none of them have gained necessary recognition in Serbia.

The group of hydrological heritage sites is not in the official classification of geoheritage, which is recommended by the ProGEO (European Association for the Conservation of the Geological Heritage), but it can be found within "related" geomorphologic group [16]. ProGEO was the first international body of geoconservation founded in 1993, and its regional and national groups contribute to the geosites project which establishes frameworks for a selection of geoconservation sites of international importance. According to ProGEO, Inventory of geoheritage sites of South-East Europe (which includes Serbia) was based on criteria provided by Wimbledon [20], who classified geoheritage sites into 9 main groups: historical-geological and stratigraphic, structural sites, petrologic sites, geomorphological sites, neo-tectonic activities sites, speleological sites, hydrogeological sites, pedologic sites and archeological geoheritage sites. Some other authors classify individual hydrological sites into geological or geomorphological (such as springs, waterfalls, etc.). For instance, Plyusnina *et al.* [21] classified hydrological phenomena under geological heritage types (Geological heritage of the Bahariya and Farafra oases), based on the classification by Ruban [22] and Ruban and Kuo [23], who distinguished 21 types of geosites (i.e. stratigraphical, paleontological, mineralogical, geochemical, geothermal, hydrological and hydrogeological etc.).

In Serbia, Gavrilović *et al.* [13], identified and presented a preliminary list of 247 objects of the hydrological heritage of Serbia, and recommend that there are much more. In the current study, the authors use the classification provided by Simić *et al.* [17], who presented a modified classification of the hydrological heritage of Serbia and consider it a necessary starting point in the separation of water specificities. This classification includes springs (normal and karst springs, intermittent (rhythmic) springs, geothermal hot springs and those with specific socio-cultural values), rivers, lakes, ponds and oxbow lakes. Moreover, Mijović *et al.* [14] made an inventory of the hydrogeological heritage of Serbia within geotectonic units of the first order (springs, mineral waters, geothermal hot water, submerged springs and hydrogeological objects of historical significance), and identified the total of 212 geosites, in which the Žagubica and the Krupaja springs are not included.

In terms of research done in Serbia, regarding this topic, only a few papers have studied water phenomena, in the context of geoheritage. For example, Belij [24] discuss the protection of the Sopotnica waterfalls as the geomorphological-hydrological monument of nature. Ilić [8] wrote about the protection and prospects of the geoheritage of North-Eastern Serbia, distinguishing the Žagubica spring, the Krupaja spring, and the Homolje intermittent (rhythmic) spring within hydrological heritage. Antić and Tomić [25] analyzed the geotourism potential of the Homolje region and presented the results of the SWOT and TOWS analyses, included the Krupaja and the Žagubica springs. Petrović *et al.* [26] presented a case study comparing values of two internationally significant wetland areas: Obedska Bara in Serbia and Lonjsko Polje in Croatia. Valjarević *et al.* [27] have evaluated the Lukovska Spa, using spatial modelling based on indices of the attractiveness of geographical and touristic attributes to determine the attractiveness of it, in terms of tourism. Regarding international case studies of hydrological phenomena, Pralong [28] applied his method on hydrographic sites (Finges and Diosaz gorges), and was first to present and develop the assessment of tourist value. Erhartič [29] compared four assessment methods in assessing 15 similar geomorphological and hydrological features. He concludes that adequacy of assessment method depends on the research aims. For instance, he claims that "for the needs of nature protection, greater emphasis should be put on scientific and management aspects, with additional emphasis on the social component or the cultural value" [29, p.308].

In the last two decades, numerous methods have been developed to evaluate geoheritage objects. Some evaluation methods focus only on the scientific values [30–33], while other methods also introduce additional values [34,28,35-39]. Different criteria were used within scientific values, such as rareness and representativeness [31, 33, 36–40], palaeogeographic criteria [31, 37], protection [31–33, 36–40] etc. Additional values were included by many authors with various criteria such as cultural [28, 34, 36, 37, 41, 42], aesthetic [37-40], ecological [36, 37], educational [36, 37, 40] and economic or potential use value [28, 36, 37, 43], functional [38, 39], and touristic values [28, 38–40].

In the context of hydrological sites, specific hydrological evaluation models have not been developed so far. There is only a universal theoretical model for identifying hydrological heritage sites [44], that represents a good basis for the application of other specific methods. In the absence of specific hydrological evaluation model, the authors applied Modified Geosite Assessment Model (M-GAM) for evaluation of the selected hydrological sites. This model is applied because it represents a comprehensive model consisting of both Scientific and Additional values (including the majority of value categories found in previously analyzed evaluation models). Moreover, it is the only assessment model that introduces the Importance factor (Im), which enabled us to compare the importance of subindicators perceived by different target groups. It is also important to note that assessment should not only involve classification of sites, but offer suggestions for their protection, promotion, and monitoring [36].

The principal aim of this study is to apply three different methods for the comparative analysis of the Krupaja spring and the Žagubica spring. As M-GAM (Modified Geosite Assessment Model) considers that not all indicators for evaluation of geosites are of the same importance, this paper applies two methods for comparing and determining the importance of indicators and subindicators in the model (Analytical-hierarchy process (AHP) and descriptive statistics (mean value calculation) done in SPSS (Statistical Software for Social Sciences)). Also, it is assumed that different target groups will give different importance to some indicators in the model, which would result in various evaluation scores for the same geosites. The paper also provides a comparative analysis of the assessment done by two different target groups – potential geotourists and geoexperts.

2 Study area

The investigated sites are situated in Homolje region, one of the most outstanding geomorphological areas of Eastern Serbia, surrounded by the Beljanica Mountain on the south, the Homolje Mountains on the north, the Crni Vrh Mountain on the east and the Gornjak Mt. on the west (Figure 1). According to the Spatial plan of the Republic of Serbia (2010-2014) [45], Homolje represents an area of protected natural values with specific geodiversity and biodiversity of national importance.

The Krupaja spring (GS_1) is located below the western limestone section of the Beljanica Mountain, at an altitude of 220 m. It is placed in the southeastern part of Krepoljin-Krupaja valley, 10.5 km southern from Krepoljin, the nearest large settlement. The Krupaja spring is fed by atmospheric waters, mostly rainwater and snowmelt which infiltrates into the subsurface of the western part of the Beljanica Mt. There are no permanent or periodic streams in the collection area of the Krupaja spring, which water flows would be directed to the spring [46]. The basis of the geological structure of the Beljanica Mt. is made up of the crystalline schists of Paleozoic age. Limestones of the Middle and Upper Jurassic lie over them, while the

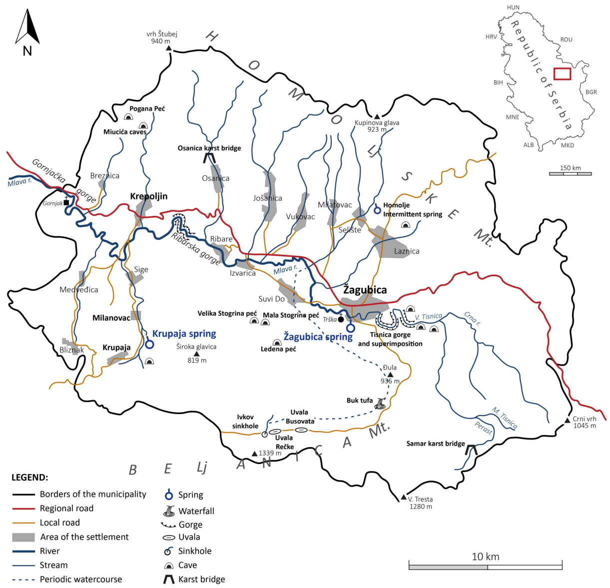

Figure 1: The position of the Krupaja and the Žagubica springs in the Homolje region (Eastern Serbia) with the main karst geoheritage sites.

limestones of Cretaceous age represent the final stratum of this geological structure. The Krupaja spring (Figure 3a) is on the fault line along which the Permian sandstones and conglomerates coated over the Lower Cretaceous limestone [46, 47].

The Krupaja spring is protected in the area of 9 hectares. It stands as the true representative of the hydrological heritage of Homolje, but also of Serbia, which led to its protection in 1979 as a hydrological natural monument of II category. This category assumes limited and strictly controlled use of natural resources, while activities in the area can be carried out to an extent that enables improvement of the state and presentation of the natural monument without consequences for its primary value. This also means that this protection category allows the building of tourist facilities, catering, nautical tourism, tourist infrastructure, and the construction of smaller facilities for the presentation of natural values or objects in a traditional style that are in accordance with the needs of cultural, rural and ecotourism [48]. The spring belongs to a siphon type. Until 1946, the spring seeped from the cave entrance in the form of river flow and lifting masonry dam (height 3 m, length 3 m and width 1 m) the spring has the appearance of a smaller lake which dimensions are 40 m longer axis and the shorter is 17 m (Figure 2a). According to the latest measurements, which were conducted in 2009 under the leadership of members of the "TRITON" diving club from Belgrade, the maximum depth of the Krupaja spring is 123 m, and it belongs to the deepest karst springs in Serbia [49] (Figure 3a).

Water transparency is the highest with small flow rates. Exceptional turbidity was on May 16, 2014, when the centennial maximum of 25 m^3/s was recorded. Based on this, this spring can be considered as one of the strongest karst springs in Serbia. Considering that the lowest discharge was only 125 l/s in 1974 [46], it follows that the Krupaja spring has a very high amplitude of discharge. The temperature of the water springs varies between 9 to 11 °C. Next to the leading path to the main entrance of the spring are fishponds (in Figure 2b situated on the left of the leading path). On the outflow of the spring, there is a water mill, which is still active (In Figure 2b, this construction is situated in front of the leading path). Approximately 40 m from the site, there is a thermal spring which temperature is around 26 °C, which fills a small outdoor swimming pool in the summer period. Next to the pool, there is a residential building with a restaurant and rooms for visitors (Figure 2d).

Scientific, educational, aesthetic, cultural and ecological values of this unique hydrological complex confirm its place on the National list of the geoheritage of Serbia [49]. Although not sufficiently exploited, the Krupaja spring has the immense economic potential for tourism development: preserved nature, a unique set of various natural attractions (caves, waterfalls, thermal spring), rural tourism (accommodations in ethnic style, organic food, activities such as mushroom hunting and harvesting medicinal plants), educational tourism (school excursions, forest school), sport tourism (hiking, cycling, sport fishing, cave diving), cultural tourism (various manifestation, art colony) [49]. Also, settlements close to the spring offer visitors a great opportunity for recreation. Within a radius of about 50 km away from the Krupaja spring, you can visit numerous sites, such as: Monastery Gornjak (18 km), Monastery Manasija (23 km), Osanica karst bridge (25 km), old Trška church (27 km), Resava cave (30 km), Waterfall Lisine (31 km), the Žagubica spring (32 km), Homolje intermittent spring (37 km), etc.

The Žagubica spring (GS_2) is located in the lower part of the northeastern side of the Beljanica Mountain, at an altitude of 314 m. It is situated in the southern part of Žagubica settlement, 1 km from its center. It was created in the period of complex geological, geomorphological, hydrological and climatic conditions of this part of the Homolje area. Its morphogenesis was in accordance with the morphological evolution of limestone terrain on the north side of the Beljanica Mt. and the Žagubica basin. The spring is located at the contact of Lower Cretaceous limestone and neogenic lake sediments [47].

Figure 2: Surroundings of the Krupaja spring: main cave entrance and lake of the Krupaja spring with waterfall over the dam (a), a fishpond (left from the path), water mill (in front of the path) and outflow of the spring (right from the path) (b), an interpretative panel at the entrance of protective springs' area (c), pool filled with thermal water and a residential building for visitors (next to the pool) (d).

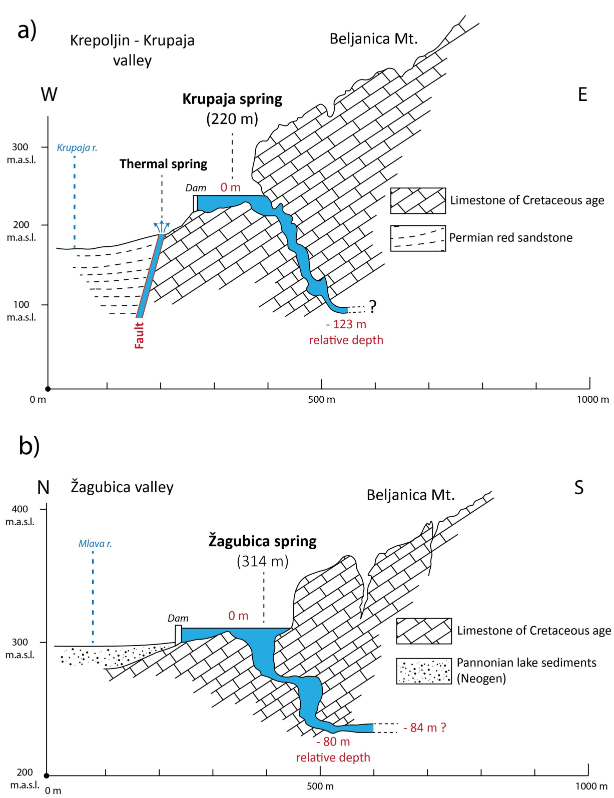

Figure 3: Cross-section of the investigated springs: **a)** the Krupaja spring and **b)** the Žagubica spring.

More than 4 hectares of the Žagubica spring area was protected as a valuable "Hydrological Natural Monument" of the I category in 1979. In this category of protection, the use of natural resources is prohibited and excludes all

Figure 4: Surroundings of the Žagubica spring: submerged sinkhole of the Žagubica spring (a), wooden bridge over the outflow (spring is located left from the bridge) (b), interpretative panel located next to the submerged sinkhole of the spring (c), motel "Vrelo" located next to the outflow (d).

other forms of use of space and activity other than scientific research and controlled education [48]. This spring also belongs to a siphon type of springs. It resembles a smaller lake, but it is actually a submerged sinkhole with a diameter of 25 m in the northwest-southeast direction and 29 m in the east-west direction (Figure 4a). The entrance of the siphon canal is situated at the bottom of the lake. The last recorded depth of this canal is 72 m, performed by a Serbian diver in 1996, but the scientifical assumption is that this depth is even higher, thus requiring additional measurements [50] (Figure 3b).

The discharge of the spring depends on the amount of precipitation that is precipitated on the surface. In 1910, the highest discharge of 70 m^3/s was recorded. The lowest flow rate was recorded on August 1, 1950, when it was 0.25 m^3/s, but in the measurements of the hundred years of observation, the appearance of complete drought was recorded 1893, 1957 and 1971 [51]. Well known Serbian geographer, Jovan Cvijić (1865-1927) in 1893 was the first academic to report this phenomenon, and he wrote: "water in the lake (as he called the spring because of its appearance) fell so low that his diameter was reduced" [52, p.51]. The disappearance of the water in the spring and drying of the outflow was due to the clogging of underground canals' narrow parts. Outflow from the lake flows around 100 m, where it joins river Velika Tisnica and forming river Mlava, which explains why the Žagubica spring is also called the Mlava spring. The average temperature of the water is 10°C.

One of the main aesthetic values of the surroundings is a conifer, together with deciduous trees (poplars, birch, osier willows etc.), that surrounds the lake in the spring, giving it a dark green color. On the edge of the spring, there is a motel “Vrelo” with accommodation capacity of 70 people and a restaurant (Figure 4d). Although the motel has an ideal location, it lacks other accompanying facilities. The Žagubica spring has more developed tourism infrastructure in comparison to Krupaja. However, certain construction activities have damaged its wildness (the asphalt road around the spring, the parking lot, the rubbish dump), and the access to the lake by cars should be completely prohibited. The Žagubica spring region has high tourism potential of: surrounding landscape and nature, preserved nature, a set of various natural attractions in vicinity (caves, gorges, tufa on the rivers), ecotourism and rural tourism (accommodations in ethnic style, organic food, activities such as mushroom hunting and harvesting medicinal plants), educational tourism (school excursions, forest school), congress tourism, sport tourism (hiking, cycling, sport fishing, cave diving), cultural tourism (various traditional manifestation, art colonies, ethnic (folk) dance) etc [53]. Within a radius of about 50 km away from the Žagubica spring, you can visit numerous sites, such as: old Trška church (5 km), Homolje intermittent spring (15 km), Osanica karst bridge (20 km), ski-run Crni Vrh – Bor (27 km), Monastery Gornjak (29 km), the Krupaja spring (32 km), the Bor Lake (35 km), Samar karst bridge (37 km), Rajko’s Cave (44 km), The Lazar Canyon (48 km).

3 Methodology

3.1 Study sample and procedure

The total of 58 respondents participated in the research (41 potential geotourists – geography students, and 17 geoexperts). While geoexpert sample is not difficult to identify as these are people who professionally work within geosciences (universities, institutes), geotourists are quite hard to differentiate from regular tourists. This task is even more difficult as in Serbia geotourism does not exist as individual tourism segment and all geoheritage sites that have tourism traffic are mostly visited by school excursions, which could not be included in the research due to their age (under 18). Instead, we were led by Hose [54] who divided geosite visitors into two groups: dedicated users (students and specialists) and non-dedicated (non-specialists, casual recreationalists). Similarly, many other authors made divisions of geotourists according to their knowledge and interests e.g. [55–58]. As in Serbia it would be quite hard to find non-experts with interested in geosites i.e. geotourists, for the purpose of this study, we only targeted dedicated visitors to geosites: geoexperts and students of geography. Students of geography have a certain level of knowledge and awareness of geoheritage so we can identify them as potential geotourists (how they will be labeled in the further reading). Therefore, these two groups are recognized as true geotourists with certain knowledge and awareness related to investigated hydrological sites.

The research was carried out from March until May 2016. Geoexperts were selected according to their field of expertise related to geology, geoheritage and geotourism. All geoexperts selected for the study have Ph.D. degree and were approached at Faculty of Sciences in Novi Sad, Faculty of Geography in Belgrade and Institute for Nature Protection in Novi Sad. Important criteria of geoexperts selection were that they have visited these natural curiosities or are very familiar with them. A semi-structured interview was conducted with each expert, while the researcher thoroughly explained the purpose of research and clarified each individual question. All interviewed geoexperts have Ph.D. in geosciences. From them, nine experts are specialized in the field of physical geography, three in tourism, two in geotourism, one in regional geography, one in social geography and one in geoecology. Their demographics are shown in Table 1.

Another target group were students of geography (41 students) who were interviewed after their field trip in May 2016. These students were selected to take part in the research as they have visited the Krupaja (GS_1) and the Žagubica springs (GS_2) as a part of the mentioned organized field trip. The dominant focus of their field trip was geomorphology, so they were familiar with genesis and importance of the visited sites. Considering that these students were in their third year of bachelor studies, they had some pre-knowledge about sites, which they have gained through physical geography lectures. This was of great importance for the objective assessment of indicators/subindicators and comparison of two selected sites.

Table 1: The socio-demographic profile of the respondents.

	Potential geotourists	Geoexperts	Total
Gender			
Male	54%	76%	60%
Female	46%	24%	40%
Average age	21.9	37.9	29.9
Age range	21-25	27-66	

From Table 1 we can see that in both target groups the male respondents are dominant. The table also shows the average age and age range for both target groups. For students, the highest level of completed education is a secondary school (90%), followed by the college (10%), while all geoexperts have Ph.D. degree.

3.2 Questionnaire design

Two different questionnaires were designed and used to evaluate two sites of the hydrological geoheritage - the Krupaja and the Žagubica spring as well as to assess the importance of subindicators in the GAM model. Before conducting the research, the pilot survey has been done with five people employed at Faculty of Sciences and five students of the same faculty who have filled out the survey and provided a feedback on clarity and preciseness of defined questions.

The first questionnaire was designed for geoexperts ("Questionnaire 1" in Appendix 1) and their evaluation of the mentioned sites according to the methodology of M-GAM. The first part of Questionnaire 1 measured the socio-demographic variables (gender, age, the field of scientific research). The second part of Questionnaire 1 was related to the assessment of the importance of indicators and subindicators in the GAM model. Geoexperts were asked to estimate, on the 5- point Likert scale (0.00, 0.25, 0.50, 0.75 and 1.00, where 0 is not important at all and 1 - very important), how each of the 27 subindicators (from the original GAM) is important in the evaluation of geosites in general. The third part of the questionnaire also referred to the evaluation of the importance of each subindicators, but in this case by applying AHP method. The respondents were asked to compare all indicators / subindicators - each subindicator was compared to another one by using Saaty's scale (see Table 2). The fourth part of Questionnaire 1 was related to geosite evaluation according to GAM methodology. Geoexperts were asked to evaluate each subindicator of the Main and Additional Values for both Krupaja and Žagubica springs. Geoexperts evaluated all 27 subindicators on a scale of 0 to 1 (0.00, 0.25, 0.50, 0.75 and 1.00), which provided expert evaluation of the current state of these geosites. A table explaining the meaning of each score in the scales for evaluation of subindicators is provided in Appendix 3.

The second questionnaire was designed for potential geotourists – students of geography ("Questionnaire 2" in Appendix 2). The first part of Questionnaire 2 also referred to socio-demographic variables (gender, age and the highest level of completed education). The second and the third part of Questionnaire 2 were identical to that of Questionnaire 1. The fourth part of the Questionnaire 2 differed from that in Questionnaire 1, in the way that potential geotourists were asked only to evaluate subindicators of the Additional Values for both Krupaja and Žagubica springs. Students were not asked to evaluate the Main values for these two springs from two main reasons. The first is that students do not have enough expert knowledge to assess the majority of subindicators (such as the level of site investigation, level of interpretation, carrying capacity, etc.), so asking them to evaluate these would question the reliability of the judgments. The second reason lies in the fact that students belong to the group of potential geotourists whose needs and interests often require the existence of Additional values of geosites, and the quality of these often influence their final decision whether to visit a certain geosite or not [59]. This is why they were considered relevant to evaluate the current state of Additional values.

3.3 Geosite assessment – MGAM (Modified Geo Assessment Model)

The methodology implemented in this paper is based on M-GAM model (Modified Geo Assessment Model) developed by Tomić and Božić [39]. M-GAM is based on Geosite Assessment Model (GAM) created by Vujičić *et al.* [38] and consists of the same structure of indicators and subindicators: GAM consists of two key indicators: Main Values and Additional Values, which are further divided into 12 and 15 indicators respectively (Table 3 and 4), each individually marked from 0.00 to 1.00. In this model, Main values - are mostly generated by the geosite's natural characteristics; while Additional values are mostly human-induced and can be changed in order to adapt to visitors' needs. The Main Values (MV) comprise of three groups of indicators: Scientific/educational (VSE), Scenic/aesthetical (VSA) and Protection values (VPr). The Additional Values (AV) are divided into two groups of indicators, Functional (VFn) and Touristic values (VTr) [38]. On balance, 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:

$$AV + MV = GAM,$$

where MV and AV are signs for main values and the additional values, respectively. If we take into account the main groups of indicators of Main and Additional values, two equations are derived – one for the Main values, representing the sum of the three groups of indicators (Scientific/educational (VSE), Scenic/aesthetical (VSA) and Protection values (VPr)), and one for Additional values representing the sum of Functional (VFn) and Touristic values

(VTr):

$$MV = VSE + VSA + VPr \text{ (or} MV = \sum_{i=1}^{12} SIMVi),$$

$$\text{where } 0 \leq \text{ SIMV}^i \leq 1$$

$$AV = VFn + Vtr \text{ (or } AD = \textstyle\sum_{j=1}^{15} SIAVj))$$

$$\text{where } 0 \leq \text{ SIAV}^j \leq 1$$

Here, $SIMV^i$ and $SIAV^j$ present 12 subindicators (^{i} = 1... 12) for the Main Values and 15 subindicators (^{j} = 1...15) for Additional Values. 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.

The difference between GAM and M-GAM model is in the fact that M-GAM assumes that not all indicators and subindicators are of the same value when assessing certain geosite. Thus, it introduces Im (Importance factor):

$$Im = \frac{\sum_{k=1}^{k} IVK}{K}$$

where *IV* is the assessment/score of one visitor for each subindicator and K is the total number of visitors. To be precise, Im represents the mean value of importance given to each subindicator by all respondents. 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:

$$MGAM = Im(GAM) = Im(MV + AV)$$

This paper, besides applying the method used to determine the value of Im in M-GAM, which included descriptive statistics (each respondent was asked to rate the importance (Im) of each from the 27 subindicators (from 0.00 to 1.00) and then the mean values for each Im were counted), it also introduces the AHP (Analytical-hierarchy process) as a way of calculating Importance factor. The main idea was to compare the results of descriptive statistics and those obtained by AHP, in order to confirm the validity of the obtained results and analyze if there are larger differences in the Im scores obtained by two different methods.

3.4 Calculation of Importance factor (Im)

In order to calculate the Importance factor of indicators and subindicators in the GAM model, two methods were applied – AHP method and mean values calculation (descriptive statistics) done in SPSS. It is important to mention that mean values calculation (descriptive statistics) is a standard way of calculating Importance factor (Im) described in the M-GAM subsection. The AHP method was applied to subindicators' comparison in order to confirm the results obtained by descriptive statistics. As mean values are calculated based on the importance assessment respondents have done using a Likert scale, the AHP was implemented as a way of controlling the validity of this method, which is referred to have some disadvantages. One of these indicates that *Likert scales* assume an even metric between the various points. For instance, in this case when we have a 5-point Likert scale (0.00, 0.25, 0.50, 0.75 and 1.00, with 0 - meaning not important at all and 1 - meaning very important), respondents will assume that the metrics between all five pints are the same, which is difficult to confirm [60]. On the other hand, AHP is a more sophisticated method as it assumes a comparison between all subindicators in the model regarding their importance to respondent, thus providing us with the more precise subindicators' importance hierarchy. The study also assumes that application of two different methods will contribute to the research validity, especially in case the results obtained in the mentioned two ways are similar. The similar approach is already common in the research, where for instance, the study by [61] compared these two approaches of data collection and obtained the similar rank of the compared attributes and levels. However, the obtained weights from both approaches were not totally similar.

In this study, AHP method was applied in order to construct the hierarchy of importance of all indicators and subindicators in the GAM model, by determining their individual weights. The Analytic Hierarchy Process (AHP) is a Multi-Criteria Decision Making (MCDM) methodology used in many decision-making contexts [62]. Its advantage lies in the fact that, the subjectivities and biases given by individual responses can be factored into the model, enhancing the validity and reliability. In addition, this approach is beneficial in case the researcher is interested in assessing a large number of decision factors, measuring the importance of each factor influencing the decision, and engaging large groups of decision participants to optimize a decision [63]. By using AHP, experts and decision makers are only required to give verbal, qualitative statements regarding the relative importance of one criterion over another. For this reason, the AHP approach can be more accurate than other MCDM methods, which require respondents to express themselves in more complex ways. As AHP is applied for measuring the importance of each factor influencing the decision, it provides a hierarchy of factors according to their importance, which helps managers and other stakeholders to make decisions. This is why we have found it as appropriate for this study, where obtaining subindicators' importance hierarchy and its influence on the final site ranking is of especial importance.

AHP enables decision makers to compare the elements (in this case subindicators) in pairs. This means that all elements are compared to each other according to defined criteria (in this case their importance for geosite evaluation). In this way, each subindicator obtains its weight as a measure of the relative importance given to them by expert decision makers [64]. This means that not all elements have the same importance, but they have different weights. To calculate the weights of n elements, by the comparison of the two elements (A, B), the Saaty's scale [65] is used (Table 2).

Table 2: Saaty's scale for pairwise comparisons in AHP*

Judgment term	Numerical term
Absolute preference (element *A* over element *B*)	9
Very strong preference (*A* over *B*)	7
Strong preference (*A* over *B*)	5
Weak preference (*A* over *B*)	3
Indifference of *A* and *B*	1
Weak preference (*B* over *A*)	1/3
Strong preference (*B* over *A*)	1/5
Very strong preference (*B* over *A*)	1/7
Absolute preference (*B* over *A*)	1/9

**An intermediate numerical values 2,4,6,8 and 1/2,1/4,1/6,1/8 can be used as well*

The comparison is done in the following way: for instance, if alternative **A** (Scientific Value) has absolute dominance (is absolutely more important) compared to alternative **B** (Scenic/Aesthetic) 9 is selected, but if **B** (Scenic/Aesthetic) for instance has the strong dominance (in terms of its importance to respondent) compared to **A** (Scientific Value), 1/5 is selected. In case **A** (Scientific Value) and **B** (Scenic/Aesthetic) are of the same importance to respondents, they mark 1 (see the questionnaire in Appendix 1, 2). The answers are then inserted into Expert Choice software and subindicator weights are calculated.

This method also enables the establishment of the consistency of the decision-making process checking the reliability of the research. It also provides an opportunity to measure the errors in judgment by calculating the index of consistency for the obtained matrix of comparison, after which the ratio of the consistency itself can be measured. If the consistency ratio (CR) which is calculated by the software is less than 0.10, the result is sufficiently accurate and there is no need for adjustments in comparison or for repeating the calculation. If the ratio of consistency is greater than 0.10, the results should be re-analyzed to determine the reasons for inconsistencies, to remove them by partial repetition of the pairwise comparison, and if repeating the procedure in several steps do not lead to the reduction of the consistency to the tolerable limit of 0.10, and the whole procedure should be repeated from the beginning [64].

4 Results and Discussion

The purpose of this research was to assess two hydrological sites by different methods which are applied to the same sample. One of the methods is a comparative analysis of the assessment done by two different target groups. One of the important aims of the paper was to compare results of the geosite assessment done by two different segments of visitors: geoexperts and geotourists.

Thus, Importance of the indicators and subindicators in the model was determined by geoexperts and geotourists separately. This was informed by the study of Božić and Tomić [66] which confirmed that different target groups give different importance to certain geoassessment indicators, which results in different overall assessment.

Afterwards, in order to evaluate geosites, the value of the importance factor (Im) for obtained by each segment is multiplied by the value that was given by geoexperts (from 0.00 to 1.00) who evaluate the current state and value of subindicators. Thus, two different assessment scores were obtained by geoexperts and potential geotourists (indicators value for each geosite were multiplied by Importance given by geoexperts, and Importance given by potential geotourists). Finally, the results of the assessment obtained in this way are shown on M-GAM matrix.

Moreover, besides the overall assessment done by geoexperts who have knowledge on both Main and Additional values, the assessment for the Additional values was also done by potential geotourists and compared with the assessment done by geoexperts. This is very important, as in this way, we obtain two different perspectives on Additional values and their current state. Here, it is expected that potential geotourists will give lower grades to the current state of Additional values, as they are supposed to be more important to them so they pay more attention to their performance (as proved in the study of Božić and Tomić [66]).

The differences between segments but also between two different methods for assessing the importance factor are discussed in the paper.

4.1 Calculation of the Im (Importance factor) value using AHP and descriptive statistics (mean values calculation)

In order to calculate the Importance factor of indicators and subindicators in the GAM model, two methods were applied – AHP method and descriptive statistics (mean values calculation) done in SPSS. Also, in this part, the differences of importance given to certain (sub)indicators by geoexperts and potential geotourists will also be discussed.

The overall results are shown in Table 3. When we analyze the importance of subindicators within Scientific value, the mean values indicate that geoexperts give more importance to all subindicators (compared to potential geotourists). Within Aesthetic value, Surrounding landscape and nature is the most important subindicator. Within Protection subindicators, for both groups, Current condition is the most important. Importance of Functional values is higher for potential geotourists than geoexperts, in all analyzed subindicators except Accessibility, which has the same importance for both groups. According to descriptive statistics, Interpretative panels and Promotion are of the highest importance for geoexperts, while for potential geotourists, besides Tourism infrastructure, the highest importance is given to Hostelry service and Tour guide service. Promotion and Interpretative panels are, however, not so important for potential geotourists compared to geoexperts, which was an unexpected finding. However, this can be explained by the fact that potential geotourists were mainly highly educated (bachelor students) who have visited these sites as a part of excursion (the promotion is not so important for them). Also, they were accompanied by their professors who provided some detailed explanations about these sites, making interpretative panels less interesting for them. Moreover, as pointed out by Hose and Vasiljević [67] areas of diverse geosite values, such as karst regions should adopt and implement comprehensive interpretative strategies that could lead to designation and improved level of protection. This may explain why Promotion and Interpretative panels are more important to geoexperts, as they relate it to education and geosite protection.

Analysis of the subindicators' hierarchy (Table 3), it can be noticed that the ranking of subindicators for Scientific values is the same for geoexperts and potential geotourists. Rarity is the most important factor within Scientific values for both groups, which is in accordance with the previous studies [39, 66]. Surrounding landscape and nature got the highest rank for both groups, while geoexperts gave more importance to Environmental fitting of sites comparing to potential geotourists. Significant differences could be seen in the rankings of Protection subindicators. While for geoexperts, Vulnerability and Current condition are the most important, for potential geotourists, the most important are the Protection level and Suitable number of visitors. In the hierarchy of Functional values, the results are very similar, both potential geotourists and geoexperts gave the highest ranks to Additional natural values. Some significant differences in ranking of potential geotourist subindicators are observed, the most important factor is Tourism infrastructure for both geoexperts and potential geotourists, but Hostelry service is not so important for geoexperts than for potential geotourists (Figure 5). Promotion and Interpretative panels are more important for geoexperts than for potential geotourists.

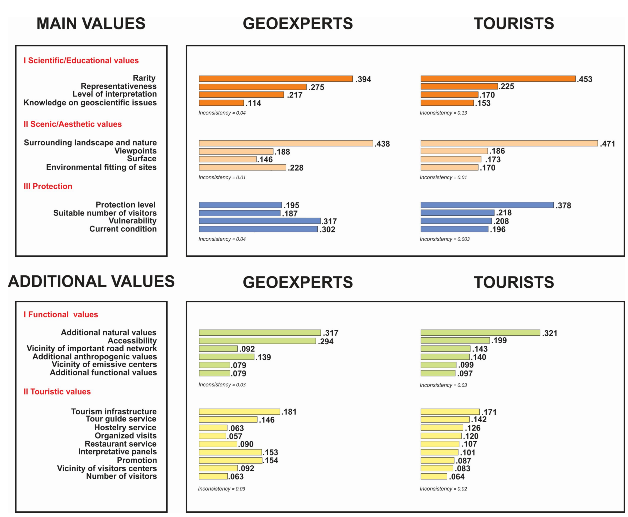

Figure 5: Hierarchy of subindicators' importance – comparison of geoexperts and potential geotourists.

When comparing the results obtained by these two models it can be seen that there are no larger differences, both gave almost the same weights indicating to the higher reliability in the respondents' answers.

Table 3: The results obtained by Analytical hierarchy process (AHP) and Mean Values calculation (descriptive statistics).

Indicators/subindicators	Geoexperts (criterion weights obtained by AHP)	Potential geotourists (criterion weights obtained by AHP)	Geoexperts (mean values)	Potential geotourists (mean values)
MAIN VALUES				
I Scientific/Educational values (VSE)				
1. Rarity	.394	.453	**0.85**	0.73
2. Representativeness	.275	.225	**0.81**	0.67
3. Knowledge on geo-scientific issues	.114	.153	**0.62**	0.61
4. Level of interpretation	.217	.170	**0.68**	0.65
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)	.188	.186	**0.74**	0.72
2. Surface (each considered in quantitative relation to other)	.146	.170	0.47	**0.54**
3. Surrounding landscape and nature	.428	.471	0.75	**0.87**
4. Environmental fitting of sites	.228	.173	0.65	0.72
III Protection (VPr)				
1. Current condition	.302	.208	**0.85**	0.75
2. Protection level	.195	.378	0.72	**0.74**
3. Vulnerability	.317	.196	**0.76**	0.68
4. Suitable number of visitors	.187	.218	**0.68**	0.63
ADDITIONAL VALUES				
I Functional values (VFn)				
1. Accessibility	.294	.199	0.68	**0.68**
2. Additional natural values	.317	.321	0.57	**0.69**
3. Additional anthropogenic values	.139	.140	0.43	**0.55**
4. Vicinity of emissive centres	.079	.099	0.37	**0.58**
5. Vicinity of important road network	.092	.143	0.49	**0.65**
6. Additional functional values	.080	.097	0.40	**0.68**
II Touristic values (VTr)				
1. Promotion	.154	.087	**0.65**	0.62
2. Annual number of organised visits	.057	.120	0.59	**0.62**
3. Vicinity of visitors centre	.092	.083	**0.63**	0.55
4.Interpretative panels (characteristics of text and graphics, material quality, size, fitting to surroundings, etc.)	.153	.101	**0.81**	0.65
4. Annual number of visitors	.063	.064	**0.32**	**0.48**
5. Tourism infrastructure (pedestrian pathways, resting places, garbage cans, toilets, wellsprings etc.)	.181	.171	0.69	**0.82**
6. Tour guide service (expertise level, knowledge of foreign language(s), interpretative skills, etc)	.146	.142	0.60	**0.65**
7. Hostelry service	.063	.126	0.51	**0.71**
8. Restaurant service	.090	.107	0.54	**0.63**

4.2 M-GAM results – comparative analysis of the Krupaja and the Žagubica springs

For the purpose of this study, two representative hydrological sites in Serbia were assessed by M-GAM method. In this part, we can see the final M-GAM results of these two springs and how differences in important factor given by geoexperts (Im_1) and potential geotourists (Im_2) affect the final ranking in M-GAM model (Table 4). Furthermore, we analyzed how different opinion regarding the importance of subindicators of two target groups can affect the position of geosites in the M-GAM matrix (Figure 6).

The results indicate that the Krupaja and the Žagubica spring have very similar Scientific/Educational value as well as Scenic/Aesthetic, due to the fact that both springs are of the same type (siphon type) and similar surrounding landscape and nature. The highest values for both springs within Scientific group are their Rarity and Representativeness which proves that these sites are a true representation of hydrological heritage, one of the strongest and deepest karst springs in Serbia, with high water quality. In terms of Scenic/Aesthetic values, the highest values were given to Environmental fitting of sites and Surrounding landscape and nature for the Krupaja spring (GS_{1a},GS_{1b}), which has an attractive position, imposing appearance and present ecological resource with the preserved area. Within Protection, the Žagubica spring (GS_{2a},GS_{2b}) has slightly higher values for Suitable number of visitors, because it can receive more tourists and has a better traffic approach. The Krupaja spring (GS_{1a},GS_{1b}) has a higher value for Current conditions, with nature untouched and protected species[1] of flora and fauna significant for the ecosystem of the area. Within Functional values, the Žagubica spring (GS_{2a},GS_{2b}) has the higher values in all subindicators except in case of Additional natural values, which is higher for the Krupaja spring (GS_{1a},GS_{1b}). Other Functional subindicators are higher for the Žagubica spring (GS_{2a},GS_{2b}), which are "accessible for buses", "the regional road is in its vicinity" and "has many anthropogenic values in its surrounding". For example, Museum is in the center of the settlement, the old Trška church is 5 km away, ski-run Crni Vrh – Bor is 27 km from the locality. In terms of Tourist values, the Žagubica spring (GS_{2a},GS_{2b}) has higher values for all nine subindicators, of which the Restaurant service has the highest scores for both, the Krupaja and the Žagubica springs. The tourist characteristics got the lowest scores of all indicators because these values are not so developed in this area yet.

The final results of the assessment in the overall ranking, the results of main and additional values for both springs are shown in Table 5. The results show that Žagubica spring (GS_{2a},GS_{2b}) has higher values, both in main and additional subindicators. The difference between geoexperts and potential geotourists is expressed through higher values of main subindicators for geoexperts (GS_{1a}, GS_{2a}) and higher values of additional subindicators for potential geotourists for the Žagubica spring (GS_{2b}).

Figure 6 shows the position of the hydrological sites based on the assessment done by geoexperts and potential geotourists (according to their Importance). In both assessments, by geoexperts and potential geotourists, the Krupaja spring ($GS_{1a,b}$) has lower position compared to the Žagubica spring ($GS_{2a,b}$). The overall grade puts the Žagubica spring ($GS_{2a,b}$) in the Z_{22} and the Krupaja spring ($GS_{1a,b}$) in the Z_{21} which is shown in the matrix. This indicates that further attention should be directed to tourism infrastructure and services. Also, we can see that from the potential geotourist point of view the Žagubica spring is better ranked geosite.

5 Conclusion

Given the relatively scarce number of studies focused on karst hydrogeological sites, the given study presents a modest contribution to the investigation of these geodiversity elements. Three different methods implemented in this study could improve further evaluation of the Main and Additional Values of the Krupaja and the Žagubica springs, hydrological phenomena of Eastern Serbia and South-Eastern Europe in general. The Importance factor (Im) values calculated by AHP and descriptive statistics are quite similar, which confirms the reliability of respondents' answers and the obtained results. In addition, the results of the assessment indicate that both target groups

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1 The protected species in the Krupaja spring area are: rustyback (*Ceterach officinarum*), algae (*Batrachospermum*), yellow-green algae (*Vaucheria*), species of macrozoobenthos (*Gammarus balcanicus* - an amphipod crustacean genus; *Ancylus fluviatilis* - very small, freshwater, air-breathing limpet; *Erpobdella octoculata* - a genus of leeches; *Dendrocoelum lacteum* – a flatworm; *Esolus angustatus* - an insect), species of fishes (*Salmo trutta* – the brown trout; *Phoxinus phoxinus* – the common minnow; *Leuciscus cephalus* - the chub; *Cottus gobio* - the bullhead; *Alburnoides bipunctatus* - the schneider), amphibians (*Rana ridibunda* - marsh frog; *Rana dalmatina* - agile frog; *Salamandra salamandra* - fire salamander), species of bird (*Parus caeruleus* – the Eurasian blue tit; *Garrulus glandarius* – the Eurasian jay; *Dendrocopos minor* - lesser spotted woodpecker), mammals (*Lepus europaeus* – the European hare; *Lutra lutra* - the Eurasian otter), butterflies (*Aglais io* - the peacock butterfly; *Melitaea athalia* - heath fritillary, Issoria lathonia - the Queen of Spain fritillary) [68].

Table 4: Values given by geoexperts and potential geotourists for each subindicator in the M-GAM model.

ain Indicators/subindicators	Values given by geoexperts (0-1)		Im1 geoexperts	Im2 potential geotourists	Total 1 geoexperts		Total 2 potential geotourists	
	GS_{1a}[1]	GS_{2a}[2]			GS_{1a}	GS_{2a}	GS_{1b}[3]	GS_{2b}[4]
I Scientific/Educational values (VSE)								
Rarity	0.68	0.59	0.85	0.73	0.58	0.50	0.50	0.43
Representativeness	0.84	0.81	0.81	0.67	0.68	0.66	0.56	0.54
Knowledge on geo-scientific issues	0.72	0.78	0.62	0.61	0.45	0.48	0.44	0.48
Level of interpretation	0.62	0.68	0.68	0.65	0.42	0.46	0.40	0.44
II Scenic/Aesthetic values (VSA)								
Viewpoints	0.04	0.1	0.74	0.72	0.03	0.07	0.03	0.07
Surface	0.51	0.54	0.47	0.54	0.24	0.25	0.28	0.29
Surrounding landscape and nature	0.79	0.74	0.75	0.87	0.59	0.56	0.69	0.64
Environmental fitting of sites	0.97	0.94	0.65	0.72	0.63	0.61	0.70	0.68
III Protection (VPr)								
Current condition	0.78	0.68	0.85	0.75	0.66	0.58	0.59	0.51
Protection level	0.71	0.72	0.72	0.74	0.51	0.52	0.53	0.53
Vulnerability	0.54	0.51	0.76	0.68	0.41	0.39	0.37	0.35
Suitable number of visitors	0.56	0.84	0.68	0.63	0.38	0.57	0.35	0.53
ADDITIONAL VALUES								
I Functional values (VFn)								
Accessibility	0.81	1	0.68	0.68	0.55	0.68	0.55	0.68
Additional natural values	0.78	0.66	0.57	0.69	0.44	0.38	0.54	0.46
Additional anthropogenic values	0.60	0.79	0.43	0.55	0.26	0.34	0.33	0.43
Vicinity of emissive centres	0.31	0.38	0.37	0.58	0.11	0.14	0.18	0.22
Vicinity of important road network	0.43	0.53	0.49	0.65	0.21	0.26	0.28	0.34
Additional functional values	0.43	0.74	0.40	0.68	0.17	0.30	0.29	0.50
II Touristic values (VTr)								
Promotion	0.38	0.56	0.65	0.62	0.25	0.36	0.24	0.35
Annual number of organised visits	0.43	0.60	0.69	0.62	0.30	0.41	0.27	0.37
Vicinity of visitors centre	0.24	0.68	0.63	0.55	0.15	0.43	0.13	0.37
Interpretative panels	0.35	0.56	0.81	0.65	0.28	0.45	0.23	0.36
Annual number of visitors	0.25	0.38	0.32	0.48	0.08	0.12	0.12	0.18
Tourism infrastructure	0.41	0.47	0.59	0.82	0.24	0.28	0.34	0.39
Tour guide service	0.15	0.18	0.60	0.65	0.09	0.11	0.10	0.12
Hostelry service	0.63	0.78	0.51	0.71	0.32	0.40	0.45	0.55
Restaurant service	0.81	0.90	0.54	0.63	0.44	0.49	0.51	0.57

[1] GS_{1a} – the Krupaja spring evaluated by geoexperts
[2] GS_{2a} – the Žagubica spring evaluated by geoexperts
[3] GS_{1b} – the Krupaja spring evaluated by potential geotourists
[4] GS_{2b} – the Žagubica spring evaluated by potential geotourists

give higher scores to the Main values of the model (compared to Additional values). Only in case of the Žagubica spring, potential geotourists give a higher score for Additional values. The Touristic values are the lowest ranked in total score for both geoexperts and potential geotourists, so in the future, the main focus should be on this segment,

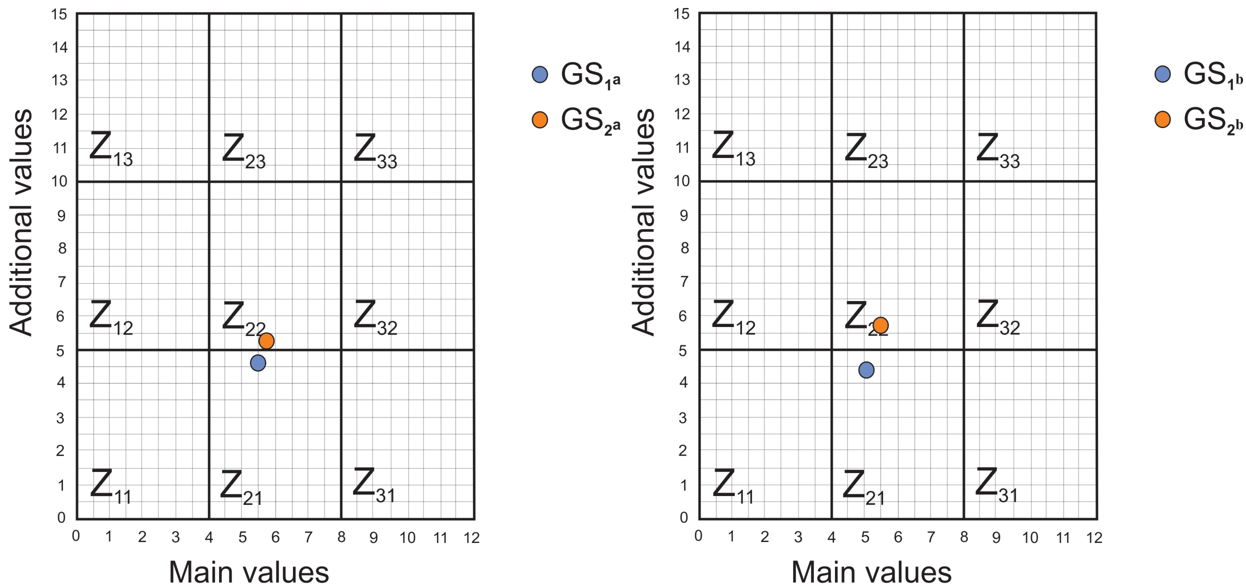

Figure 6: The position of the hydrological sites evaluated by the geoexperts – on the left (the Krupaja spring GS_{1a} and the Žagubica spring GS_{2a}) and potential geotourists – on the right (the Krupaja spring GS_{1b}, the Žagubica spring GS_{2b}).

Table 5: Overall ranking of the analyzed hydrological sites by M-GAM (assessment done by geoexperts and potential geotourists).

Geosite Label	**Values**				
	Main		**Additional**		Field
	VSE + VSA +V Pr	Σ	VFn + VTr	Σ	
The Krupaja spring – GS_{1a}	2.13+1.49+1.96	5.58	1.74+2.15	4.56	Z_{21}
The Žagubica spring – GS_{2a}	2.1+1.49+2.06	**5.65**	2.1+3.05	**5.15**	Z_{22}
The Krupaja spring – GS_{1b}	1.9+1.7+1.84	5.44	2.17+2.39	4.53	Z_{21}
The Žagubica spring – GS_{2b}	1.89+1.68+1.92	**5.49**	2.63+3.26	**5.89**	Z_{22}

in order to implement certain improvements and obtain the better position of the geosites. Firstly, this should include improvements in the interpretation of both springs, as the current interpretative panels (Figure 2c, Figure 4c) do not provide all relevant information for visitors. Also, the existing tour guide service in the Žagubica spring is the part of Tourism organization of Žagubica (located 1km from the geosite), and it provides guiding services only for tour visits booked in advance. The Krupaja spring does not have a professional tours guide on the site, but the interpretation is done by the owner and the other staff employed at the site. Interpretative panels at the Krupaja and the Žagubica springs lack not only aesthetic elements (the bad quality of images, panel material and small letters – Figure 2c; and low-quality design of the panel without photographs – Figure 4c) but also the qualitative scientific interpretation as well. There is no information about geosites' features, genesis and evolution. For instance, an interpretative panel on the Krupaja spring contains information about local legends and stories, while there is no crucial scientific data about the spring. Moreover, it contains information only in the Serbian language, while in the Žagubica spring the interpretative panel contains information not correctly translated into the English language. Beside this, interpretative panels should present sites' map/plan, which are not developed yet, a map of the site location, and the adequate cross-section scheme (as created for the purpose of this study – Figure 3a, b).

In terms of tourism infrastructure, some improvements should be done in terms of expanding the accommodation and restaurant capacity, enriching the tourist offer with new, attractive tourism facilities such as sport and recreational services, congress center as well as tourist activities in form of cycling and hiking tours.

As these two investigated geosites are 32 km away (one hour away by car) from each other, one of the development options could be an intense collaboration of these complementary geotourism destinations not only in the better promotion, protection, and conservation but also through local and regional infrastructure development and through concept of joint offer. This could initiate new geo-destinations that would further improve and develop conservation and promotion of geoheritage in a wider region of Homolje and Eastern Serbia as well. In this way, Serbian karst region could be more promoted internationally.

As it was mentioned before, the analyzed sites are on the list of protected areas of extraordinary national importance, but still without necessary recognition in Serbia. Municipality and Tourist Organization of Žagubica should upgrade its administration plan, succeed a higher level of protection, and improve tourism infrastructure for these geosites. Further steps should involve improving promotion on a wider scale, and the local population should be educated about the significance of the phenomenon that surrounds them in order to preserve the nature of this region and reduce negative anthropogenic influence.

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