

# Cultural Ecosystem Services Provided by Natural Heritage Sites in Karst Territories of Smolyan Region, Bulgaria

Mariana Nikolova, Stoyan Nedkov

National Institute of Geophysics, Geodesy, and Geography at the Bulgarian Academy of Sciences  
Bilyana Borisova

Sofia University "St. Kliment Ohridski"

Velimira Stoyanova

National Institute of Geophysics, Geodesy, and Geography at the Bulgarian Academy of Sciences  
Radenka Mitova

Sofia University "St. Kliment Ohridski"

**Abstract:** *The karst territories are characterized by landscape aesthetics, and provide knowledge for the natural systems and their specific ecosystem services. They are important part of the natural heritage and geodiversity. The aim of this study is to present karst territories as an element of the national natural heritage and as a source of cultural ecosystem services. The results provide a new type of knowledge for the recreational capacity of the karst territories in Bulgaria, and in particular of the caves in district of Smolyan.*

**Keywords:** caves, speleological tourism, recreative industries

*Prof. Dr Mariana Nikolova is working in the Department of Geography at the National Institute of Geophysics, Geodesy, and Geography at the Bulgarian Academy of Sciences.*

*Stoyan Nedkov is a Professor in the Department of Geography at the National Institute of Geophysics, Geodesy, and Geography at the Bulgarian Academy of Sciences. His research area is landscape ecology and application of GIS in environmental assessment.*

*Dr Bilyana Borisova is an Associate Professor; Vice Dean of the Faculty of Geology and Geography at Sofia University "St.Kliment Ohridski"; Director of Master Degree Program "Landscape Ecology and Natural Capital" at Department of Landscape Ecology and Environmental Protection.*

*Dr Velimira Stoyanova works as Assistant Professor at the Department of Geography at the National Institute of Geophysics, Geodesy, and Geography, Bulgarian Academy of Sciences.*

*Dr Radenka Mitova is Assistant Professor in the Department of Geography of Tourism at the Faculty of Geology and Geography of Sofia University "St. Kliment Ohridski", a specialist in landscape ecology, cultural tourism and geography of recreation and tourism.*



## INTRODUCTION

Karst landscapes are characterized by a variety of landforms, which bring aesthetic delight and inspiration for adventurous, extreme and cognitive tourism. Karst forms are distributed both on the surface and underground. The most common types of karst forms are closed depressions, noors, vertops, karst marshes, canyons, gorges, precipices, dry valleys, epicarst, caves with underground rivers and diversity of limestone formations etc.<sup>1</sup>

In Bulgaria, karst territories occupy 22,7% of the country's territory<sup>2</sup>. In these karst areas there are sites declared as natural landmarks, and some have cultural heritage value. There are over 1000 caves (from the investigated 5184 to 12.12.2015) protected by the legislation in Bulgaria, and of them 111 caves are with status of natural landmarks. They are protected together with their adjacent area, according to the order for their announcement, which is published in the State Gazette. The objects and elements that are protected include underground landscape and groundwater, biota and archaeological or paleontological sites. The protection of karst is regulated by the Protected Areas Act (1998), the Cultural Heritage Act (2009), and the Water Act.

In this study we have set ourselves the following tasks: (1) to identify caves that meet the criteria for national natural heritage on the territory of Smolyan region; (2) to assess their capacity to provide cultural ecosystem services according to the CICES 4.3 ecosystem services classification<sup>3,4</sup>; (3) to apply a new approach for prioritisation of these services and (4) to assess the ecosystem services and benefits that have capacity to contribute for development of the recreative industries.

## STUDY AREA, DATA AND RESOURCES

### *Study area*

For the purposes of this study the mountain territory of Smolyan region is selected, which provides sufficient number of karst sites with different characteristics, status, access regime and tourist potential. The sites belong to the Rila-Rhodope Karst District, which is one of the four

karst districts in the country, according to the country's karst regionalization of<sup>5</sup>. The focus of this study is on the caves in the administrative boundaries of the Smolyan district. The studied karst sites (caves) belongs to the following karst regions: Dobrostan (Chudnite mostove (Wonderful Bridges), Trigrad (Yagodinska cave, Dyavolskoto Garlo (Devil's Throat) cave, Sanchova Dupka, The Spring of Kastrakli, Eminova Dupka, Drangaleshka, Kambankite and Ledenitsata caves, as well as the Trigrad and Buynovski gorges) and Smolyan (Borykovska cave, Goloboitsa 1 and 2 and Cladeto). The largest karst region is Dobrostan, where more than 200 caves and precipices have been studied so far<sup>6</sup>. Of the 17 caves we explore on the territory of the Smolyan region, eight are chasm, one of which is icy, two are watery, one is passable and the other six are horizontal. Four of these caves have the status of protected natural sites. Most are developed in Proterozoic marbles. An exception is the Cave "Cladeto" in the municipality of Rudozem, which is in breccia-conglomerate Paleogenic sediments, made of marble pieces and metamorphites<sup>7</sup>. The rest of the studied caves are distributed between the municipalities of Smolyan District as follows: Smolyan (6), Borino (4), Devin (3), and Chepelare (3). Nine of the caves have been well studied in faunistic terms, in two there are archaeological finds, in one are found paleontological finds of cave bears, and three others are related to interesting legends (Table 1). The Protected Areas of Trigrad Gorge and Buynovsko Gorge are adjacent to the study area. This diversity of the investigated objects, as well as their spatial connectivity, a favorable condition for testing the proposed research methods, which is also a starting point in their selection.

The choice of this model territory is also based on the fact that sustainable tourism, based on the natural resources, has been made a major strategic priority in the Strategy for Development of District Smolyan (2014 – 2020). The implementation of an ecosystem approach to assess the capacity of the natural heritage to provide recreational services in the area can contribute to systemicity, sustainability and innovation in the management of natural tourist resources, as well as to the development of the recreative industries and social innovations in a peripheral mountain region. The

<sup>1</sup> The study is a result of the project BG05M2OP001-1.001-0001 "Building and Development of Center for Excellence "Heritage BG", funded by the OP Science and Education for Innovative Development 2014 – 2020, co-financed by the European Regional Development Fund".

<sup>2</sup> Popov 1970: 5-17.

<sup>3</sup> Haines-Young, Potschin 2013.

<sup>4</sup> Haines-Young, Potschin 2013a.

<sup>5</sup> Popov 1970: 5-17.

<sup>6</sup> Beron et al. 2009: 134-140.

<sup>7</sup> Beron et al. 2009.

wide distribution of variety of karst sites – caves, gorges, karst springs, etc., which in Smolyan region are over 350, is a good prerequisite for the development of speleotourism and related specific recreative industries. In this study we focus on the ecosystem benefits and services provided by only a small part of the District's natural heritage, It is due to the exceptional geodiversity and biodiversity of the studied territory.

### Data and resources

Karst complexes in Bulgaria are relatively well studied. Comprehensive information about karst sites throughout the country is contained in the monographs "Caves and Speleology in Bulgaria" (2009) and "Karst and Karst Natural Complexes in Bulgaria" (2018), as well as in a number of publications from the annual conferences of the Bulgarian Federation of Speleology (BFS). Karst regions provide diverse information about the material and spiritual culture of mankind from prehistory to the day, as well as on the evolution of a number of rare and unique representatives of cave's fauna. Previous studies of the caves in Smolyan region date back to 1885, when Stoyu Shishkov made the first description of the cave Chudnite mostove (Herkupria) (Beron et al., 2009). The brothers Hermengild and Karl Shkorpil also

described this natural phenomenon in their book "Krazhsky Phenomena" (Underground Rivers, Caves and Springs) in 1900. The studied caves had been subject of a series of expeditions of speleologists from various Cave Clubs, scientific expeditions of biologists and archaeologists, geographers and geologists. Karst regions were thoroughly examined in the period 1968 – 1978 by the Institute of Geography at Bulgarian Academy of Sciences (BAS) under the leadership of the prominent Bulgarian geographer Vladimir Popov. He proposed the karst regionalization of Bulgaria<sup>8</sup>, which remains the last generally accepted one. The information we draw from these studies is valuable both with the detailed descriptions of the objects, and with the information about their historicity and the time during which they have not ceased to provoke the interest of scientists and tourists. These characteristics play an important role in the assessment of ecosystem services provided by the natural heritage sites. Other data sources include cave club's newsletters. There is a valuable database in the Register and Cadastre of Geological Phenomena, as well as in the publications dedicated to them<sup>9</sup>. Another comprehensive source is the webbased database of the Bulgarian Federation of Speleology "Caves and Precipices in Bulgaria". On the base of these publications, some main characteristics of the objects examined have been synthesized in **Table 1**.

**Table 1.** Description of the studied caves in Smolyan District

CAVES IN SMOLYAN DISTRICT	STATUS/STATE	TYPE / AREA / LENGTH (L)	GEODIVERSITY	BIODIVERSITY	SCIENTIFIC/CULTURAL/HISTORICAL SIGNIFICANCE	TOURIST MASTERY
<b>BORYKOVSKA CAVE</b>	ORDER No.283 of 04.05.1979, issue 1/2013 45/1979 Update with Order No.RD-148 of 23.03.2018, SG No. 37/2018	Horizontal (9,99ha) / 470 m	Poor in formations (secondary formations only at the end of the cave); Captive karst spring water at the entrance to the cave supplying the village	Cave grasshopper and two bat species	<i>Paleontological</i> finds from cave bears	It is forbidden to visit the cave freely
<b>GOLOBOITSA 1 &amp; 2</b>	Not well-accessible	Water, L 1800 m	Two separate caves and a karst spring connected to each other. In Golobitsa 1 flows a river with a flow rate of 30 to	No data available	No data available	Local Cave Club organizes boat trips and extreme tourism

<sup>8</sup> Popov 1976: 14-24.

<sup>9</sup> Sinnyovsky 2011: 99-110.

			300 l/s, which is lost in a siphon and springs like karst spring Goluboitsa. Goluboitsa 2 is located above Goluboitsa 1 and connects with it through a 12-meter plumb in the rock.			
<b>DRANGALESHKKA (DANGALASHKA) DUPKA (HOLE)</b>	Not well-accessible	Water L 1142 m	The entrance is a 45-meter well with a depth of -165 m. The underground river has a flow rate of 30-50 l/s and flows more than 80 m below the level of the Muglenska River.	The fauna was studied by P. Beron in 1998.	No data available	Extreme tourism
<b>DYAVOLSKOTO GARLO (DEVIL'S THROAT)</b>	Well-accessible	Precipice L 450 m	Mapted are 15 waterfalls of different heights, ending in euorsion boilers and 272 horizontal galleries. The flow rate of the water, which is poured from 34 m waterfall into the precipice, reaches over 2300 l/s.	The largest colony of cave long-winged bats in the Balkans and several other bat species	1. <i>The Legend</i> of Orpheus and Eurydika 2. <i>Culture</i> : The Thracians believed that Devil's Throat was a portal to the afterlife and threw their dead chiefs and warriors there to provide them with immortality; Along the tourist trail there are three reliefs – a devil's head cut out near the entrance for visitors, figure of a man in full stature in antique style and a small spring with healing water, where the Virgin Mary's lychee is located. The legend states that in this place desires come true.	It accepts tourists all year round on a route of about 350 m.
<b>EMINOVA DUPKA</b>	Not well-accessible	Precipice L 635 m	Very beautiful and diverse formations, 15-18 meters of shelter in the rocks, sinth waterfall .	No data available	No data available	Hard to reach, requires good preparation and is suitable for extreme tourism. It is visited by tourists with guides.

<b>IZVORA NA KASTRAKLI</b>	Not well-accessible	Horizontal L 2480 m	With the longest thin stalactites in Bulgaria - up to 3 m in length. Its entrance is a periodic spring 1 m above the right bank of the Izvorska River. The cave is dry and accessible in the second half of summer, autumn and winter for about 7-8 months. It haven't been studied in full	No data available	No data available	It is visited by tourists and researchers
<b>KAMBANKITE (Chasm M-4)</b>	Not well-accessible	Precipice L 456 m	The gap contains 5 wells connected to horizontal galleries with a depth of 10 to 25 m. Difficult to reach.	No data available	No data available	Hard to reach and dangerous. Extreme tourism.
<b>CLADETO</b>	Not well-accessible	Horizontal L 236 m	Karst-accumulation forms – synth formations.	No data available	No data available	Опасна е поради падащи камъни.  It's dangerous because of falling rocks.
<b>LEDENITSATA</b>	ПЗ Заповед No.РД-1120 от 02.07.1968 г., бр. 83/1968  Благоустроена  PA Order No.RD-1120 of 02.07.1968, issue 1/2/2014 83/1968	Precipice 4.6 ha  L 1419 m	Beautiful ice formations (colonnade, swords,frozen waterfalls, etc.), as well as stalactites, stalagmites and aragonite curtains. A large underground river emerges from a	Speocyclops rhodopensis, troglobin Lithobiusstygius and 22 other species of animals, of which 9 bat species	The cave has an interesting history of research and was first described by H. and K. Shkorpil ( 1900).	Easily accessible and suitable for tourism

	well-accessible		siphon with a flow rate of 360 l/s. Huge halls up to 8 m high, a third water gallery, along which flows the deepest and fastest underground river. It is assumed that its waters go to the Nastan Karst Spring at the village of Nastan. Very pretty.			
<b>SANCHOVA DUPKA</b>	Not well-accessible	Horizontal L 455 m	Playstocene cave with secondary karst forms	10 species of animals and <i>Plusiocampa bulgarica</i> - inferior insect	It is of scientific interest that the cave is young, formed at the time when the middle floor of the Yagodinska Cave was formed	Local cave clubs offer tourist visits
<b>UHLOVITSA (ULTSATA)</b>	P.A. 283/04.05.1979 COPS/ SG issue, 45/1979 Well-accessible	Precipice, 2 storey, 1 ha L 330 m	Excluded wealth of all genetic types of synth formations. There are infiltration dripping waters that form ponds, petrified waterfalls, stalactites, etc. The cave ends with 7 beautiful lakes, which are filled with water early in the spring. The most attractive formation is the large stone waterfall, sparkling in white.	4 bat species	Legend: The cave was once also home to Devil and Devil's wife. The Devil was powerless to help his wife give birth and asked for help from a Rhodope grandmother who helped give birth to a healthy first child	Accepts tourists all year round only with a guide
<b>HARAMIJSKA DUPKA</b>	Not well-accessible	Chasm - Pass, Two-storey L 510	Poor on current formations, but seasonally formed icy forms	4 species, triglobine <i>Plusiocampa bulgarica</i>	<i>Archaeology</i> : Studies have found findings from the Eneolithic to the beginning of the Bronze Age	Extreme tourism offers local cave companies
<b>CHELEVESHNITSA v. Orehovo</b>	Not well-accessible	Horizontal to descending, three-storey, L 303 m	Various synth formations and gravitational collapses, but generally poor in formations	5 species of fauna, of which triglobins are the centipede <i>Trogodicustridentifer</i> and the <i>litobiuslakatnicensis</i>	<i>Legend</i> : It is known legend that children and old people hiding in the cave were suffocated by the kardzhalii with fire and smoke at the end of the 18th - early 19th century. Many human bones were found there.	Access is possible

<b>CHELEVESHNITSA</b> <b>v. Pavelsko</b>	Not well- acesible	Precipice L 85 m	A sheer 33-metre well leads to a large hall with a cone of collapsed blocks, dips of synth partitions with sparkling walls, cave en clears and a stone forest - a colonnada of stalagtones supporting the vaulted cave	26 crows were noticed in 1978	<i>Legend:</i> From this cave Orpheus has descended into the underground kingdom to search for Eurydika	It is visited and suitable for extreme tourism
<b>CHELOVESHNITSA</b> <b>v. Zabardo</b>	Not well- acesible	Precipice L 65 m	36-meter well leads to the top of a cone of stones and clay, propped up by rock blocks	No data available	<i>Legend:</i> Nearby is the fortress of Gordyu voivode, the remains of which still stand on the opposite ridge. After the fall of the fortress, the Turks threw into the cave the living captives, the slain, their horses and their weapons. The legend was confirmed in 1962, when were discovered the bones of the defenders of the fortress, tall and short-made people, and weapons from the end of the Second Bulgarian Kingdom.	Dangerous and forbidden to visit
<b>CHUDNITE MOSTOVE</b>  <b>(THE WONDERFUL BRIDGES)</b>	P.A. No 2813/08.11.1961, GOG, SG no. 2813/08.11.1961 11/06.02.1962 Order No.RD-37 of 21.01.2008, SG No. 100.02.1962 32/2008  Well-acesible	Passable 38,92 ha, L 107 m	It consists of two rock bridges (passage caves) located 70 m apart. The largest arch is about 45 m high and 40 m wide. The small bridge is along the river - impassable, 60 m long, with a total height of 50 m, and the height of the arch is 30 m. After it there is a pore cave, in which the waters of the River Hercupria disappear to reappear on the surface after 3 km.	Falls under the Protected zone under the Birds Directive, Persenk	<i>Legend</i> says that the creation of the Wonderful Bridges is a result of the battle between the local shepherds and the Dragon.	Accepts tourists all year round

<b>YAGODINSKA CAVE (IMAMOVA DUPKA)</b>	Well-accessible	Horizontal, Two-Storey L 8501 m	Very beautiful and third in length in Bulgaria and the longest in the Rhodope Mountains. A gap with a depth of 15m connects the two floors of the cave. Formations: cave bidders, synth lakes, leopard skin, stalagmites and stalactites	42 species of animals, inferior insect <i>Plusiocampa bulgarica</i> and centipede <i>Troglodocus meridionale</i>	<i>Archaeology:</i> It is an Eneolithic dwelling - an outbreak of the stone-copper age and ceramics with decoration from the Bronze and Iron Ages.  <i>Legend:</i> 400 of the inhabitants from the village were hidden in the cave, but were betrayed, charred, walled and suffocated in it by invaders in the village of Yagodina,	Accepts tourists all year round
--	-----------------	------------------------------------	--	--	---	---------------------------------

Sources: Beron et al. (2009); <https://bulgarianhistory.org/dqvolskoto-garlo/>; <https://www.bulgariatravel.org/bg/> ; <https://opoznai.bg/view/borikovska-peshtera?mobi=false>; <http://www.hinko.org/bg/caves/viewcaves.php>

## METHODOLOGY

The research is based on the integration of methods for categorization of sites as a natural heritage at national level and methods for assessing, prioritizing and mapping the ecosystem services which they provide for development of the recreative industries.

*Categorization of sites with qualities to be nominated for the category "natural heritage" at national level.*

The categorization distinguishes the following categories of sites with the meaning of "natural heritage": 1) Established sites of natural heritage; 2) New sites of geodiversity/ biodiversity and 3) Cultural landscapes.

The selection is based on a specially developed system of criteria tailored to the definition adopted for the purposes of the study: "The natural heritage is a geospatial natural element of the socio-ecological system, which has material and spiritual benefits of sustainable importance for previous, present and future generations"<sup>10</sup>. The criteria also comply with those adopted by various international conventions and

other documents, complemented by those which reflect the importance of the sites at national level (Table 2).

The selection of the entities under these five criteria is based on the proposed Index of Significance (I)<sup>11</sup>, of the nominated entity, which reflects the sum of the number of metrics that have been given a positive rating for the respective entity divided by the number of all metrics

$$I = \frac{\sum (p_1 \dots p_n)}{\sum (P_1 \dots P_{15})}$$

Where:

I – Index of Significance

p – Number of positive-rated indicators for a site

P – Number of indicators

Sites with  $I > 0,5$  have the capacity to be classified as "New sites of the national natural heritage". These sites must be assessed as having national significance. Furthermore, the site should have maintained its importance to past and present generations and have the potential to retain its importance to the future generations.

Sites with  $I < 0,49$  could be assigned to the category "New sites of the national natural

<sup>10</sup> Nikolova, Nedkov, Dimitrov, Borisova, Zhiyanski 2021.

<sup>11</sup> Nikolova 2020: Second progress report, 28.02.2020.

**Table 2.** Criteria and indicators for selection of natural systems (ecosystems), natural components and elements, and cultural landscapes, seen here as natural heritage sites of Bulgaria<sup>12</sup>

№	Criteria	Indicators
1.	<b>Site status</b> (environmental significance / value demonstrated by presence of the sites in the relevant official registers/thematic campaigns)	1. Sites recognised as significant under well-established international criteria of UNESCO, IUCN, WCPA, Ramsar site, etc.; 2. Sites of European and National importance (have a place in the European Ecological Network of protected areas, protected species and protected areas (NATURA 2000)); 3. Objects that are symbols of important international causes related to the conservation of nature.
2.	<b>Scientific significance / value</b> (official documents, protected scientific developments, certificates, etc.)	4. The object displays unique or rare characteristics; 5. The site is a prospective source of new knowledge, registers increased interest from the research community, including for visits with the importance of scientific tourism.
3.	<b>Educational significance / value</b> (educational programs/initiatives and derived publications and products)	6. The site has a recognised and well-established role in terms of important educational objectives at the respective educational levels and in thematic areas; 7. The site has a recognized and well-established cognitive value for all ages.
4.	<b>Public significance/value</b> (proven by presence of the sites in official registers/documents/programming materials and thematic initiatives)	8. The site has a recognized and well-established role in terms of human health and psycho-physiological comfort; 9. The site has recognized sacral and religious value; 10. The site has a recognized value of national symbol and national identity; 11. The site has proven and lasting cultural and/or historical significance over time;

<sup>12</sup> Borisova, Mitova 2020: Second progress report, 28.02.2020.

		12. The site is known as a source of inspiration for culture and art.
5.	<b>Business potential for recreative industries</b> (proven by presence of sites in official registers/documents/programming materials and thematic initiatives)	13. The site has been developed or can be developed as a recreational attraction, on the base of its recognized aesthetic qualities;  14. The site has been developed or can be developed as a tourist attraction;  15. The site has been developed or can be developed as a sports attraction.

heritage” if they bear specific and rare characteristics or when they are on the territory of protected area or on the territory of cultural landscapes that meet the criteria for natural heritage.

All natural sites protected by one or another normative document, law or international convention, refer to the category “Established sites of natural heritage”. They must be of supranational and/or national importance.

*Methods for assessment and prioritization of ecosystem services for recreation and tourism.*

The purpose of prioritisation is to identify those ecosystem services that natural heritage provides for the development of recreative industries. There are 48 classes of ecosystem services evaluated and divided into three main groups – material, regulatory and cultural. All ecosystem services relevant to the recreational industries are identified as “Recreational ecosystem services” after the evaluation. The CICES 4.3 classification of the ecosystem services is used for the evaluation. Assessed are 48 classes of ecosystem services in terms of their relevance to seven benefit criteria related to the recreative industries (**Table 3**). Each one ecosystem service

in the table is evaluated for each group of criteria separately for each natural heritage site. The assessment of the benefits provided by the ecosystem services to the recreative industries is made on a relative scale from 0 to 5: 0 (none), 1 (very weak), 2 (weak), 3 (moderate), 4 (high) and 5 (very high). The evaluation criteria are based on a review of publications related to the concepts of natural recreational resources<sup>13,14,15,16,17,18,19</sup> and cultural ecosystem services<sup>20,21,22</sup>.

The term “Recreational ecosystem services” refers to all ecosystem services relevant to the recreative industries. Some of them have a direct impact by creating an environment for the implementation of recreation activities, and others contribute indirectly, as factors influencing individual aspects of recreation. Identifying and prioritising ecosystem services in terms of recreation is one of the main tasks in this study. Prioritisation makes it possible to assess the relevance of the provided ecosystem services to the benefits criteria<sup>23</sup>. For this aim we calculate Index of Relevance (R)<sup>24</sup>. It reflects the ratio between the sum of the assessment scores for the benefits provided by ecosystem services to the number of ecosystem services from a given natural heritage site:

<sup>13</sup> Popova 1993: 127.

<sup>14</sup> Evrev 1999: 38-45.

<sup>15</sup> Nedyalkov, Bekyarova 2000: 240.

<sup>16</sup> Borisova, Mitova 2020: 366.

<sup>17</sup> Priskin 2001: 637-648.

<sup>18</sup> Çetin and Sevik 2016.

<sup>19</sup> Cocklin, Harte, Hay 1990: 291-303.

<sup>20</sup> Daily 1999.

<sup>21</sup> Reid et al. 2005: 155.

<sup>22</sup> De Groot et al. 2010: 260-272.

<sup>23</sup> Nedkov et al. 2021.

<sup>24</sup> Nikolova 2020: Second progress report, 28.02.2020.

**Table 3.** Criteria for assessing the benefits provided by ecosystem services for the recreative industries

Criteria	Description
<b>Functional and technological</b>	Provide favourable conditions for certain recreational activities and industries, tourism and sport
<b>Physiological (health)</b>	Have a beneficial effect on human health, stimulate a healthy lifestyle: comfort, security, healing properties, clean environment
<b>Aesthetic</b>	They bring aesthetic delight, have a beneficial effect on the psychological state of people
<b>Economic</b>	Provide cost-effective opportunities for economic development
<b>Cognitive</b>	Meet knowledge needs and pass them on to future generations (science, education, culture) and have a cognitive effect
<b>Spiritual</b>	Stimulate spiritual development and creativity, have a connection with the tangible and intangible cultural heritage (religion, myths, art, life, traditions, folklore, crafts, cuisine, etc.), ethno- and civilization identity, local culture and a sense of belonging to the place
<b>Ethical</b>	Stimulate the need to protect the natural environment and cultural heritage, promote responsible behaviour of local populations, tourists and businesses

$$R = K/E$$

Where:

R – Index of Relevance;

K – Sum of the assessment scores for the benefits of ecosystem services according to all criteria

E – Number of ecosystem services provided by a natural heritage site

The Index of Relevance shows which natural heritage sites provide the greatest variety of recreational benefits. In view of the scale adopted for assessing the criteria by which prioritisation is carried out, as well as the number of classes of ecosystem services to be assessed under them, the maximum value that the Index of Relevance may have is 35. On this basis, we propose that objects with index values from 1 to 15 are poorly relevant, from 15.1 to 25 – relevant, and from 25.1 to 35 – highly relevant.

## RESULTS AND DISCUSSION

*Results from the categorization of the sites with qualities to be nominated for “natural heritage” at national level*

According to the used methodology, four of the studied sites have the status of protected natural sites from the category “Natural landmark” (NL) and we accept them on this basis as “Established sites of natural heritage”. These are the caves: Borykovska, Ledenitsata, Uhlovitsa and Chudnite mostove (Herkupria). Table 1 provides information on their characteristics, and since when they have been protected. The first three of these natural heritage sites are located on the territory of the municipality of Smolyan, and the fourth one is situated in Chepelare municipality.

The remaining thirteen sites, the “New national natural heritage sites”, were assessed

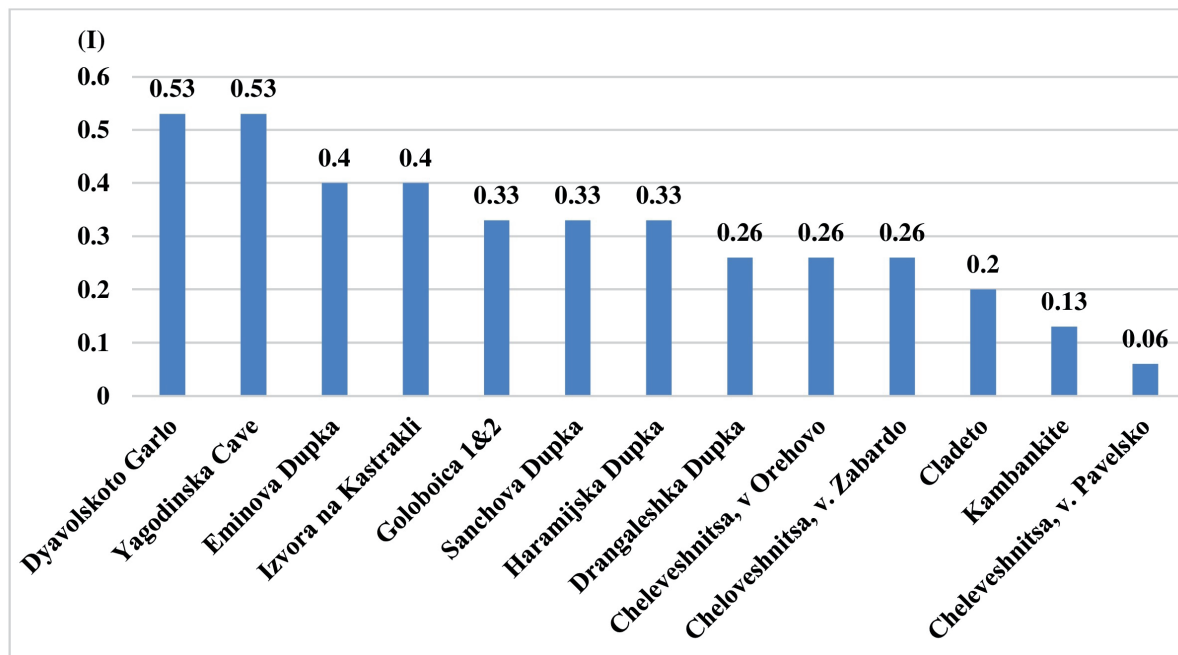


Figure 1. Index of Significance (I) of the studied caves

according to the seven criteria presented in Table 2. For each of them, an Index of Significance (I) was calculated. The results presented on Fig. 1 shows that with values of  $I > 0.5$  are only two caves – Dyavolskoto Gartlo and Yagodinska. These caves are very popular tourist destinations located respectively in the Trigrad and Buynovo gorges.

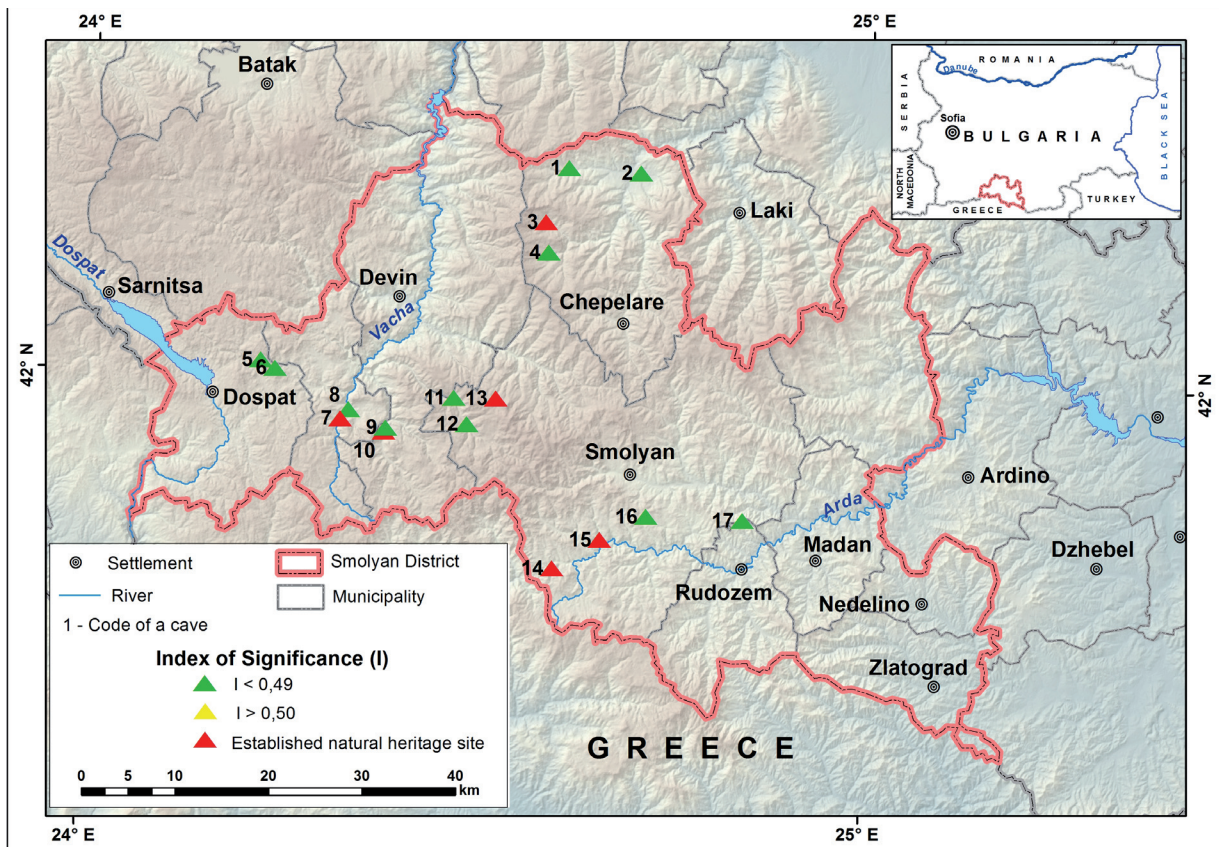
The Trigrad Gorge is a Protected Area of 710.57 ha. Protected are endemic plant and animal species, as well as natural habitats. There is also on this territory a large geodiversity, which is not limited to the Dyavolskoto Garlo cave. In the village of Trigrad, where the cave is located, are registered 80 more caves and precipices. Another 157 caves there are on the territory of Devin municipality, including the cave Haramiyska Dupka, where archaeological finds from the Eneolithic to the beginning of the Bronze Age were found.

The Buynovo Gorge is declared a natural landmark with an area of 759.15 ha. The purpose of conservation is the Gorge of the Bunovska River with some protected plant and animal species. The area overlaps in part or in full the areas of the popular tourist sites Dyavolskiya Most and Vodopada (The Devil's Bridg and the Waterfall), as well as the Protected Area under the Trigrad-Mursalitsa Birds Directive. Besides the Yagodinska Cave, there are another 61 caves and precipices on

the territory of Borino Municipality, among which the subject of this study are Eminova Dupka, the Spring of Kastrakli and Sanchova Dupka. Their Index of Significance is between 0.4 and 0.33 because of the beautiful formations in the first two and because of the cognitive value of the latter.

The spatial connection between the established and the nominated for new sites of natural heritage, and other karst objects in the studied area, has a certain synergistic effect in terms of the ecosystem benefits provided for the development of speleological tourism and other related recreation activities in Smolyan region. For example, on the territory of the municipality of Smolyan are concentrated six of the sites subjected to the categorization (Drangaleshka, Goloboitsa, Kambankite, Ledenitsata, Borykovska and Uhlovitsa caves), of which the last three have the status of natural landmarks (Fig. 2).

On the territory of Chepelare municipality, along with the natural landmark Chiudnite mostove, there are 30 other caves, among which the Cheleveshnitsa cave in the village of Orehovo, the Cheleveshnitsa cave in village of Pavelsko and Cheloveshnitsa in the village of Zabardo. All four sites are related to interesting legends, and the one about Gordyu voivode has been confirmed as a historical fact by the archaeological artifacts found in the cave.



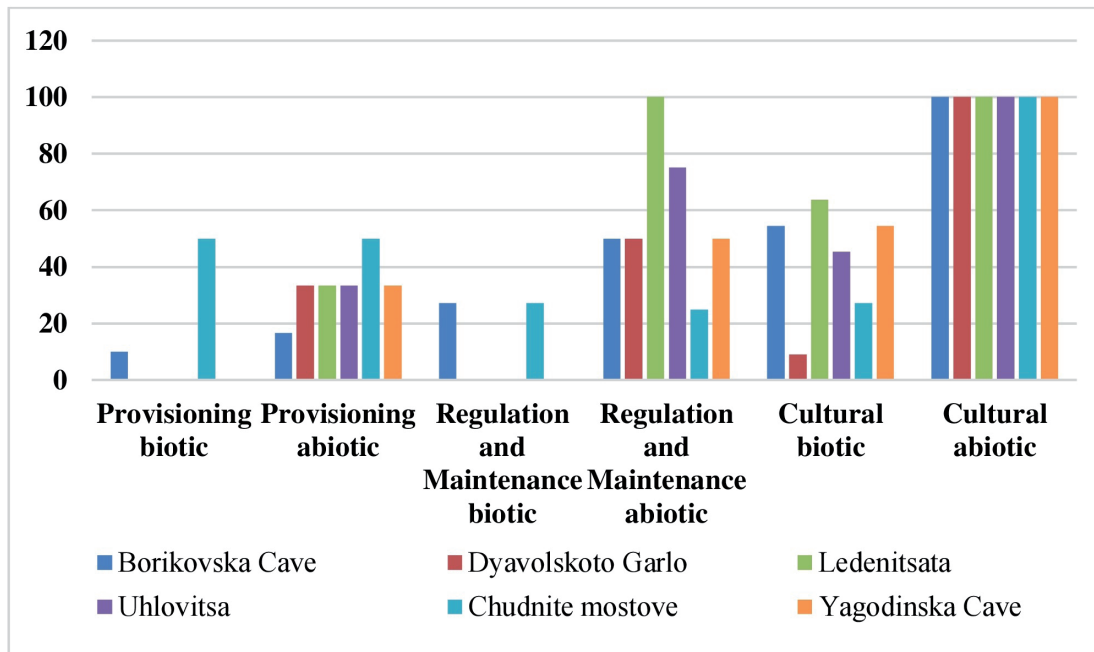
**Figure 2.** Location of the studied caves by their Index of Significance: 1 – Cheleveshnitsa, v. Orehovo; 2 – Cheleveshnitsa, v. Zabardo; 3 – Chudnite mostove; 4 – Cheloveshnitsa, v. Pavelsko; 5 – Izvora na Kasytrakli; 6 – Eminova duplka; 7 – Yagodinska cave; 8 – Sanchova Dupka; 9 – Haramijska Dupka; 10 – Dyavolskoto Garlo; 11- Drangaleshka Dupka; 12 – Kambankite; 13 – Ledenitsata; 14 – Borikovska; 15 – Uhlovitsa; 16 – Goloboica 1 and 2 and 17 – Cladeto

In addition to a territorial proximity, the assessed sites could provide conditions for the development of extreme, adventurous, historical or cognitive type speleotourism united into the relevant tourist packages.

#### *Prioritisation of ecosystem services with capacity for recreation and tourism*

The results of the prioritization of ecosystem services provided by the surveyed caves show that they all provide 100% cultural abiotic ecosystem services. The provided cultural biotic services vary from 9% in Dyavolskoto Gurlo to 64% in Ledenitsata, where the biodiversity is the greatest. Ledenitsata also provides 100% of the regulating and supportive abiotic services. It is due to the exceptional role of groundwater in the cave for the regulation of the current in the region. Only two of the sites – the Borykovska

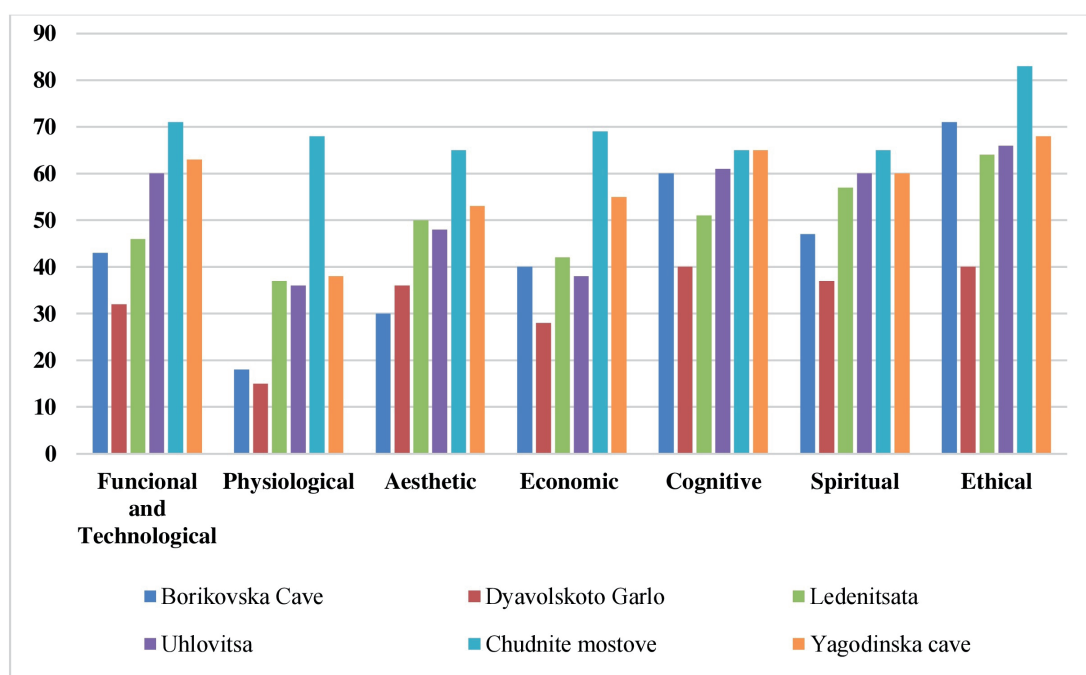
Cave and Chudnite mostove, provide up to 27% of the Regulating and supporting biotic ecosystem services. The Chudnite mostove cave is a source of 50% of material biotic and abiotic services (Fig. 3). These results reflect well the nature of the assessed sites from the geoheritage of Bulgaria. In the caves, due to the specific conditions and lack of natural light, the biotic ecosystem services have a smaller share, which is formed mostly by cave fauna. On the other hand, these sites are rich of geodiversity and unique karst forms which provide originality of the experience that tourists get in them. The ability of karst territories to regulate the water flow has been demonstrated by the group of “Regulatory and supporting abiotic” services. The “Regulating and supporting biotic” services matter in the sites that are protected in the category natural landmarks, which determined the area adjacent to the caves on the surface, where there are plant communities, including rare or protected species.



**Figure 3.** Relative share (%) of the classes of ecosystem services provided by the natural heritage sites examined to all classes of the relevant CICES 4.3 section

The distribution of the prioritisation assessments of all classes of ecosystem services for each of the criteria and for each of the natural heritage sites assessed is presented in Fig. 4. It shows that the Chudnite mostove cave is rated highest, followed by the Yagodinska Cave, Uhlovitsa and Ledenitsata. For the other sites, the estimates vary between different criteria, but are significantly lower. Ecosystem services prioritisation provides

a good basis for analysis, but the absolute sum of the scores by the criteria estimates does not indicate whether the number of services or the scores of the ratings plays a greater role in the final result. It is not clear whether it was formed because of the quality of the services or because of their larger number. To make prioritization more precise, we use the Index of Relevance (R), Fig. 5.



**Figure 4.** Allocation of assessments (scores) of the prioritised ecosystem services for each of the criteria and for each of the assessed caves

The Index of Relevance (Fig. 5) shows that Yagodinska cave (28.71) has capacity to provide the most recreational benefits, and with the lowest capacity is the Borykovska Cave (18,17).

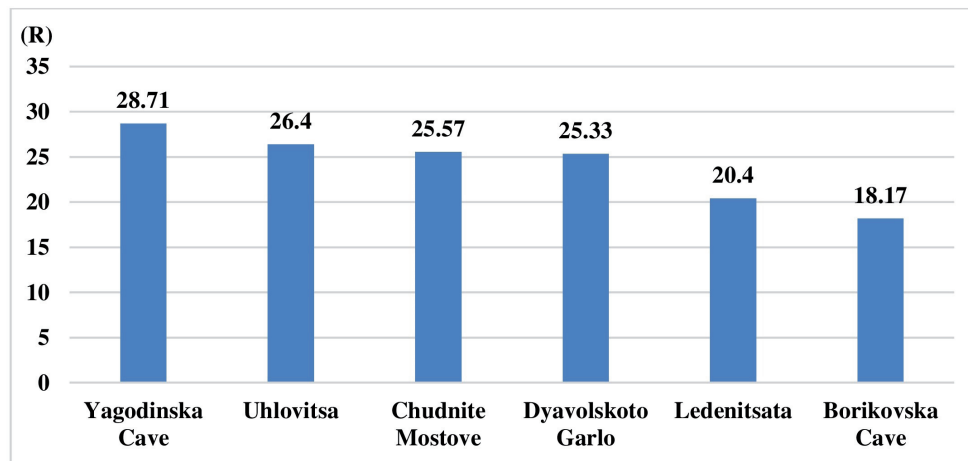


Figure 5. Index of Relevance (R) of the selected caves

The data from Table 1, confirm that the Yagodinska Cave actually provides rich geodiversity and biodiversity, has archaeological sites and legends and is open for visitors, unlike the Borykovska Cave, which is protected as the natural landmark because of the paleontological finds in it, but has limited access and is poor of attractive karst forms and biodiversity. There is no year-round access to the Ledenitsata and

it is not open for visitors. From the values of the Index of Relevance, we can conclude that Yagodinska, Chudnite mostove, Uhlovitsa and the Dyavolskoto Gurlo caves are very relevant to the recreation industries, and Ledenitsata and Bornikovska caves are relevant, i.e. the utilization of their capacity will require more efforts and investments from the local communities (Fig. 6).

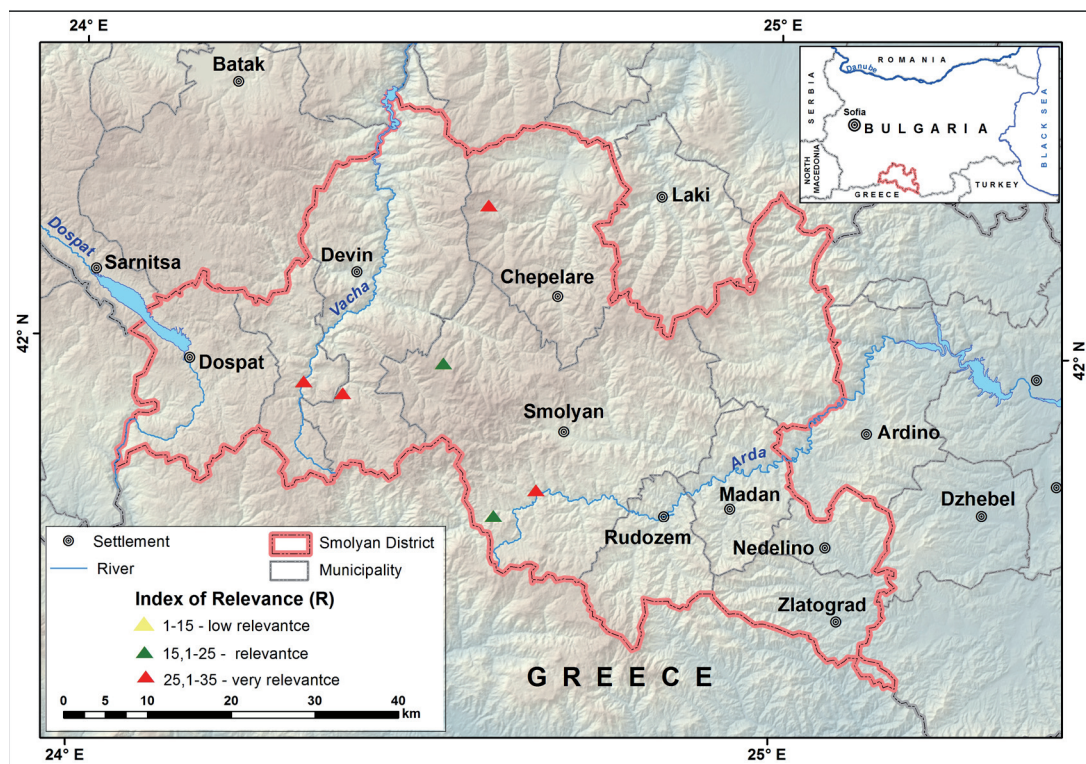


Figure 6. Distribution of caves according to the Index of Relevance: 1 – Cheleveshnitsa, v. Orehovo; 2 – Cheleveshnitsa, v. Pavelsko; 3 – Chudnite mostove; 4 – Cheloveshnitsa, v. Zabardo; 5 – Izvora na Kasytrakli; 6 – Eminova duplka; 7 – Yagodinska cave; 8 – Sanchova Dupka; 9 – Haramijska Dupka; 10 – Dyavolskoto Garlo; 11 – Drangaleshka Dupka; 12 – Kambankite; 13 – Ledenitsata; 14 – Borikovska; 15 – Uhlovitsa; 16 – Goloboica 1 and 2 and 17 – Cladeto

## CONCLUSION

The results provide a new kind of knowledge about the recreational potential of the karst territories in Bulgaria and can be used to optimize and develop recreation and tourism in these regions. The categorization of the sites with qualities to be nominated for “natural heritage” on national level shows that there are four “Established sites of natural heritage” on the territory of Smolyan district – the caves Borikovska, Ledenitsata, Uhlovitsa and Chudnite mostove. From the other thirteen sites, subject to this categorization, nominated as “New sites of national natural heritage”, according the Index of Significance, are only two caves – Dyavolskoto Garlo and Yagodinska Caves.

The prioritization of ecosystem services by all criteria shows that Chudnite Mostove Cave is rated highest, followed by the Yagodinska, Uhlovitsa and Ledenitsata caves. The estimates for the rest sites, vary between different criteria, but are significantly lower.

The Index of Relevance (R) of the sites shows that Yagodinska Cave has the highest capacity to provide recreational benefits, and Borykovska Cave has the lowest capacity. From the values of the (R), we can conclude that Yagodinska, Chudnite Mostove, Uhlovitsa and Dyavolskoto Garlo caves are very relevant for development

of the recreational industries, and the caves Ledenitsata and Borykovska are relevant and also have potential, but using their capacity will require more efforts and investments.

The results of the study confirm that the proposed methodology provides reliable results for assessing the capacity of specific natural heritage sites to provide ecosystem services for the development of recreation and recreative industries. These results can serve to optimize and integrate policies regarding sustainable management of the Bulgarian natural heritage and for development of tourism, innovation and services in the region through a more active partnership between stakeholders.

The presence of different type of caves within a compact territory allows the tourist product to be addressed to a wide range of users with varying degrees of preparation and with different interests in speleology (scientific, historical, archaeological, literary, artistic, photographic, zoological, etc.). Currently, less than half of the caves surveyed are developed and provide access of the tourists in them. At the same time, some local cave clubs provide the necessary assistance to for the visitors in the caves that are not well-accessible. In these activities, there is also potential for the development of recreative industries and other accompanying the “adventure” activities, with economic and social benefits for the local communities.

## BIBLIOGRAPHY

*Beron et al.* 2009: *Beron*, Petar, *Trifon Daaliev* and *Aleksey Zhalov*. Caves and Speleology in Bulgaria, Published by BFU, NPM-BAS and COM Foundation. S. 134-140.

*Borisova, Mitova* 2020: *Borisova*, Bilyana and *Radenka Mitova*. Development of a Methodology for Assessment of the State and Mapping of the Potential of the Natural Ecosystems with the Meaning of “Natural Heritage” to Provide Recreational Ecosystem Services. In: Conceptualization, Flexible Methodology, and Pilot Geospatial Platform for Access of the Bulgarian Natural Heritage to the European Digital Single Market of Knowledge and Information Services. Second Progress Report, 28.02.2020.

*Çetin, Sevik* 2016: *Çetin*, Mehmet and *Hakan Sevik*. Evaluating the Recreation Potential of Ilgaz Mountain National Park in Turkey. *Environmental Monitoring and Assessment*, 188:52, DOI 10.1007/s10661-015-5064-7.

*Cocklin et al.* 1990: *Cocklin*, Chris, *Michael Harte* and *John Hay*. Resource Assessment for Recreation and Tourism: a New Zealand example. *Landscape and Urban Planning*, 19(3), 291-303, [https://doi.org/10.1016/0169-2046\(90\)90027-Y](https://doi.org/10.1016/0169-2046(90)90027-Y).

*Daily* 1999: *Daily*, Gretchen. Developing a Scientific Basis for Managing Earth’s Life Support Systems. *Conservation Ecology*, 3(2)

*De Groot et al.* 2010: *De Groot*, Rudolf,

*Rob Alkemade*, *Leon Braat*, *Lars Hein* and *Louise Willemen*. Challenges in Integrating the Concept of Ecosystem Services and Values in Landscape Planning, Management and Decision Making. *Ecological Complexity*, 7(3), 260-272.

*Evrev* 1999: *Evrev*, Petko. Spatial Planning of Recreation and Tourism. SU “St. Kliment Ohridski”, ISBN 954-07-1146-0, Sofia, 38-45.

*Haines-Young, Potschin* 2013: *Haines-Young*, Roy and *Marion Potschin*. CICES V4.3 - Report Prepared Following Consultation on CICES Version 4. August-December 2012. EEA Framework Contract No EEA/IEA/09/003.

*Haines-Young, Potschin* 2013a: *Haines-Young*, Roy and *Marion Potschin*. Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. EEA Framework Contract No EEA/IEA/09/003 (Download at [www.cices.eu](http://www.cices.eu))

*Mitova* 2020: *Mitova*, Radenka. Concept for Sustainable Development of Tourism on Vitosha. SU “St. Kliment Ohridski”, ISBN 978-954-07-5065-1, Sofia.

*Nedkov et al.* 2021: *Nedkov*, Stoyan, *Mariana Nikolova*, *Radenka Mitova*, *Bilyana Borisova*, *Dessislava Hristova*, *Lidiya Semerdzhieva*, *Miglena Zhiyanski*, *Hristina Prodanova*. Prioritization of Ecosystem Services Related to the Natural Heritage in Bulgaria, JBGS, Pentsoft, (in print).

- Nedyalkov, Bekyarova* 2000: *Nedyalkov*, Simeon and *Zhivka Bekyarova*. Recreational Ecology, Varna.
- Nikolova* 2020: *Nikolova*, Mariana. Development of a Methodology for Assessment of the State and Mapping of the Potential of the Natural Ecosystems with the Meaning of "Natural Heritage" to Provide Recreational Ecosystem Services. In: Conceptualization, Flexible Methodology, and Pilot Geospatial Platform for Access of the Bulgarian Natural Heritage to the European Digital Single Market of Knowledge and Information Services. Second Progress Report, 28.02.2020.
- Nikolova et al.* 2021: *Nikolova*, Mariana, *Stoyan Nedkov*, *Stelian Dimitrov*, *Bilyana Borisova* and *Miglena Zhiyanski*. Conceptualization of Natural Heritage in the Context of the Ecosystem Approach (in this volume).
- Popov* 1970: *Popov*, Vladimir. Karst Spread in Bulgaria and Some of its Peculiarities, Announcements of the Geographical Institute of BAS, XIII, 5-17.
- Popov* 1976: *Popov*, Vladimir. Zoning of the Caves in the People's Republic of Bulgaria. Problems of Geography, Book 2, 14-24.
- Popova* 1993: *Popova*, Nikolina. Natural Recreational Resources. SU "St. Kliment Ohridski", ISBN 954-07-0181-3, Sofia.
- Priskin* 2001: *Priskin*, Julianna. Assessment of Natural Resources for Nature-based Tourism: the Case of the Central Coast Region of Western Australia, Tourism management, Vol. 22, 637-648.
- Shkorpil, Shkorpil* 1900: *Shkorpil* Hermengild and *Karl Shkorpil*. Krazhsky Phenomena. (Underground Rivers, Caves and Springs).
- Simyovskiy* 2011: *Simyovskiy*, Dimitar. Geoconservation and the Geological Heritage of Bulgaria. Journal of the Bulgarian Geological Society, year 72, vol. 1-3, 99-110.
- Reid et al.* 2005: *Reid*, Walter, *Harold Mooney*, *Angela Cropper*, *Doris Capistrano*, *Stephen Carpenter*, *Kanchan Chopra*, *Partha Dasgupta*, *Thomas Dietz*, *Anantha Kumar Duraiappah*, *Rashid Hassan*, *Roger Kasperson*, *Rik Leemans*, *Robert May*, *Tony McMichael*, *Prabhu Pingali*, *Cristián Samper*, *Robert Scholes*, *Robert Watson*, *A.H. Zakri*, *Zhao Shidong*, *Neville Ash*, *Elena Bennett*, *Pushpam Kumar*, *Marcus Lee*, *Ciara Raudsepp-Hearne*, *Henk Simons*, *Jillian Thonell* and *Monika Zurek*. Millennium Ecosystem Assessment (MEA) Ecosystems and Human Well-Being: Synthesis, Island Press, Washington, DC, ISBN 1-59726-040-1.
- SITES**
- Bulgarian history* – <https://bulgarianhistory.org/dqvolskoto-garlo/>
- Caves and Precipices in Bulgaria* – <http://www.hinko.org/bgcaves/viewcaves.php>  
[https://sm.government.bg/upload/files/Strategia\\_OblSm%202014-2020.pdf](https://sm.government.bg/upload/files/Strategia_OblSm%202014-2020.pdf)
- The Cultural Heritage Act* (2009) last. ed. State Gazette, issue 19/2009, in force since 26.02.2021 - <https://www.lex.bg/laws/ldoc/2135623662>
- Opoznaibg* – <https://opoznai.bg/view/borikovska-peshtera?mobi=false>
- Protected Areas Act*, published SG 133/1998, last. ed. State Gazette, issue 66/2013, in force since 26.07.2013 – <http://extwprlegs1.fao.org/docs/pdf/sin28773.pdf>
- Register and Cadastre of Geological Phenomena* – <http://mgu.bg/geosites/>
- Strategy for development of Smolyan district* (2014 – 2020) – Tourist portal for Bulgaria – <https://www.bulgariatravel.org/bg/>
- Water Act*, prom. DV. No. 67 of July 27, 1999, last ed. and ext. DV. No. 17 of February 26, 2021, in force since January 28, 2000 - <https://www.lex.bg/laws/ldoc/2134673412>
- Cultural Heritage Act*, 2009 adopted Official Journal No.19/13.03.2009, amend. OJ. 17/26. 02. 2021 [https://en.unesco.org/sites/default/files/bulgaria\\_culturalheritageact\\_2009\\_entof.pdf](https://en.unesco.org/sites/default/files/bulgaria_culturalheritageact_2009_entof.pdf)

## Културни екосистемни услуги, предоставяни от обектите на природното наследство в карстови територии на област Смолян

Мариана Николова, Стоян Недков, Биляна Борисова,  
Велимира Стоянова, Раденка Митова

Авторите предлагат и прилагат нова методология, основана на интегрирането на методи за категоризиране на природните обекти като природно наследство на национално ниво и методи за оценка, приоритизиране и картографиране на екосистемни услуги за развитието на рекреативните индустрии. Представени са резултатите от категоризацията на седемнадесет пещери на територията на област Смолян, номинирани за включване в категорията „национално природно наследство“. Оценява се техният капацитет да предоставят рекреационни екосистемни услуги въз основа на нов подход за приоритизиране на екосистемните услуги. Оценката е извършена чрез предложените Индекс на значимост и Индекс на релевантност. Въз основа на резултатите от оценката са определени пещерите, които отговарят на критериите да бъдат номинирани за национални обекти на природното наследство. Изследването показва приложното значение на екосистемния подход за развитие на рекреативните индустрии въз основа на действителния капацитет на обектите на природното наследство да предоставят съответните екосистемни услуги и ползи за отдих и туризъм.