Cave Vjetrenica

Volume I – Nomination file

World Heritage Nomination

Bosnia and Herzegovina, 2022

good management of the nominated property

United Nations Educational, Scientific and Cultural Organization · World Heritage Convention

UNESCO World Heritage Centre
7, place de Fontenoy
75352 Paris 07 SP
France
Telephone: +33 (0) 1 4568 1571
Fax: +33 (0) 1 4568 5570
E-mail: wh-nominations@unesco.org

Nomination Document for the Inscription on the UNESCO World Heritage List

Bosnia and Herzegovina

Volume 1: Nomination Dossier

Contents

Executive Summary

State party:	Bosnia and Herzegovina
State, province or region:	Herzegovina-Neretva Canton, Ravno
Name of nominated property:	Vjetrenica Cave, Ravno
Geographical coordinates to the nearest second:	N 42° 50' 45" E 17° 59' 1"

Textual description of the boundary of the nominated property

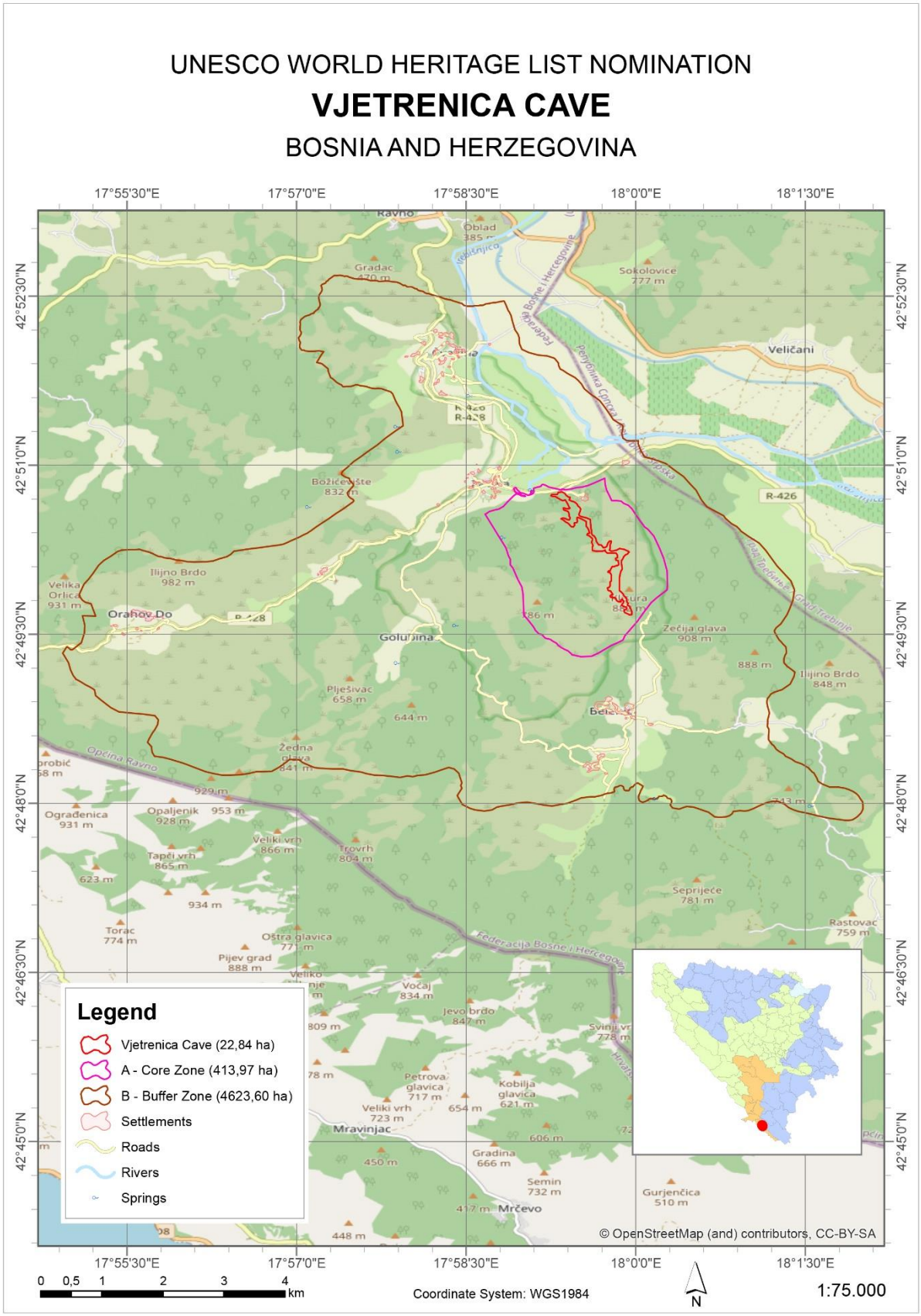
Vjetrenica is a complex cave system with passage length of 7.323,9 m; as such, it is the second longest cave in Bosnia and Herzegovina. The cave consists of the main passage of Upper Vjetrenica, about 2,500 m in length, and numerous side passages, the most important being: Lower Vjetrenica, Absolon's upper and lower passage, Radovanović's passage, Leopard's passage, Wales passage and Ravno passage named after the nearby settlement of Ravno.

It is located within the protected landscape "Vjetrenica-Popovo polje". Cave Vjetrenica sits in the area of the south Dinaric karst, in a karst hill stretching from the outhern edge of the western part of the Popovo polje plains (Eastern Herzegovina) to the Adriatic Sea. Its entrance is located on the very edge of the Popovo polje plains, 300 meters east of the central part of the village of Zavala, at 260 meters above sea level, 12 km by air to the Adriatic Sea (Republic of Croatia). The main direction of the cave passages is south – southeast, or in the direction of the coast. Noteworthy, the cave is located in the immediate hinterland of the city of Dubrovnik, a leading tourist hub. In addition to Vjetrenica, the cave system includes the Lukavac spring, located below the entrance to Vjetrenica, and the smaller Bjelušica cave, above the entrance to Vjetrenica.

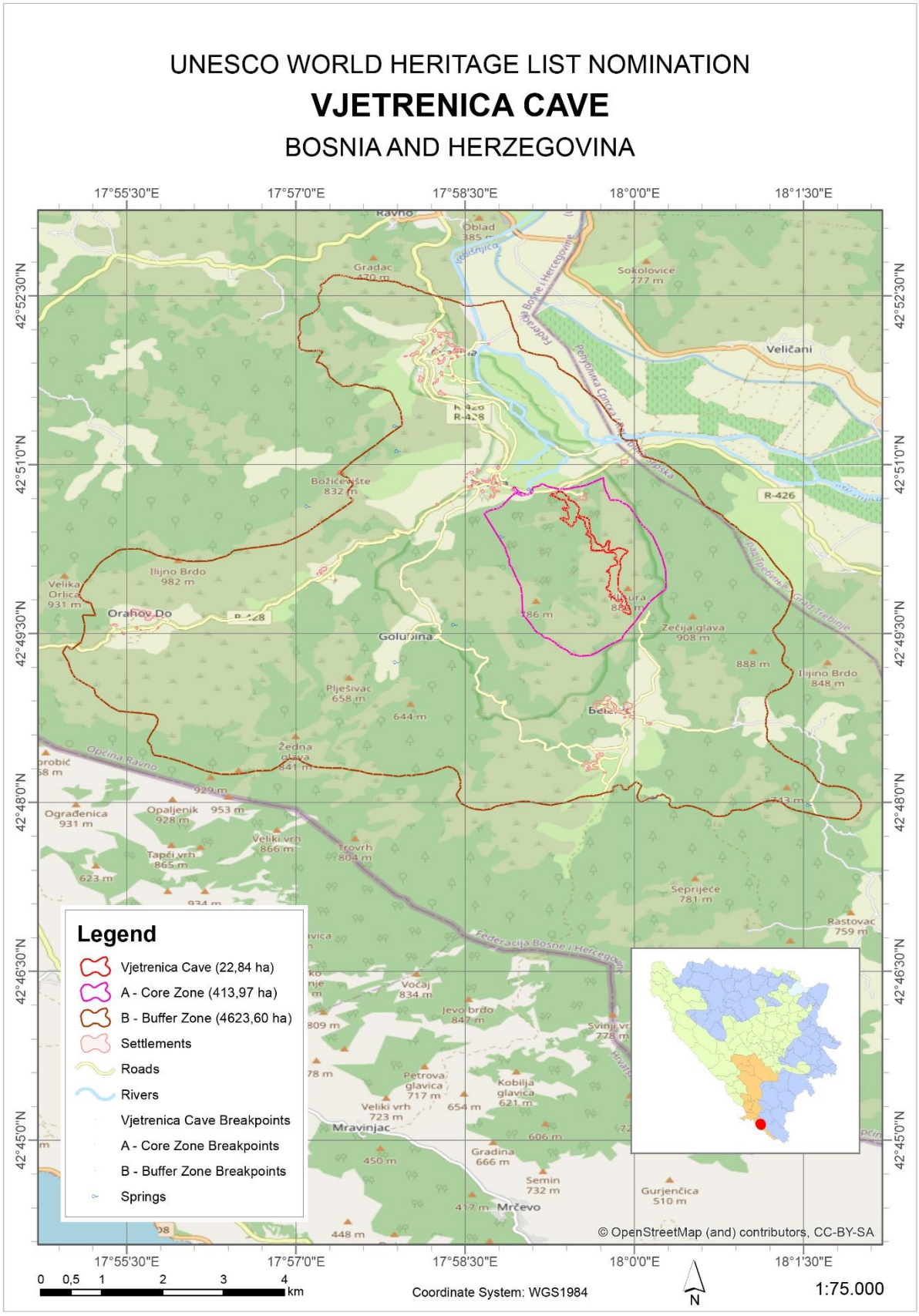
The cave has several permanent and disappearing streams and lakes, the largest some 180 m in length. It abounds in countless stalactites, flowstone, draperies, cascades and other cave formations. Also, it is it is one of the richest caves in the world in terms of its biological diversity, officially ranked as second, with 85 troglobionates. So far, over 231 cava taxa have been identified, of whitch over 65 stenoendemic. The remains of eight fossilised animals have been recovered in the cave, the largest being the cave bear (Carnivoria, *Ursus spelaeus* Rosenmüller, 1794) and one full skeleton of a leopard (Carnivoria, *Panthera pardus* (Linnaeus, 1758)). The rocks at the entrance to the cave have two carved stones, with drawings typical of medieval tombstones in the region. In scientific terms, Vjetrenica has been the site of numerous different forms of research, dating as far as back to the 16th century. In his work Historia Naturalis published in 77, Pliny the Elder makes a first reference to Vjetrenica in the mid-1st century a.d., with many references to follow by other authors, such as Getaldić. Systemic scientific research, however, will start only in late 19th century with Groller (1889), Vavrović (1893), Katzer (1903) and others. Vjetrenica Cave

was adjusted for tourist purposes even before 1940, with extensive works and lighting introduced in 1964, including a passageway of as many as 1800 meters long, and lighting in the length of 1050 meters, including a nearby motel built to accommodate tourists. The cave suffered major devastation in the period from 1991 to 1996, during the war.

Map 1 *Geografical location of "Cave Vjetrenica"*



Map 2 *Size map of the nominated property showing boundaries for Vjetrenica - Popovo polje*



Map 3 *Size map of the nominated property showing buffer zones for Vjetrenica - Popovo polje*

Criteria under which property is nominated (itemize criteria)

Criterion vii - to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

The cave system of Vjetrenica and its surroundings are exceptional and well-conserved manifestations of Karst topography. It reveals a broad range of karst features with its exceptional scale and aesthetic quality. Almost all passages in Vjetrenica are wide and high in their entire length. The cave consists of several passages that could be grouped into four levels: Main Level, Upper Level, Lower Level and Vertical Level. The Main Level is semi-horizontal and the longest in the cave. It runs from the cave entrance almost to the furthermost point of the cave. This is also the level with the longest and widest passages in the cave: Main Passage (Glavni kanal) and Main Hidden Passage (Skriveni glavni kanal). Even with the debris on the cave floor, untypical horizontality of that level caused differences in views over the direction of the slope (and the direction of the former water flow) of the main part of the cave. The Lower Level is approximately 10 to 30 meters lower than the Main Level, comprising the Lower Lake (Donje jezero), Karaman's Lake (Karamanovo jezero), Absolon's Lower Passage (Donji Apsolonov kanal), Absolon's Upper Passage (Gornji Absolonov kanal) and Radovanović's Passage (Radovanovićev kanal). These passages are grouped in the first part of the cave, up to approximately 600 meters from the entrance.

The Upper Level consists of five passages – the Leopard Passage (Leopardov kanal), High Flowstone Passage (Visoki zasigani kanal), Platy Passage (Pločasti kanal), Wales Passage (Velški kanal) and Ravno Passage (Ravanjski kanal). These passages are some dozens and up to 120 meters higher than the Main Level, and sit at 1700 to more than 2500 metres from the entrance. An assumed, but undetected, fourth level – the Vertical Level of the cave is believed to consist of deep pits that lead from the surface of the terrain to the cave. Despite speleologists' efforts, none of these pits were found. The main proof of the pits' existence is the air movement at the entrance and inside the cave. Milosavljević (1979), from an unknown source, references 13 m/s as the highest speed of the wind at the entrance, while the highest recorded speed during the recent mapping of Vjetrenica was 8.5 m/s (Lučić & Sket 2003). Such a strong 'wind cave' is possible only in caves with multiple entrances situated at different heights. The movement of air is caused by differences in air pressures and temperatures between the open atmosphere and underground cavities and air velocity is fastest in narrow passages (Bögli 1980). During high waters, when the sump in the Main Passage is completely flooded, there is no wind at the entrance (I. Lučić, 2009, pers. comm.). In other words, pits are connected with a cave beyond the approximate 1000 metres from the entrance, where the sump is. Due to the topography of the hill above the cave, those pits should be at least 160 m deep to be connected with the known parts of the cave.

Several smaller streams, both permanent and intermittent, exist in the cave. Directions of the flows are on course towards or opposite of the entrance. There are also several water pools, the largest of which is the Great Lake (Veliko jezero) with some 180 m in length, and a few sumps that occasionally close some of the passages (Lučić & Sket 2003). The walls and ceiling of the cave are only sporadically covered with flowstone, in the form of thinner or thicker flowstone coating. Dripstones (stalactites and stalagmites) are rare in the cave due to the most prominent process present in the cave – breakdown. Breakdown is a mechanical failure of rocks comprising the walls

and ceiling of the underground cavities (Ford & Williams 1989).

The floor of almost the entire cave is covered with angular rocks of different size mixed with clayish sediment. Several sizable chambers are almost entirely filled with rock blocks, slabs and chips, in the form of piles tens of meters high. It is almost certain that rock breakdown at some points choked the passages by completely filling these and cutting the way into other unexplored parts of the cave. A good example of a breakdown choking the passages is the entrance into the widest passage – the Main Hidden Passage. The entrance that leads through the boulders is only some 50 x 50 cm. In addition to carbonate clasts, large quantities of clay are also found on the cave floor. According to Radovanović (1929) and Malez (1985) there are two different ages of clay. The older clay lays under the breakdown rocks, covered by the more recent clay. Scallops are spoon-shaped depressions created by a fast-turbulent water flow. Their shape could be used to determine the direction of paleoflow in relict caves (Ford & Williams 1989). In front of the cave entrance is a karst plain named Popovo polje. The Trebišnjica River, the largest European sinking river, passes through the plain. Before hydrotehnical interventions in the middle of the 20th century, Popovo Polje was flooded on an average 253 days a year (Milanović 2006). The hydrological function of Vjetrenica in the past caught attention of many researchers. Some of the authors agree that Vjetrenica had a function of a swallow hole for water from the Popovo Polje (Absolon 1916, Radovanović 1929, Cvijić 1950, Malez 1985, and that the cave spread all the way to the Adriatic coast. Milojević (1928 1938 and Zubčević & Gašparović (1958, however, argue the opposite – that water from Vjetrenica flows into the Popovo polje. The main argument in both points was the topography of the cave bottom from the entrance to the Great Lake. The problem was that the map drawn by Radovanović (1929) shows a slope in the direction inside the cave while maps drawn by Milojević (1938) and Zubčević & Gašparović (1958) show a slope in the direction of the cave entrance. The last map of the cave is the one published by Lučić & Sket (2003). According to that map, the entrance of the cave lies at some 8 metres above the Great Lake which is further at a distance of 1200 metres. In the Four-state Model (Ford & Williams 1989) of differentiation of phreatic and water table types of caves, Vjetrenica belongs to caves with a mixture of phreatic and water table levelled components, close to the ideal water table cave.

Criterion x - to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation

Vjetrenica is a remarkable and the most unique cave, located in the Popovo polje, a karstic plain in the south of Bosnia and Herzegovina. It is quite a sizable cave – more than 6000 meters have been explored, with several subterranean lakes (one is 180 meters long); and it has been known since Antiquity (Pliny the Elder makes a reference to the cave in his Historia Naturalis). It earned its name (vjetar = wind) thanks to a strong cold wind at almost all times. Yet, biodiversity is what gives it its uniqueness: while most caves on the planet harbour only a handful of animal species, Vjetrenica has the unique feature of sheltering more than a hundred, and is likely the richest in the world in terms of biodiversity. Among these cave species, more than half are endemic in the Popovo polje, while others are only know to inhabit Vjetrenica.

Vjetrenica is one of the most faunistically rich caves in the world (Culver & Sket, 2000), due to its

biogeographical position in the Dinaric karst, its size, and ecological heterogeneity. It is also one of the world's most prominent biodiversity hotspots for cave-dwelling fauna. In fact, 231 taxa were detected in Vjetrenica: two types of bacteria, 14 fungi, 35 protista and 180 animals, with 96 cave-dwelling taxa *Nitrospira (1), Gammaproteobacteria (1), Trematoda (1), Enopla (1), Gastropoda (11), Bivalvia (1), Hydrozoa (2), Amphibia (1), Myriapoda (8), Insecta (11), Entognatha (4), Crustacea (36), Arachnida (9), Polychaeta (1), Oligochaeta (7), Hirudinea (1),* and together with Lukavac spring and Bjelušica Cave, as parts of its system, Vjetrenica is a type locality for 38 taxa, of which 14 are strictly endemic, and tree are monotypic: *Zavalia vjetrenicae* ((Radoman,1973))(*Gastropoda*), *Troglomysis vjetrenicensis* ((Stammer, 1933)) (*Crustacea*) and *Nauticiella stygivaga* ((Moravec & Mlejnek 2002))(*Coleoptera*). Vjetrenica is inhabited by more than 49 troglobites and 56 stygobites.

Further monotypic genera, found in other speleological objects of the Popovo polje include: *Spelaeoconcha paganetti* (Sturany, 1901) (*Gastropoda*), *Marifugia cavatica* (Absolon & Hrabe, 1930) (*Polychaeta*), *Velkovrhia enigmatica* (Matjasic & Sket, 1971) *(Hydrozoa*), *Stalitella noseki* (Absolon & Kratochvíl, 1933) (*Araneae*), *Dinaria vjetrenicae* (Hadži, 1932) (*Opiliones*), *Typhlogammarus mrazeki* (Schaferna, 1907) (*Crustacea*), *Spelaeocaris pretneri* (Matjasic, 1956) (Crustacea) and *Proteus anguinus* (Laurenti, 1768), (*Vertebrata, Amphibia*).

Among the veterinary fauna, some taxa stand out, in particular: *Velkovrhia enigmatica (*Matjasic & Sket, 1971), the only one species of the genus, the only freshwater species of the family Bougainvilliidae and the only troglobiont species of Hydrozoa (Sket 2003). Congeria kusceri (Bole, 1962) is a living fossil, the only one of the hundred or so extinct species of congeria that peaked in the Upper Miocene, and which inhabited the freshwater remnants of the Dinaric and Pannonian seas in the Pliocene, and the only stigobiont shellfish (Bivalvia). *Marifugia cavatica* (Absolon & Hrabe, 1930) is the only freshwater serpulide (Serpulidae) and the only stigobiont tubeworm (Polychaeta) (Sket 2003).

Pholeoteras euthrix (Sturany, 1904) is the only known snail from the Cyclophoridae family in Europe, a relic of old tropical fauna (Sket, 2003).

Dina absoloni (Johansson, 1913) is the first discovered stigobiont species of leech (Hirudinea) in the world; *Proteus anguinus (*Laurenti, 1768) the well-known olm, is the only European troglobiont vertebrate. With as many as ten species of the genus *Niphargus* (Amphipoda), biological diversity of Vjetrenica is explained as a phenomenon of local radiation, not yet recorded in the world underground (Sket 2006). *Hadzia fragilis* (Karaman, 1932) (Amphipoda) is a typical species of crustacean for the genus *Hadziidae*. Vjetrenica is home to three troglobiont species of ten-legged crustaceans (Decapoda), of which two species of the genus *Troglocaris* (*T. anophthalmus* (Kollar 1848), *T. hercegovinensis* (Babić, 1922) and the only species of the genus *Spelaeocaris, Spelaeocaris pretneri* (Matjasic, 1956).

Vjetrenica Cave is a typical site of many invertebrates that exclusively inhabit the Vjetrenica system (according to Ozimec and Lučić, 2010). According to the data, as many as 14 of the 38 species for which the Vjetrenica system is a typical site are endemic to the Balkan Peninsula or are an endangered or vulnerable species.

Brief synthesis

Vjetrenica is one of the longest caves in Bosnia and Herzegovina. Topographic mapping is still in progress, meaning that its length exceeds the published 5699 m (Lučić & Sket, 2003). According to recent exploration and mapping, its length is 7.323,9 m meters (Ozimec et al., 2021.). In the past, the cave drew attention for its strong movements of air or 'wind' that blows from the cave in warm months and into the cave in cold months. The cave is located in the south Dinaric karst, between the Popovo polje plains (East Herzegovina) and Dubrovnik (Adriatic Sea, Croatia), as part of the Trebišnjica river system, the longest losing stream in Europe. The region is characterised by strong tectonic and geodynamic activity, high purity of carbonate (99.98%) and 2,000 millimetres of annual rainfall. For the first time in the world, biospeleological research of Vjetrenica established a cave hygropetric habitat, with a thin layer of water covering rocks.

In Vjetrenica, 231 taxa were detected in Vjetrenica: two types of bacteria, 14 fungi, 35 protista and 180 animals, with 96 cave-dwelling taxa. It is the very particular environmental conditions of the cave that provide a habitat for rare and threatened fauna. The cave also bears historic importance. Examples of leopards from Vjetrenica are known globally as best preserved and the most complete skeletons of its kind, with greatest importance in palaeontology. The remains are a testament to period spanning from 29000 to 37000 years, and corroborate the fact of their existence in earlier Pleistocene. Vjetrenica is both a nature and archaeological site.

Justification for Criteria

Criterion vii - to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

The cave system of Vjetrenica and its surroundings are exceptional and well-conserved manifestations of Karst topography. It reveals a broad range of karst features with its exceptional scale and aesthetic quality. Almost all passages in Vjetrenica are wide and high in their entire length. The cave consists of several passages that could be grouped into four levels: Main Level, Upper Level, Lower Level and Vertical Level. The Main Level is semi-horizontal and the longest in the cave. It runs from the cave entrance almost to the furthermost point of the cave. This is also the level with the longest and widest passages in the cave: Main Passage (Glavni kanal) and Main Hidden Passage (Skriveni glavni kanal). Even with the debris on the cave floor, untypical horizontality of that level caused differences in views over the direction of the slope (and the direction of the former water flow) of the main part of the cave. The Lower Level is approximately 10 to 30 meters lower than the Main Level, comprising the Lower Lake (Donje jezero), Karaman's Lake (Karamanovo jezero), Absolon's Lower Passage (Donji Apsolonov kanal), Absolon's Upper Passage (Gornji Absolonov kanal) and Radovanović's Passage (Radovanovićev kanal).

Criterion x - to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation

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Vjetrenica is one of the most faunistically rich caves in the world (Culver & Sket, 2000), due to its biogeographical position in the Dinaric karst, its size, and ecological heterogeneity. It is also one of the world's most prominent biodiversity hotspots for cave-dwelling fauna. In fact, 231 taxa were detected in Vjetrenica: two types of bacteria, 14 fungi, 35 protista and 180 animals, with 96 cave-dwelling taxa. Together with Lukavac spring and Bjelušica Cave, as parts of its system, Vjetrenica is a type locality for 38 taxa, of which 14 are strictly endemic, and tree are monotypic. Vjetrenica is inhabited by more than 49 troglobites and 56 stygobites. Vjetrenica Cave is a typical site of many invertebrates that exclusively inhabit the Vjetrenica system (according to Ozimec and Lučić, 2010). According to the data, as many as 14 of the 38 species for which the Vjetrenica system is a typical site are endemic to the Balkan Peninsula or are an endangered or vulnerable species.

Statement of integrity

The area of the Vjetrenica cave and its surroundings adequately represents both natural and cultural, terrestrial and aquatic features, as well as processes of importance for the long-term conservation of the rich biodiversity and exceptional natural beauty. Vjetrenica Cave is the most important and unique element of biodiversity of this part of the region. The area around the Vjetrenica cave also protects all major terrestrial vegetation species and important species habitats. The nomination of the Vjetrenica cave will include all the features that make up the outstanding universal value of the property. In addition to an internationally renowned site of Vjetrenica Cave, the nominated area includes lesser-known and as yet unexplored sites. We are thus in a position to permanently maintain the integrity of the designated property with the help of existing protective measures and safeguard provisions.

Vjetrenica Cave is a complex underground system that has not yet been fully explored, offering exceptional opportunities for further exploration of the karst underground of the Dinarides, primarily along the lines of physical speleology, geology, hydrology, ecology, biospeleology, paleontology, archeology; but also underground climatology, tectonics and more. Research brings us new insights about caves themselves, hydrogeological and ecological relations, the

present living world extremely rich endemic species and many other aspects important for this area, but also for the community as a whole.

The main threats to the integrity of the property include a wide range of anthropogenic influences (physical devastation, changes in the habitat and ecology of the cave, waste accumulation, collection and disturbance of cave fauna, uncoordinated urban development, population growth in the area above and around caves, old infrastructure, and illegal interventions at springs and tourist pressure). Total property compliance, and in particular the relationship between urban projects and landscapes, is sensitive to lack of proper control of new development.

Statement of authenticity for properties nominated under criteria (i) to (vi)

Not relevant as this property is nominated under criterions (vii) and (x)

Protection and Management Requirements

Vjetrenica Cave belongs to the system of karst areas, and it is the most endangered habitat type in BiH. Vjetrenica is a complex cave system and the longest cave in BiH, and it is also a hydrologically active cave system with active groundwater and underground lakes. The first form of protection of Vjetrenica took place already in 1952, and the relevant spatial planning documentation so far suggested that this area of Vjetrenica cave with the surroundings of the karst plateau and part of the Popovo polje should be under protection. However, the Vjetrenica cave area today does not enjoy formal legal protection; in order to achieve this, it is necessary to inspect the area as well as all other protected areas before 2003 in accordance with the 2013 Law on Nature Protection.

According to the Law on Nature Protection from 2013 (Official Gazette of FBiH, No. 66/13), which is partly harmonised with EU legislation, Vjetrenica Cave is a former natural monument, classified in Category III of protected parts of nature and is in the process of re-proclamation, entrusted to the competence of the regional administration or canton. For the procedure of classification into this category, it is necessary to determine the status of the Vjetrenica cave as a protected area.

In 2021, with the decision to declare this area as a protected landscape "Vjetrenica - Popovo Polje", this area receives formal legal protection, respecting all legally formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina. In 2021, the Municipality of Ravno held a session on 31.08.2021. (OV-III.60 / 21) adopted the Management Plan for the protected landscape "Vjetrenica-Popovo polje" for a period of 10 years.

Currently, the Ravno Municipality entrusted the management and care of the cave to Vjetrenica Public Company Ltd. Ravno, which performs daily management activities in the area, including maintenance of Vjetrenica cave. According to the current Development Plan, the Protected Landscape / Landscape “Vjetrenica - Popovo polje” covers an area of 4,710.17 ha

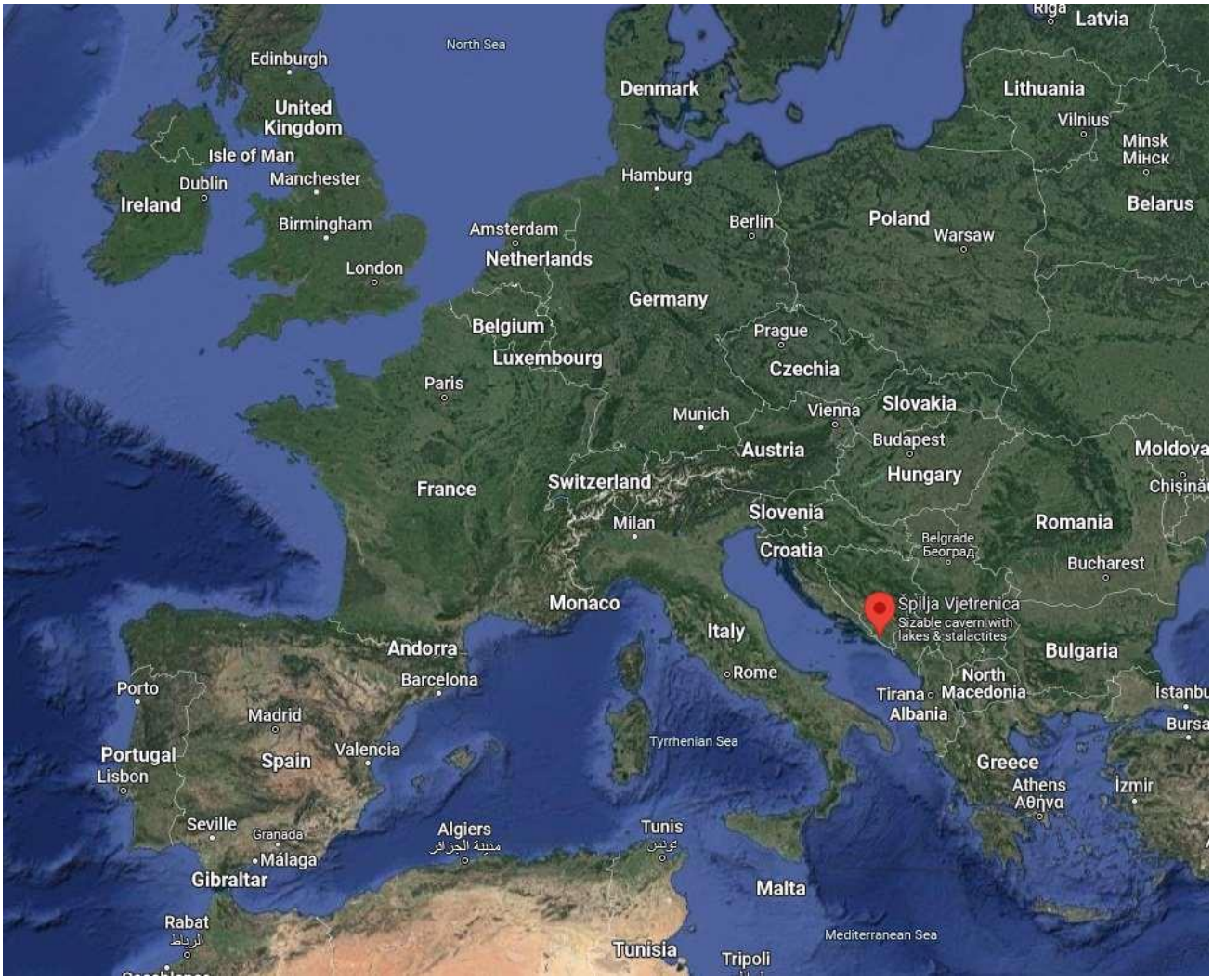
Name and contact information of official local institution/agency

Name and contact information of official local institution/agency/organisation:
FBiH Ministry of Tourism and Environment Hamdije Čemerlića 2 71000 Sarajevo Bosnia and Herzegovina Phone: +387 33 726-700 Fax +387 33 726-747 Email: fmoit@fmoit.gov.ba Web: https://www.fmoit.gov.ba/
Ministry of Trade, Tourism and Environmental Protection of the Herzegovina-Neretva Canton Braće Fejića bb 88000 Mostar Bosnia and Herzegovina Phone: + 387 36 551 823 Fax: + 387 36 552 806 Email: info@mtto-hnz-k.ba Web: https://mtto-hnz-k.ba/
Public Company Vjetrenica d.o.o, Ravno Trg Ruđera Boškovića bb 88370 Ravno Bosnia and Herzegovina Phone: + 387 36 891 034 Email: info@vjetrenica.ba Web: https://www.vjetrenica.ba/

1. Identification of the property

1.a State Party:

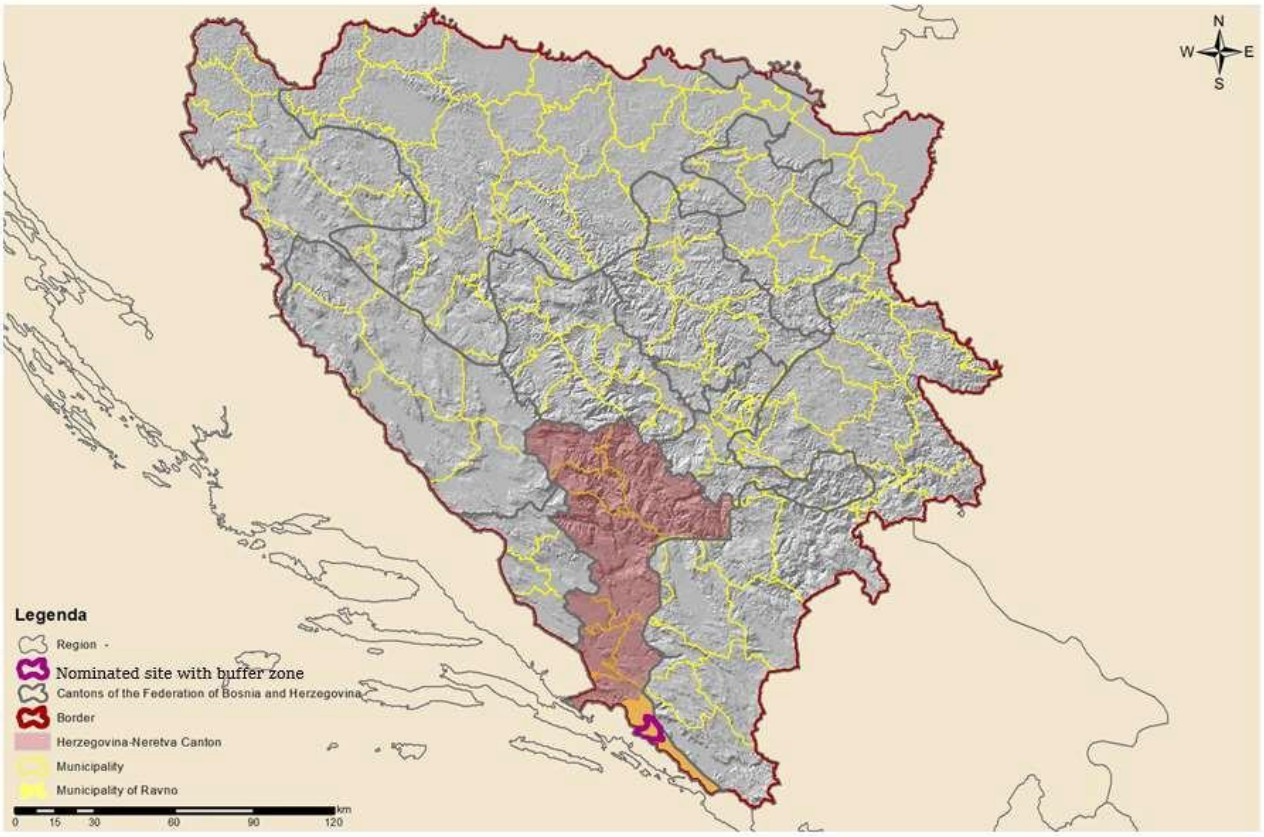
Bosnia and Herzegovina



Map 4 *Bosnia and Herzegovina and Cave Vjetrenica location*

1.b State, Province or Region:

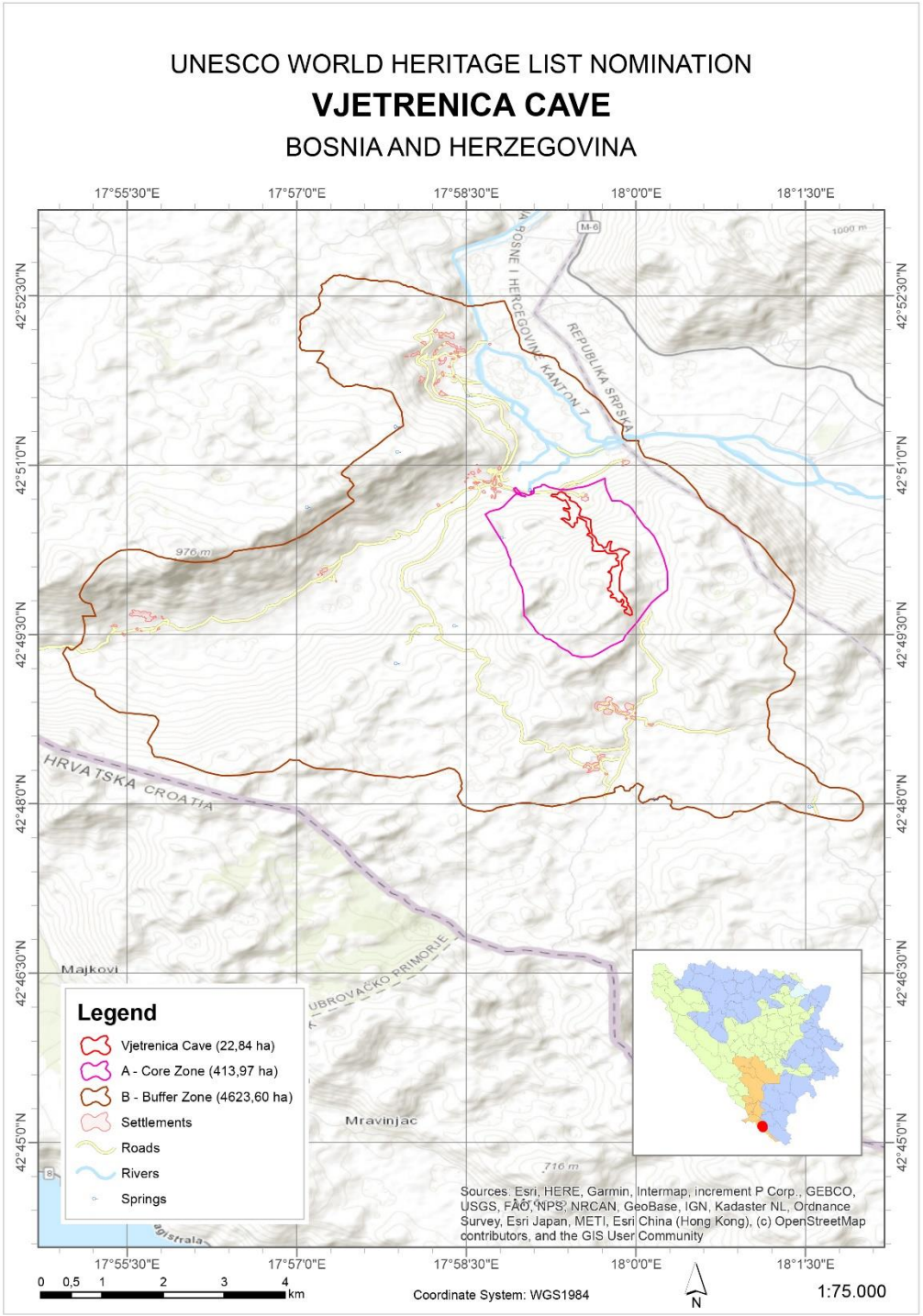
Ravno Municipality, Herzegovina-Neretva Canton



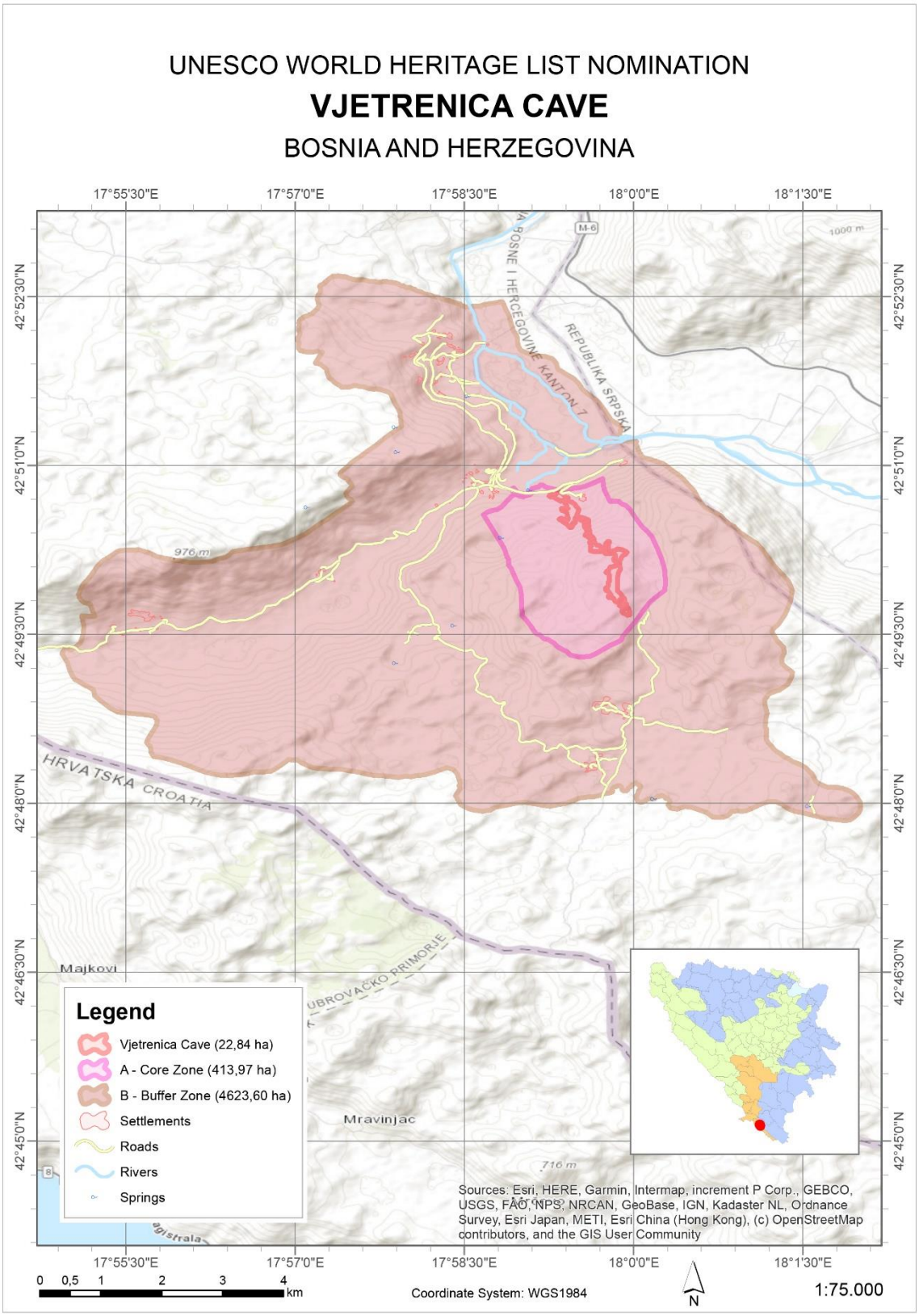
Map 5 *Position of the proposed nominated site Vjetrenica cave and its buffer zone in relation to municipalities, cantons, state border and region*

1.c Name of Property:

Vjetrenica Cave
Protected Landscape „Vjetrenica – Popovo polje“



Map 6a *The position of the nominated site Vjetrenica cave in relation to the boundaries of the buffer zone which corresponds to the boundaries of the Protected Landscape „Vjetrenica – Popovo polje“*

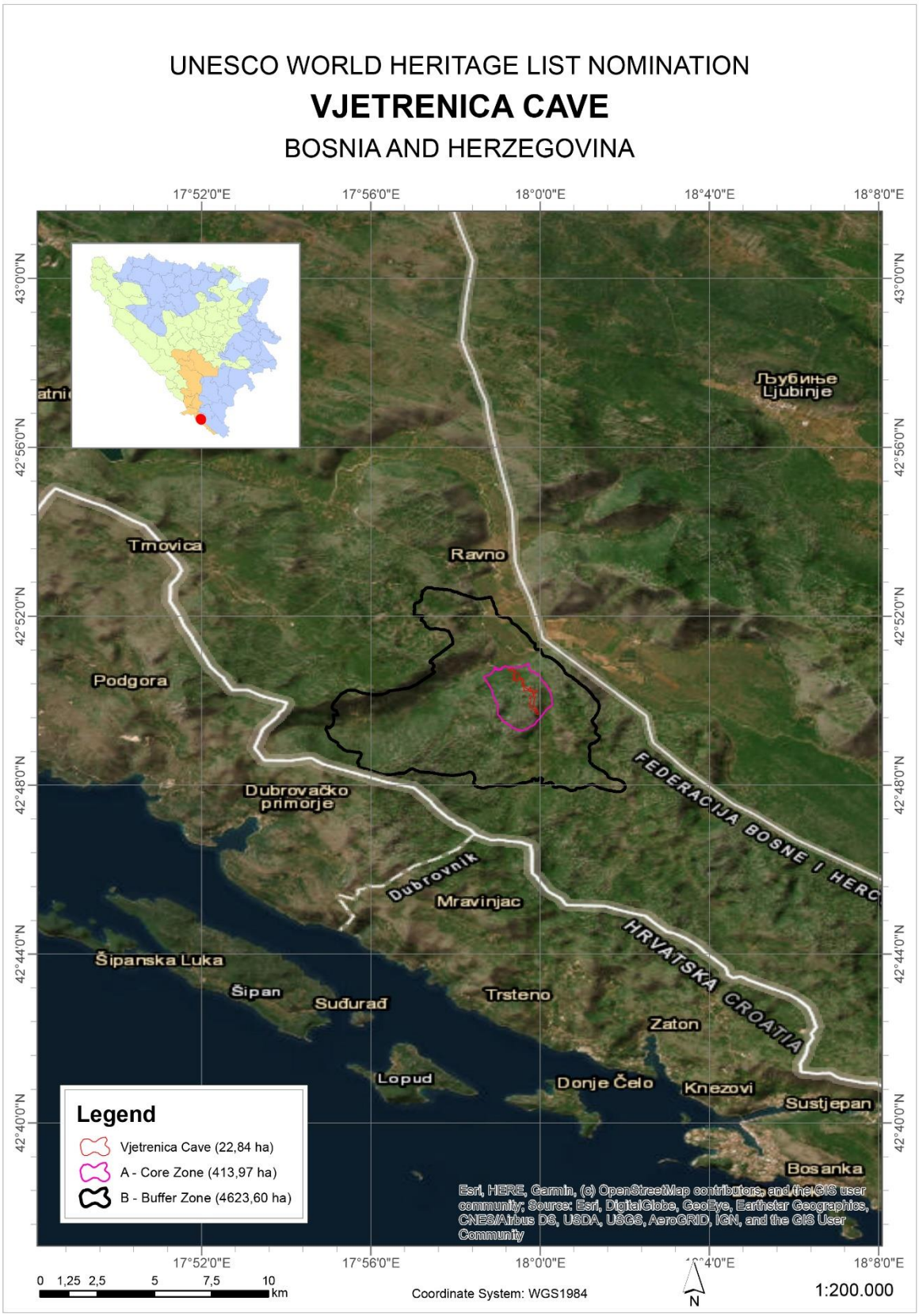


Map 6b *The position of the nominated site Vjetrenica cave in relation to the boundaries of the buffer zone which corresponds to the boundaries of the Protected Landscape „Vjetrenica – Popovo polje“*

1.d Geographical coordinates to the nearest second:

Table 1 *Geographical coordinates*

Name of the component part	**Region(s) /District (s)**	**Cordinates of the Central Point**	**Area of the Nominated component part (ha)**	**Area of the Buffer Zone (ha)**
Vjetrenica Cave	Bosnia and Herzegovina Ravno Municipality, Herzegovina-Neretva Canton	N 42° 50' 45" E 17° 59' 1"	**423 ha**	**4,290 ha**
Total area (in hectars)			**423 ha**	**4,290 ha**



Map 7 *Cave Vjetrenica position in region*

1.e Maps and plans showing boundaries of the nominated property and buffer zone

Id No. and page	Caption	Contatct detalis of copyright owner (Name, adress, tel/fax, and email)
Map 1 Page 6	Geografical location of "Cave Vjetrenica"	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
Map 2 Page7	Size map of the nominated property showing boundaries for Vjetrenica - Popovo polje	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
Map 3 Page 8	Size map of the nominated property showing buffer zones for Vjetrenica - Popovo polje	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
Map 4 Page16	Bosnia and Herzegovina and Cave Vjetrenica location	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
Map 5 Page 17	Position of the proposed nominated site Vjetrenica cave and its buffer zone in relation to municipalities, cantons, state border and region	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
Maps 6a, 6b Page 18, 19	The position of the nominated site Vjetrenica cave in relation to the boundaries of the buffer zone which corresponds to the boundaries of the Protected Landscape „Vjetrenica – Popovo polje"	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com

Map 7 Page21	Cave Vjetrenica position in region	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
Maps 8a, 8b, 8c, 8d Page 25, 26, 27, 28	Boundaries of the nominated property and buffer zone	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com
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		soldo.ana@gmail.com
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Map 14 Page 145	Land capability classes of agricultural areas within the scope of protected area Vjetrenica - Popovo polje	Trg Ruđera Boškovića bb 88370 Ravno, BiH Tel.036/891-034 info@vjetrenica.ba
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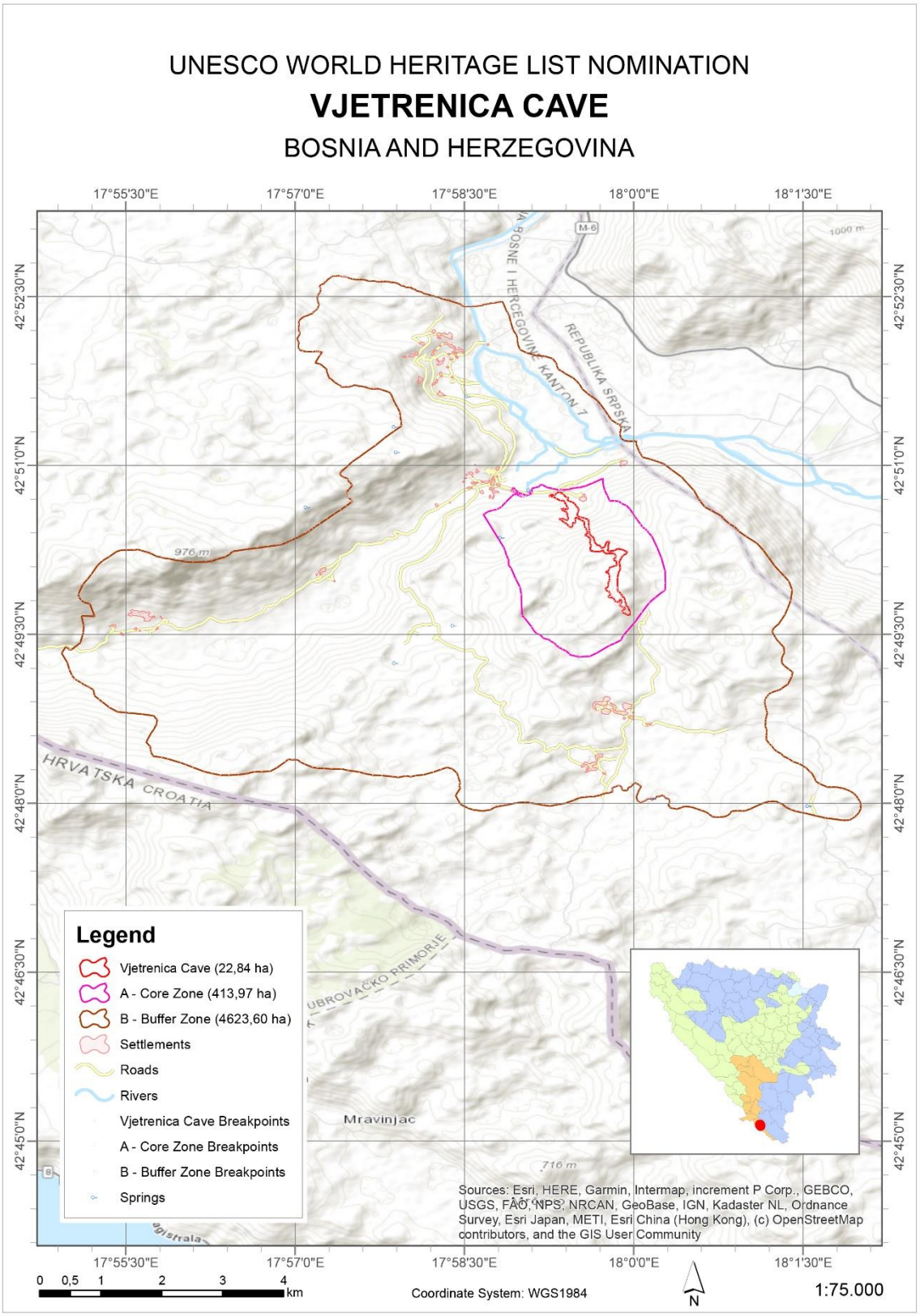
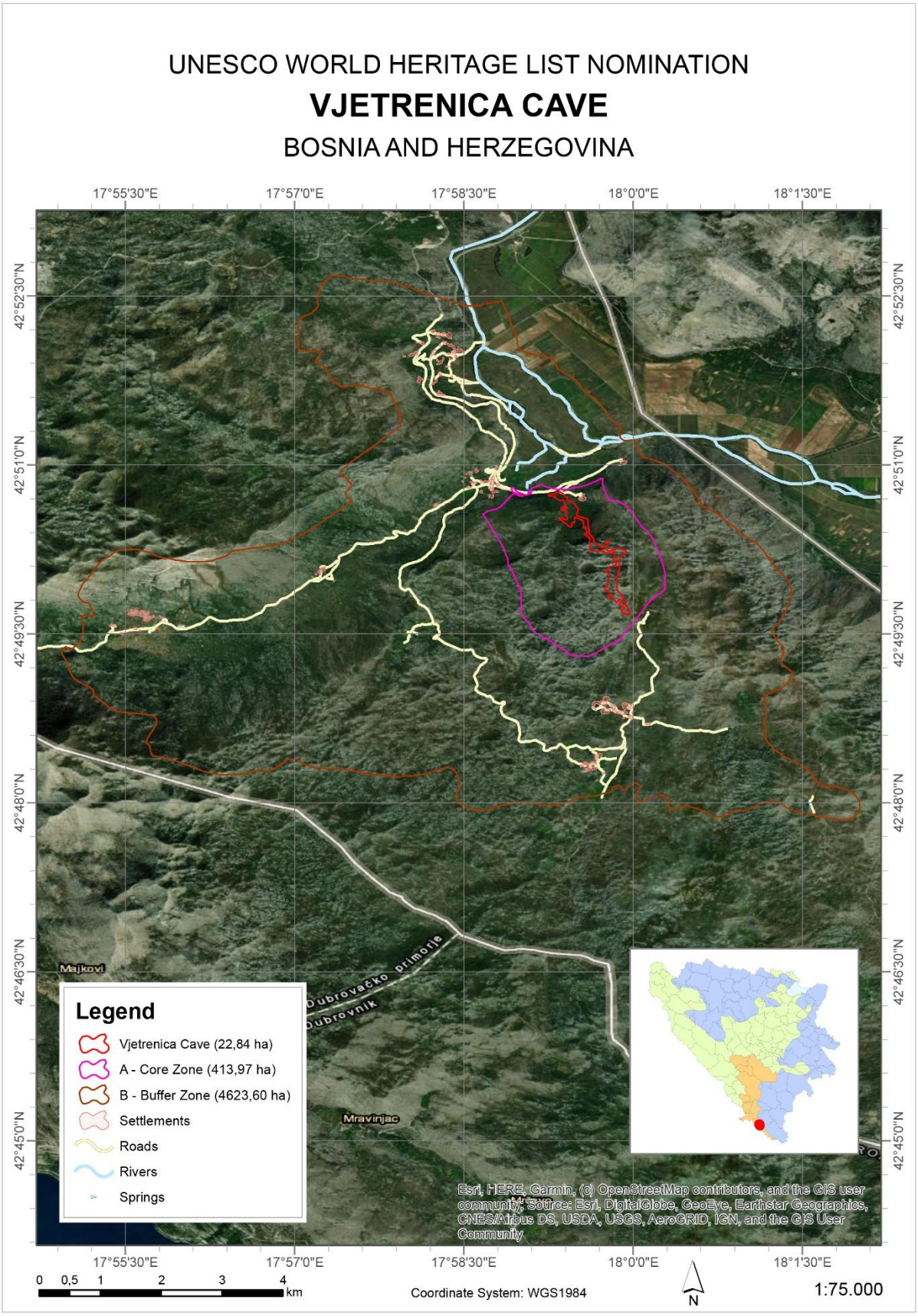
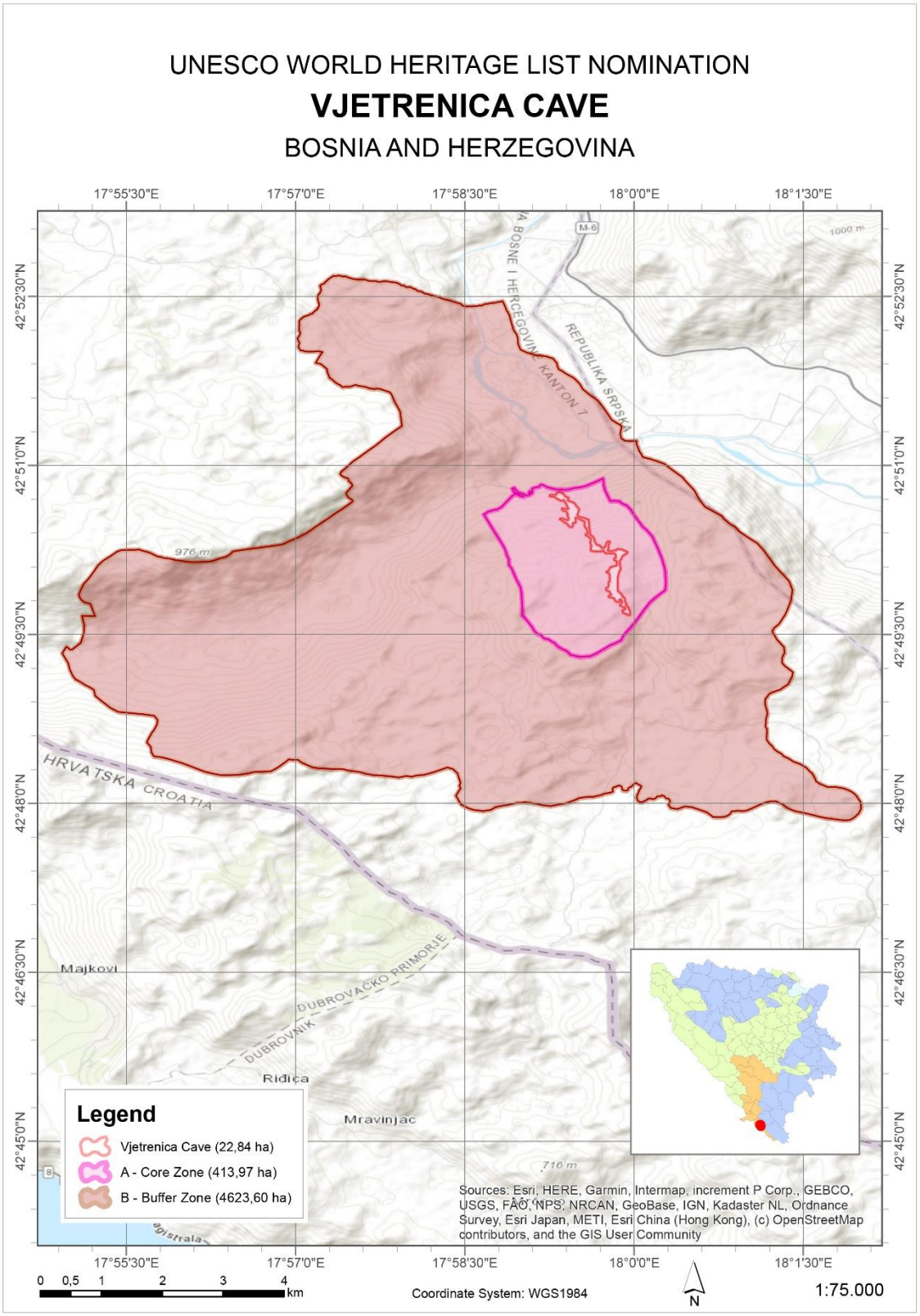
Map 18 Page 163	Transport network within the protected area Vjetrenica -	Marlena Ćukteraš Tasovčići 25 88300 Čapljina 0037863640369 mcukteras@gmail.com



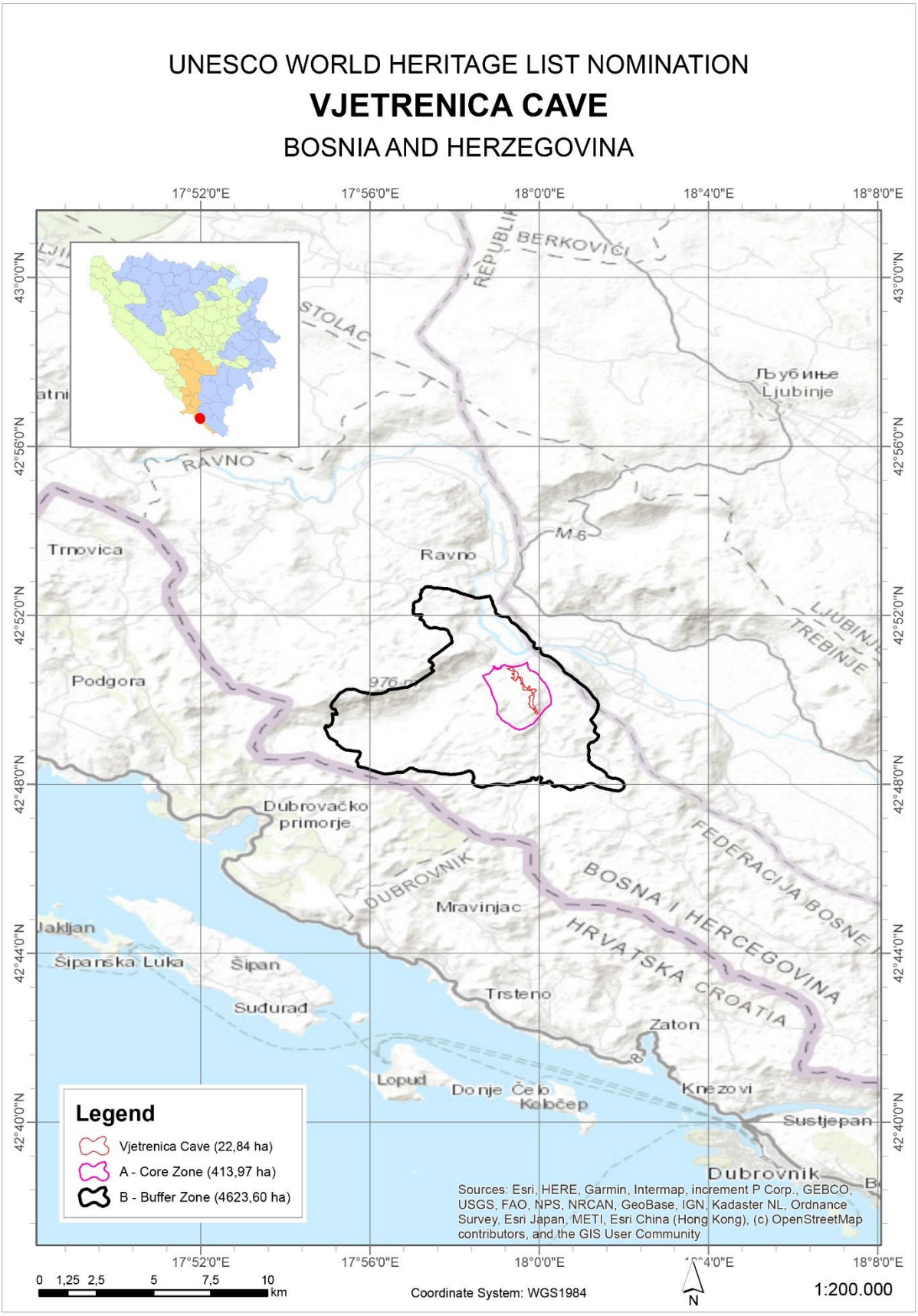
Map 8a *Boundaries of the nominated property and buffer zone*



Map 8b *Boundaries of the nominated property and buffer zone*



Map 8c *Boundaries of the nominated property and buffer zone*



Map. 8d *Boundaries of the nominated property and buffer zone*

1.f Area of nominated property and proposed buffer zone

Nominated Property: 423 ha
Buffer Zone: 4290 ha
Total: 4713 ha

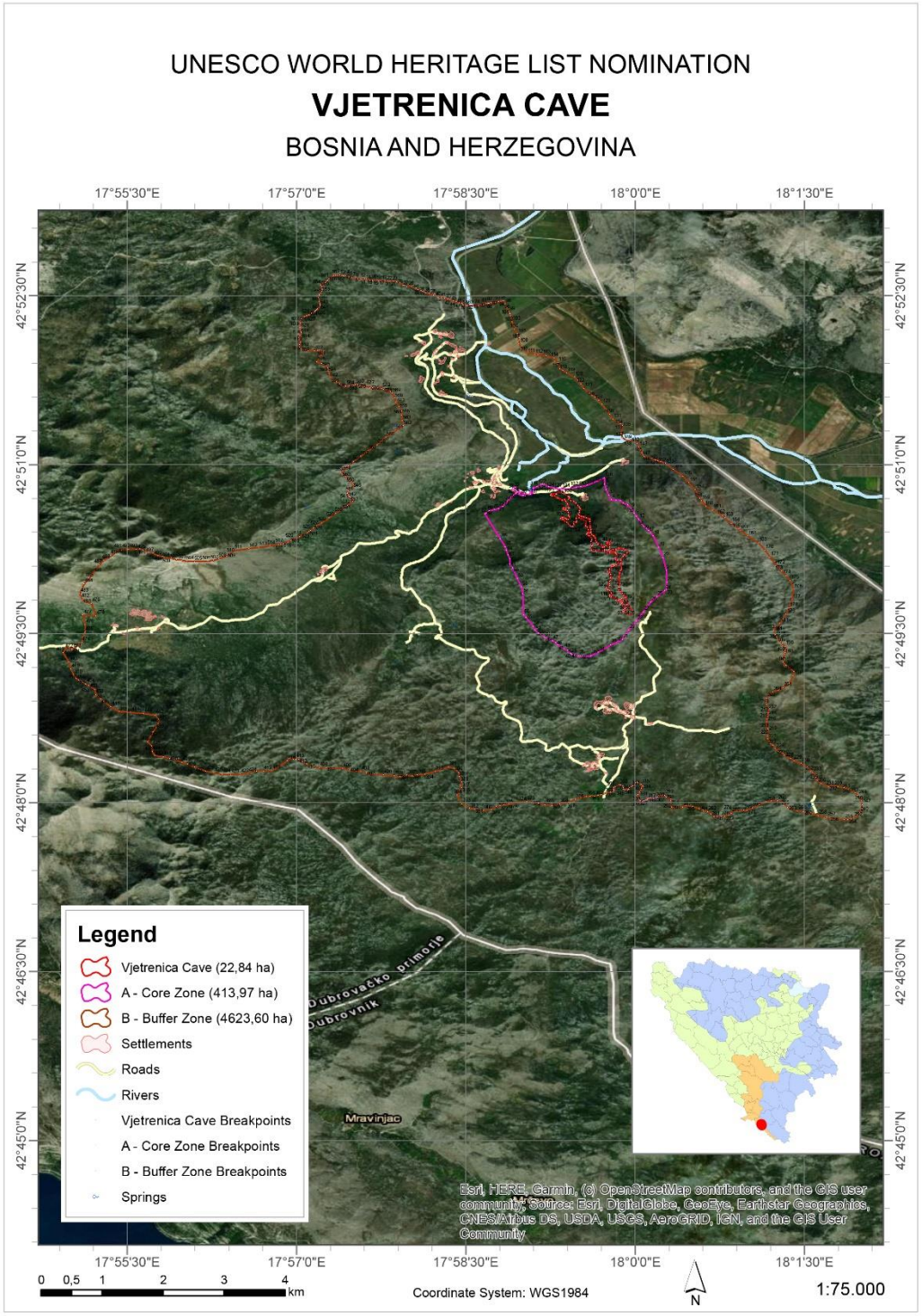
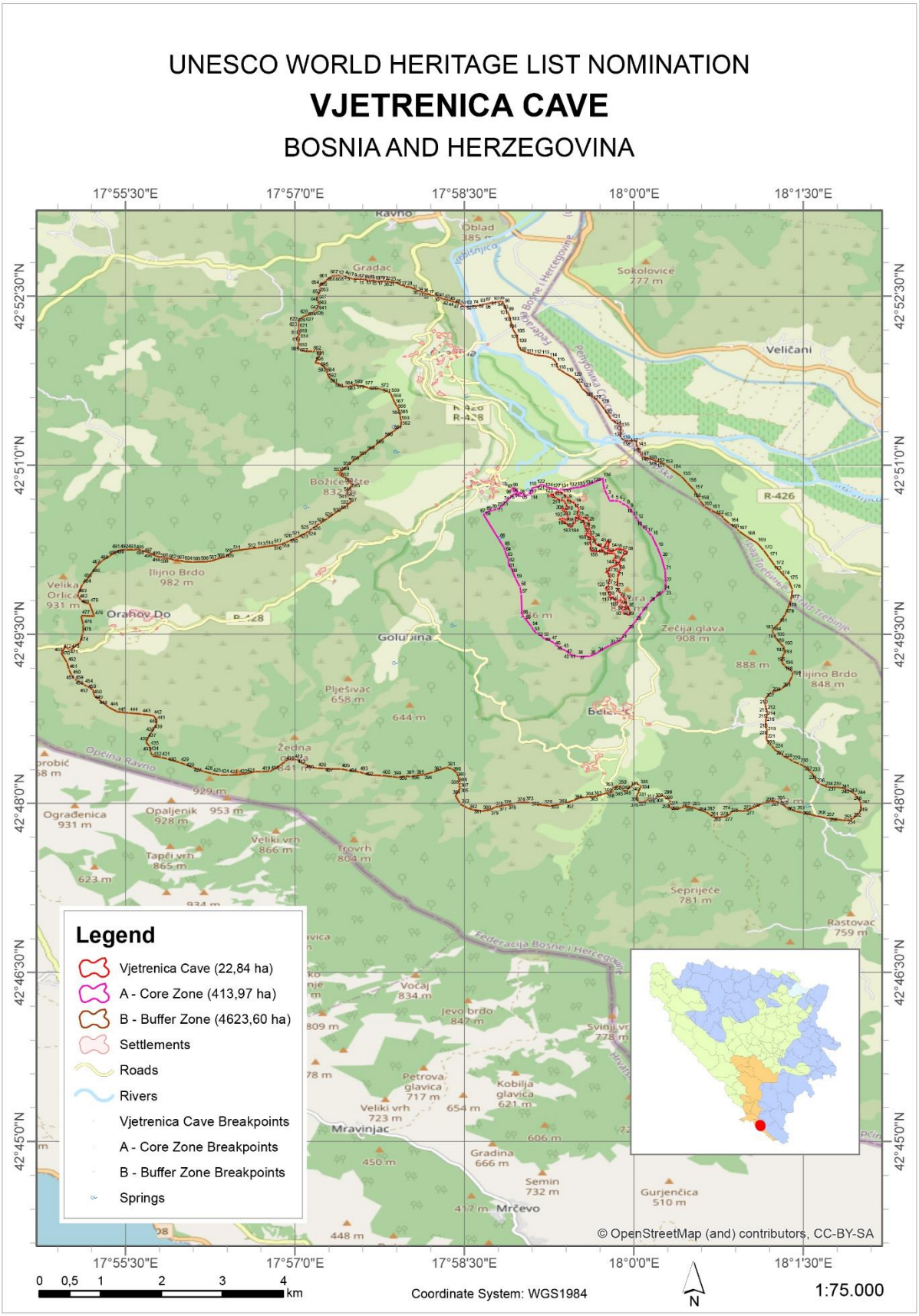
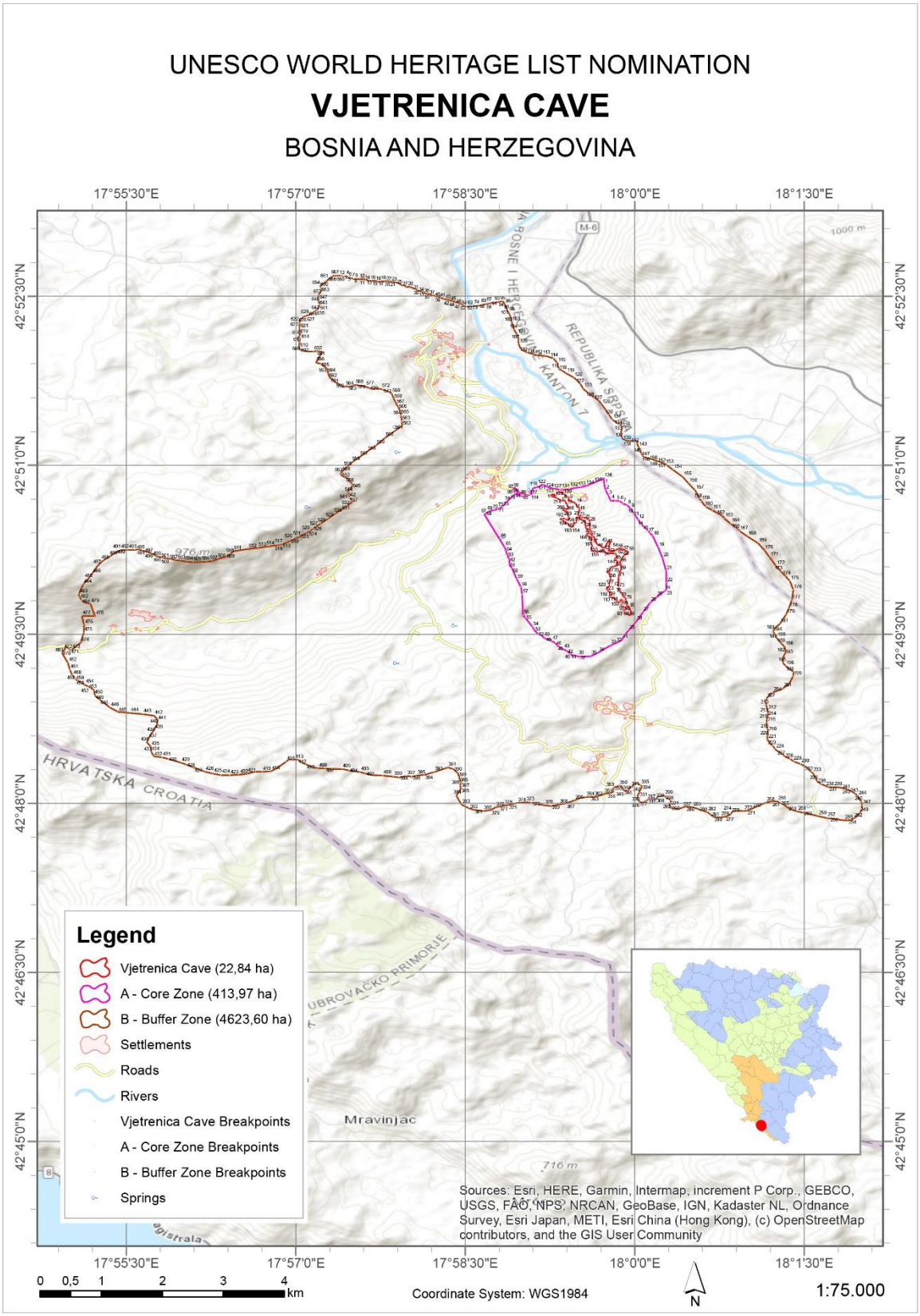


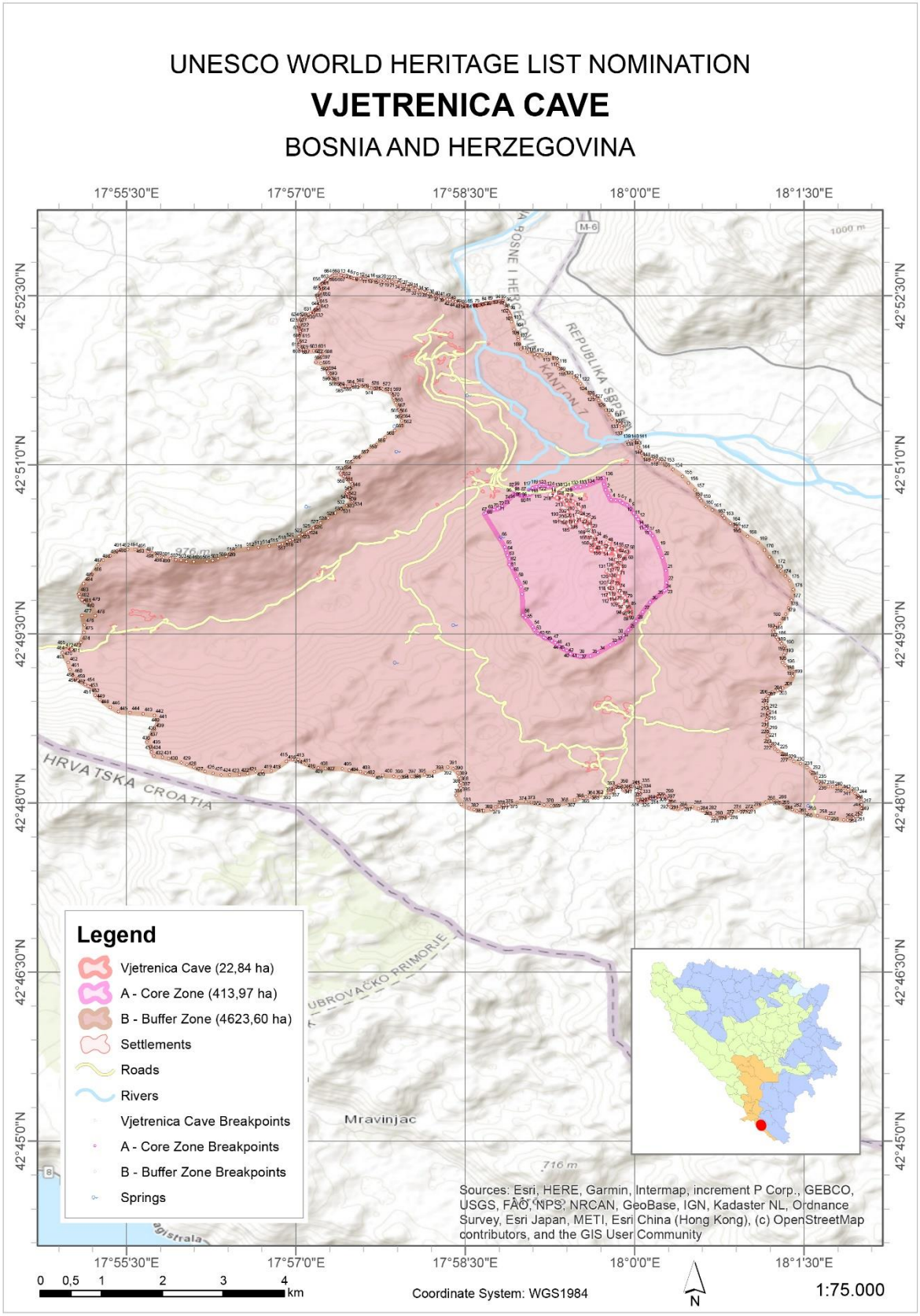
Fig. 9a *Area of nominated property and proposed buffer zone*



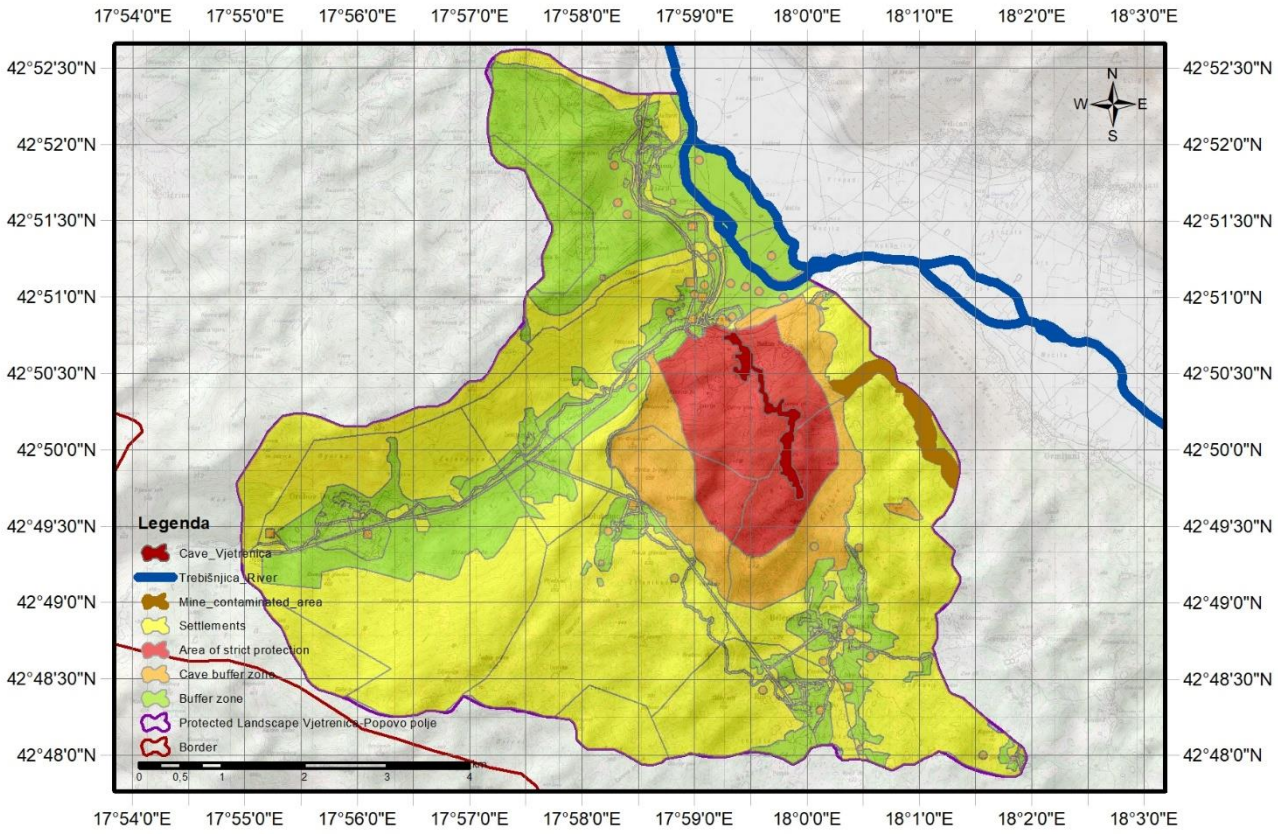
Map 9b *Area of nominated property and proposed buffer zone*



Map 9c *Area of nominated property and proposed buffer zone*



Map 9d *Area of nominated property and proposed buffer zone*

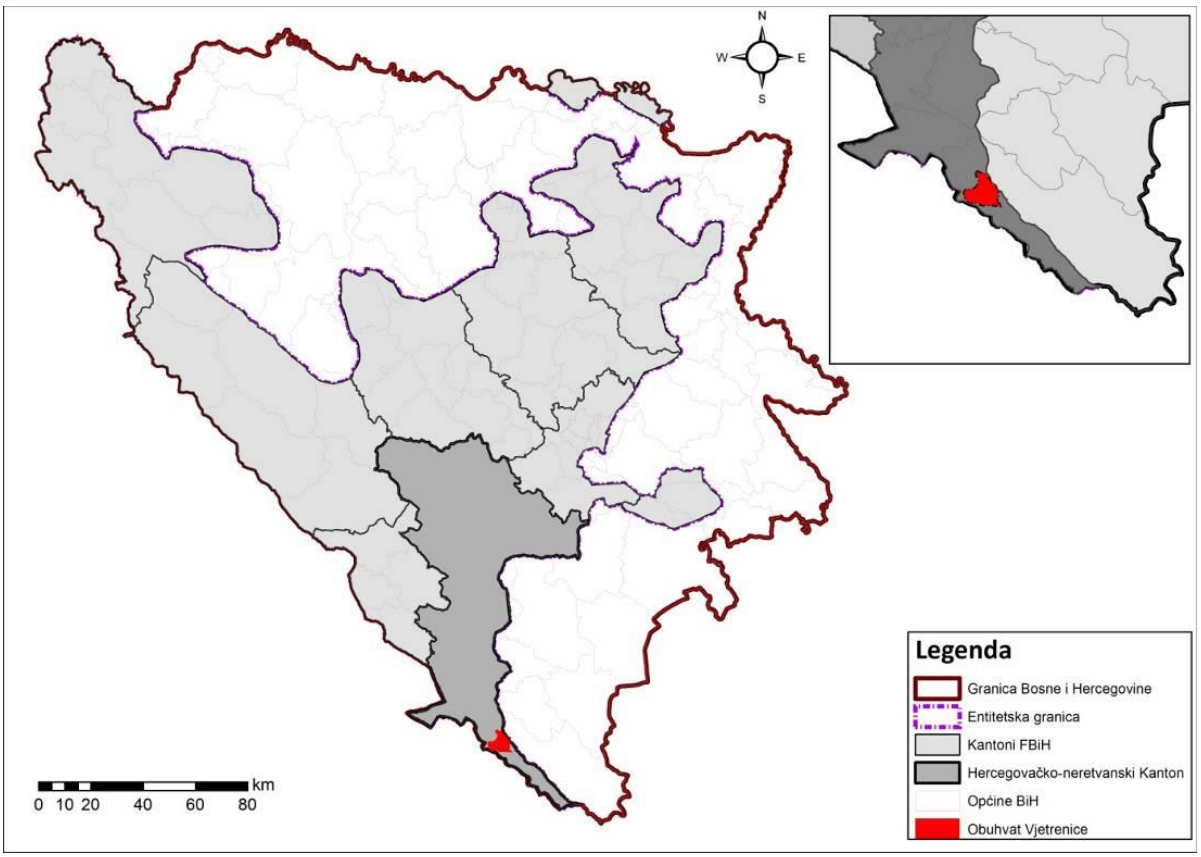


Map 9e *Size map of the nominated property showing boundaries and buffer zone for Vjetrenica - Popovo polje*

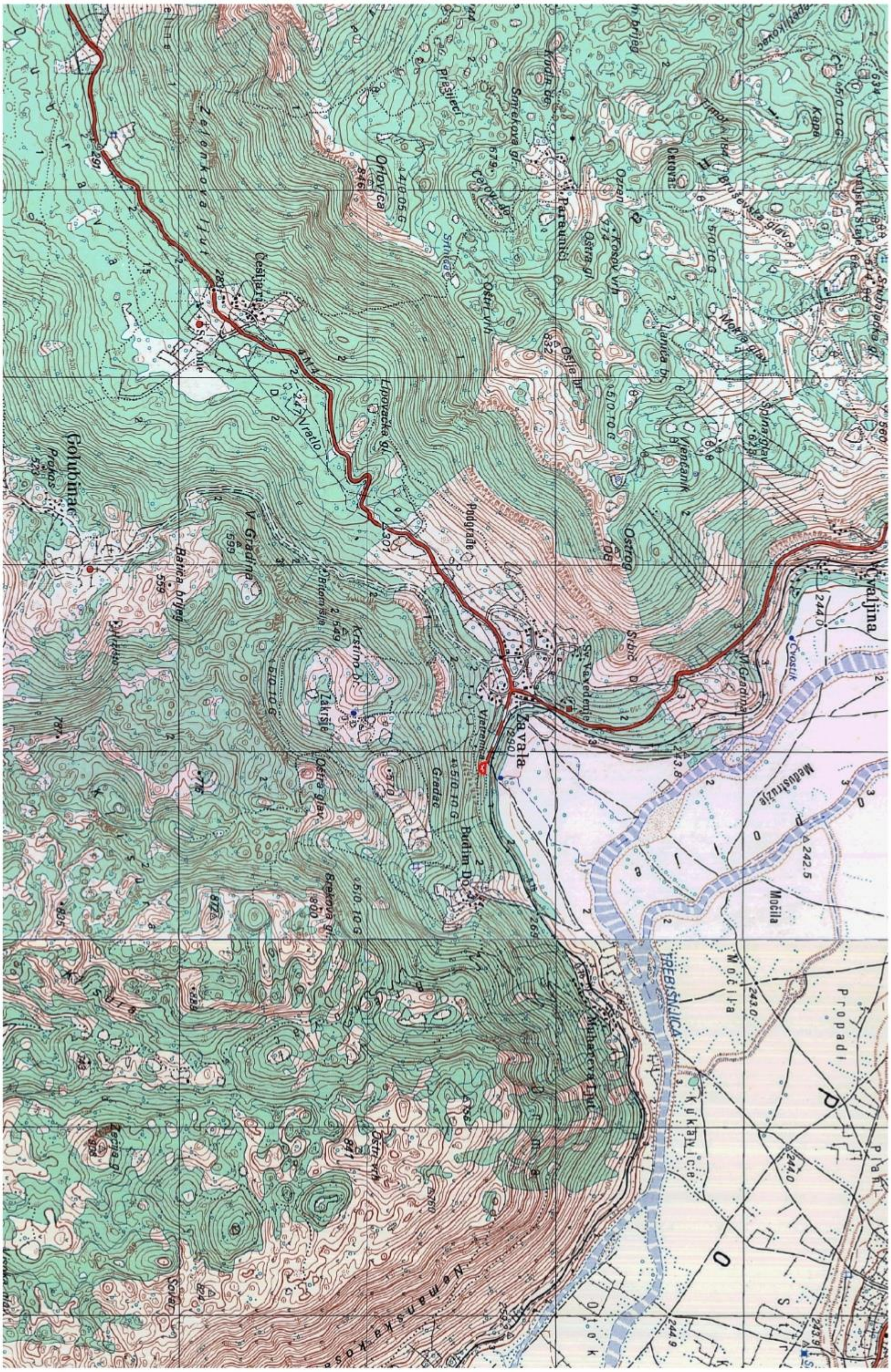
2. Description

2.a Description of property

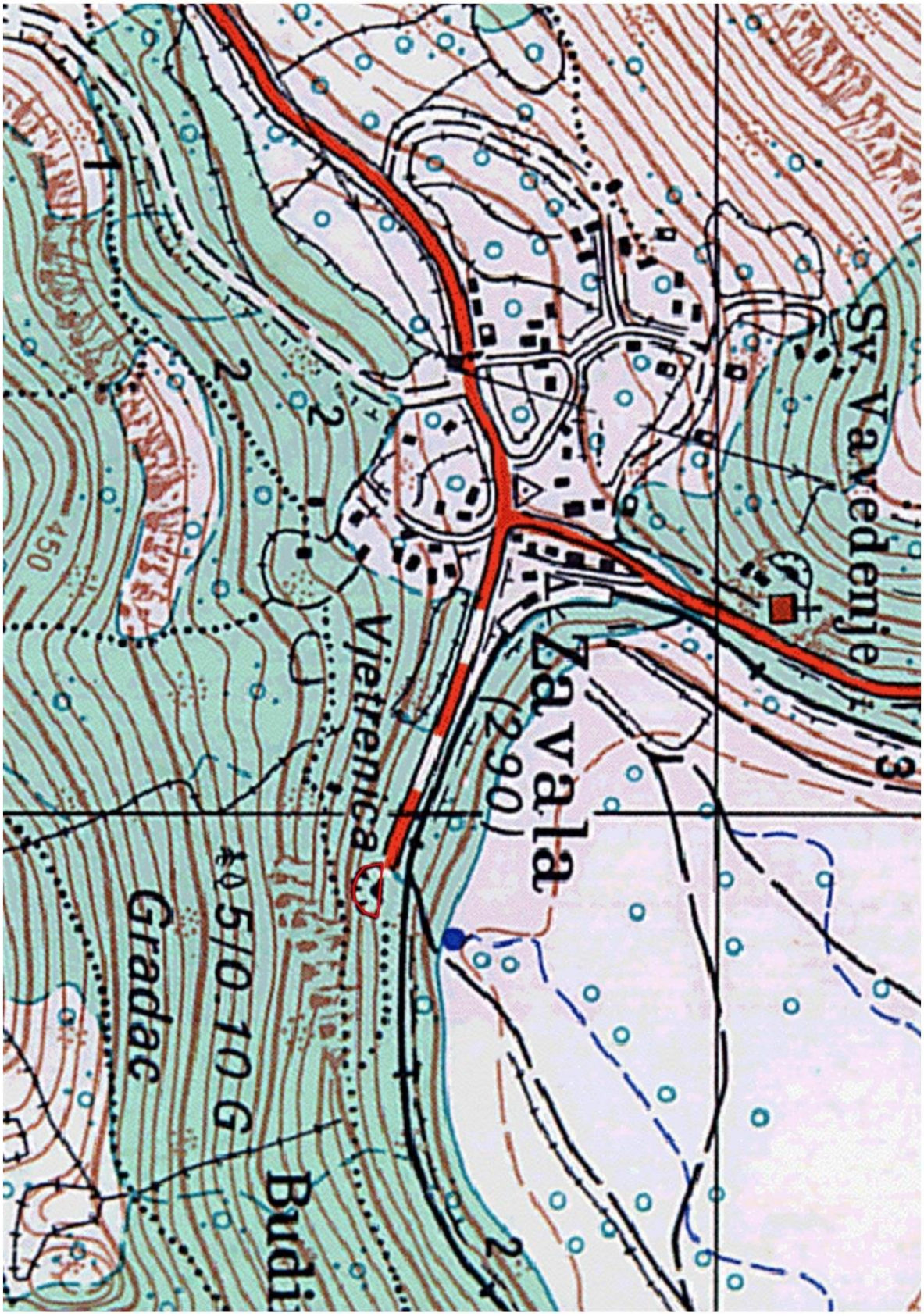
Vjetrenica Cave is located in the area of the South Dinaric Karst, in a karst hill that stretches from the southern edge of the western part of Popovo polje (Eastern Herzegovina) to the Adriatic Sea. The entrance is located on the very edge of Popovo polje, 300 m east of the center of the village of Zavala, at 260 m above sea level, 12 km by air to the Adriatic Sea (Croatia). The main direction of the cave channels is south - southeast, ie in the direction of the sea. The wider area of Vjetrenica, in the western part of Popovo polje, is located in the southeastern part of the Dinaric karst, where numerous surface and underground forms have developed. The area is characterized by geomorphological phenomena such as karst fields and a large number of speleological objects (caves and pits).



Map 10 *Geographical location of the protected area Vjetrenica - Popovo field in the context of the BiH borders – entity border. Cantons in the FBiH,– Herzegovina-Neretva Canton. Municipalities in BiH, Obuhvat Vjetrenice – scope of Vjetrenica*



Map 11 *Geographical position of Vjetrenica cave 1: 25000*



Map 12 *Geographical position of Vjetrenica cave 1: 5000*

Vjetrenica sits in the area of the south Dinaric karst, in a karst hill stretching from the southern edge of the western part of the Popovo polje plains (Eastern Herzegovina) to the Adriatic Sea. Its entrance is located on the very edge of the Popovo polje plains, 300 m east of the central part of the village of Zavala, at 260 m above sea level, 12 km by air to the Adriatic Sea (Croatia). The main direction of the cave passages is south – southeast, or in the direction of the coast. The wider area of Vjetrenica, in the western part of Popovo polje, is located in the southeastern part of the Dinaric karst, where numerous surface and underground forms have developed. The area is characterised by geomorphological phenomena such as karst fields and a large number of speleological objects (caves and pits).

Vjetrenica is a hydrologically active speleological object with as many as four autonomous watercourses, and dozens of smaller, periodic streams. There are also underground lakes, the largest of which is the Great Lake, 180 m long.

The Vjetrenica cave earned its name after the appearance of a strong wind at the entrance to the cave, but also inside the cave, especially in the summer and winter months. The strongest current was recorded at the entrance to the cave, where in the summer months it occasionally reaches over 15 m/s. The air flow in the interior of the tourist-arranged part of the cave is weak to moderate, depending on the location and position of the measuring point, and the strongest flow was recorded at the entrance to the windy gorge area. The average temperature of the cave is about 11 °C, and the humidity is up to 100 %.

The biodiversity and endemism of the fauna of the area remains unknown, but initial analyses have shown exceptional abundance. In addition to a large number of Dinaric endemics, many endemics are very narrowly distributed, only in the area south of the Neretva, the wider area of the Popovo polje or so far exclusively known from areas planned for protection. Endemics of such a narrow area are called stenoendemics, and mostly include cave, relict species (living fossils). Their closest relatives are long extinct in this area, while these survived in a kind of shelters (refuges) to this day. In the area planned for protection we find numerous tertiaries, and some ancient species are even pre-tertiary relics.

Figure 1 *Entrance to the Vjetrenica cave (Source: Vjetrenica Public Company)*

Vjetrenica Cave, as the backbone of protection of Vjetrenica, is a complex cave system with passages in length of 7.323,9 meters, and thus the longest cave in Bosnia and Herzegovina. It consists of the main passage Upper Vjetrenica, about 2500 in length, and numerous side passages, the most important being: Lower Vjetrenica, Absolon's upper and lower passage, Radovanović's passage, Leopard's passage, Wales passage and Ravno passage named after the nearby settlement of Ravno. Vjetrenica sits in the area of the south Dinaric karst, in a karst hill stretching from the southern edge of the western part of the Popovo polje plains (Eastern Herzegovina) to the Adriatic Sea. Its entrance is located on the very edge of the Popovo polje plains, 300 meters east of the central part of the village of Zavala, at 260 meters above sea level, 12 km by air to the Adriatic Sea (Republic of Croatia). The main direction of the cave passages is south – southeast, or in the direction of the coast. Noteworthy, the cave is placed in the immediate hinterland of the city of Dubrovnik, an extremely important tourist hub. In addition to Vjetrenica, the cave system includes the Lukavac spring, located below the entrance to Vjetrenica, and the smaller Bjelušica cave, above the entrance to Vjetrenica. The Vjetrenica cave earned its name after the appearance of a strong wind at the entrance to the cave, but also inside the cave, especially in the summer and winter months. The wind force at the entrance to the cave in the summer months at times reaches over 15 meters per second. Vjetrenica is a hydrologically active speleological object with as many as four autonomous watercourses, and dozens of smaller, periodic streams. There are also underground lakes, the largest of which is the Great Lake, 180 meters long. The cave is characterised by large underground halls with examples of collapsed ceilings and speleothema accumulations.

Due to the strong tectonic fracture of the rocks, in the earlier hydrologically active phase in phreatic and epiphreatic conditions, facet networks, niches and a dense network of anastomoses were formed on the surface of the rocks.

Figure 2 *Detail of the ceiling in the Spacious Hall with a network of anastomoses and deposited sigmas along tectonic and interlayer cracks (Photo: N. Buzjak)*

Part of the passage called Pjati, known for its numerous large cascades that fill it across its entire width (up to 16 m) and length of 78 m, also contributes to its attractiveness. These cascades were formed by the slow flow of water in vadose conditions when abundant speleothem sedimentation occurred from calcite-saturated water. The other calcite lake stands out for its size, the depth of which, judging by the preserved traces of the water level, was up to 1 m, and today it is up to 15 cm. In the clay at the bottom, drying cracks (desiccation cracks) are visible as a consequence of faster drying of the sediment surface, whereby the sediment shrinks and the crust cracks. In a windy environment like Vjetrenica, such phenomena weaken the sediment and make it susceptible to increased erosion, transport by air and water to other parts of the cave where it can be re-deposited. Apart from Vjetrenica, the cave system includes the Lukavac spring, located below the entrance to Vjetrenica, and the smaller Bjelušica cave, located above the entrance to Vjetrenica. The protected area of Vjetrenica-Popovo polje is a part of the Trebišnjica river basin, that is, the Adriatic basin. Large amounts of water flow out at the springs and either accumulate in the vast carbonate-karst underground or sink in the Popovo polje and other karst fields. Intensively tectonic disturbances and karstic carbonate

complexes have conditioned the development of privileged groundwater routes to the sea, whose outflow takes place in the coastal zone, at the contact of limestone and other less permeable rocks. Due to the predominant limestone- dolomite branch of the parent rock substrate, the surface river network is poorly developed. The exception is the Popovo polje, where the river Trebišnjica built a surface river flow, with merely occasional hydrological function. It is important to note that the southern edge of the Popovo polje, where the entrance to Vjetrenica is located, has undergone hydrological changes. The Trebišnjica River, once the longest sinking river in Europe, now serves four hydropower plants with many kilometres of artificial tunnels. Since 1979 it has been turned into a concrete canal, breaking off its connection to the surrounding area, and significantly reducing the surrounding groundwater level.

Figure 3 *Cascades in the part of the passage called Pjati (Photo: M. Mazija)*

Physical and geographic features

According to the data from the Study of the Management Plan for the Protected Natural Value of the Vjetrenica Cave and part of the Popovo polje in the Ravno Municipality, this area is dominated by limestone-dolomite deposits of Mesozoic and Cenozoic Paleogene flysch formations. The entire area is a part of the Trebišnjica river basin that is, the Adriatic basin. Due to the predominant limestone – dolomite branch of the parent rock substrate, the surface river network is poorly developed. The exception is the Popovo polje and its surface river flow

of the Trebišnjica River, with merely occasional hydrological function. Hydro- geological relations are quite complex due to the fact that part of the groundwater drains the Adriatic Sea while the other part flows into the Trebišnjica River. The dominant soil types of Vjetrenica were formed as a result of the relationship between the geological structure, relief structure and climatic specifics of the terrain. Fluvisols dominate in the Popovo polje, while lithosols and regosols dominate in the aboveground part of Vjetrenica (Multipurpose Land Evaluation in the Federation of Bosnia and Herzegovina, Federal Ministry of Agriculture, Water Management and Forestry of the Federation of BiH, 2013). The wider area of Vjetrenica, in the western part of Popovo polje, is located in the southeastern part of the Dinaric karst, where numerous surface and underground forms have developed. The area is characterised by geomorphological phenomena such as karst fields and a large number of speleological objects (caves and pits). Karst field is a geological phenomenon in karst that represents the largest depressions in limestone terrains. Karst field is formed by the combined action of tectonics (faults), river erosion and corrosion, less often only by joining karst bays. Some karst fields, such as the Popovo polje, developed from river valleys. When it comes to the geomorphology of the Vjetrenica cave itself, according to the data from the Management Plan, Vjetrenica is a complex cave system with a passage length of 7.323,9 m, and thus second longest cave in the country. Although there are plans for the cave, it is important to note that it has not yet been fully explored and therefore the existing plan is incomplete. Vjetrenica cave consists of the main passage Upper Vjetrenica about 2,500 m long and numerous side passages, the most important of which are Lower Vjetrenica, Absolon's Upper and Lower passage, Radovanović's Passage, Leopard's Passage, Welsh Passage and Ravno Passage, named after the central settlement of Ravno. A detailed geomorphological analysis was conducted covering the stretch of the tourist-arranged part of the cave or the so-called Hajduk table. Large underground halls with examples of collapsed ceilings and accumulations of speleothems are characteristics of the Vjetrenica cave. The initial part is dominated by the main passage in which large accumulations of speleothem can be observed in some places. Right behind the windy gorge area, the passage passes through highly tectonic deposits interspersed with numerous cracks and large mounts of sigma deposited in the form of stalactites, stalagmites, macaroni and salts. Microreliefs formed during frestic and epiphreatic conditions, in active hydrological phases, when a dense network of anastomoses was formed, have been recorded at a number of locations in the cave. Examples of some of them are flutes and niches in the Drop Columns hall, as well as knives, windows, niches and ceiling domes in the area of the entrance to Lower Vjetrenica. A part of the passage called Pjati is filled with a large number of cascades along the ntire surface (width 16 m, length 78 m). These cascades are thought to have been caused by the accumulation of speleothem due to poor water flow. One must mention the Kacit lake, which is considered to have been 1 m deep, while its depth is now only 15 cm. In the clay at the bottom, desiccation cracks (drying cracks) are clearly visible, which actually indicate rapid drying and shrinkage of the sediment, with cracking of the crust. Conditions in the Vjetrenica cave certainly weaken the sediment and make it susceptible to increased erosion, transport by air and water to other parts of the cave where it can be re-deposited. The Lukavac spring, located below the entrance to Vjetrenica, and the Bjelušica cave, located above the entrance to Vjetrenica, also belong to the cave system.

Geologically, most of the area of Vjetrenica-Popovo polje is built of carbonate rocks deposited in the geological age of the Cretaceous: limestones, dolomites and dolomitic limestones. In some layers of limestone, the percentage of calcium carbonate is as high as 99.98%, which is also an indicator of complete melting of rocks in the Popovo polje in the distant future.

When it comes to the formation of the Vjetrenica cave, according to the data from the Management Plan, the Vjetrenica cave was formed as a result of numerous different processes that caused the genesis and development of speleological objects in the karst. The mentioned processes refer to corrosion, erosion and collapse, all influenced by the lithological characteristics of rocks, tectonics and climate, as well as hydrological conditions that still favour the formation of Vjetrenica. The area where the Vjetrenica cave was formed was built of strongly oxidized Malm and Lower Cretaceous limestone and dolomite. The processes of corrosion (chemical dissolution) are the dominant processes in the first phase of cave formation, and at the same time the slowest process that significantly prolongs the first phase of cave formation. As the corrosion process progresses, so do the cracks and interconnection of cracks created by chemical dissolution, thus creating the conditions for a slow water flow. The occurrence of a slow flow causes more intense corrosion, and thus faster spread of cracks and their interconnection. At a later stage, in addition to the corrosion process, fluvial erosion also plays a more important role. Within this phase, the water mechanically destroys the rock and carries particles that further destroy the flanks of the parent rock leading to the expansion of the main passage. The widening of the passage increases the span of the unstable ceiling built of cracks, interspersed with thin and thick layers, limestones and dolomites. In the initial stage, the passages are entirely filled with water and phreatic conditions prevail. In the earlier phase of the formation of the Vjetrenica cave, which can practically be said to last even today, the ceiling collapses by lowering the erosion base and groundwater level, forming high and spacious halls and galleries in the Vjetrenica system. This phase is characterised by intermittent deposition of speleotomes.

The structural-tectonic Vjetrenica cave has numerous faults and systems of cracks that allow rapid penetration of water into the ground. The faults and cracks themselves were formed under the influence of water currents from different directions. Based on a review of the literature, it is concluded that even today the Vjetrenica cave has the function of a permanent and disappearing spring. One of the proofs in support are clay deposits inside the Vjetrenica cave. According to referenced literature sources (Radovanović, 1929), there is a difference between autochthonous (formed in the cave) clay and allochthonous clay (introduced from the surface of the terrain above the cave.

Stratigraphy

The basic line to geological structure of the wider area is given by limestone, dolomite and limestonedolomite formations of Jurassic and Cretaceous, according to the authors of basic geologic maps Ston and Trebinje, Jura is divided into: J1,2 (Jurassic), Lias-Dogger, J 1,2 (Jurassic), Oxford-Kimmeridgian J 2,3 (Jurassic), Kimmeridgian-Portlandian. Cretaceous is broken down into; 1C1 (Cretaceous), Aptian-Barremian, 2C1 (Cretaceous), part of Barremian-entire Albian, C1,2 (Cretaceous), Albian-Cenoman, C 1,2 (Cretaceous), Cenoman-Turonian and C 3 (Cretaceous), Senonian. Paleocene-Eocene formations are limited, while the Quaternary dominates the Popovo polje as an alluvial formation of the Trebišnjica river, proluvial materials and products of surface decomposition such as red soil appear to a limited extent. Registered formations tectonically belong to the high karst cover and are tectonically

broken with weak vegetation and represent an ideal environment for the appearance of numerous karst phenomena such as caves, pits, abysses and narrow gorges, and numerous scrapes appear on the surface of the limestone masses.

J1,2 - Jurassic, Lias-Dogger

They are registered on geological map (J1,2 Oolithic and pseudoolytic limestones with saliporelae) and in the far SE are presented with oolithic and pseudoolytic gray limestones that are weakly layered to unlayered, rarely followed by mostly dolomites and dolomitic limestones in the central part. The thickness of this series is about 280 meters. (Šerifović and Smailbegović, perc. Commun.)

J 1,2 - Jurassic, Oxford-Kimmeridgian

These formations (J 1, 2 Limestones with cladocoropsis) are also found in the SE part of the geological map, continuously deposited over Lias-Dogger formations. They are represented by limestones with frequent alterations of gray and brownish-gray dolomites. Based on fossil remains, these were singled out as Oxford-Kimmeridgian, and the thickness of this unit is about 300 m. (Šerifović and Smailbegović, perc. Commun.) (Šerifović and Smailbegović, perc. Commun.)

J 2,3 -Jurassic, Kimmeridgian-Portlandian

These formations (J 2,3 Limestones and dolomites with klipeins) are represented by limestones and dolomites of different facial development where a clear distinction is made between the formations between Kijev dol and Slano from the formations around Zavala. The Kijev do - Slano stretch is characterised by rey, light grey and whitish limestones with numerous finds of *Clypeina jurassica* algae in which thinner layers of dolomite alternate laterally and vertically with limestones. While the area of Zavala is characterised by the appearance of grey and dark grey dolomite with layers of limestone, their affiliation was determined superpositionally and on the basis of lithological appearance. Limestones occur in the upper part of the pillar over which the formations of older Cretaceous normally lie. In the immediate vicinity of the entrance to Vjetrenica, grey stratified limestones have been registered, while dark gray dolomites have been registered on the Belenići - Brekovac creek. In the open profile of the new road Čvaljina - Zavala, gray massive dolomite was registered. The thickness of these deposits is 350 m. (Šerifović and Smailbegović, perc. Commun.)

1C1 - Cretaceous, Aptian-Barremian

In the area of Vjetrenica, these are the most widespread formations (1K1 Limestones and dolomites with favreins, tintins and nerines) extending into two separate zones, the first central NW-SE on the Rupni Do - Budin Dover - Dobromir Peak stretch and the second occupying the SW area on the stretch Crno osoje - Kijev Do. According to the authors interpreting geological maps for Ston and Trebinje, the lower parts of this series are built of limestone with dolomite interlayers, while the upper parts of this series are built mostly of limestone. Limestones are massive and gabled and based on petrographic analyses are most often presented with allohemo-sparite and allohemo micritic limestones, the main characteristic of these limestones is a high $CaCO_3$ content ranging between 99.60 to 99.98% and the percentage of undissolved residue of 2.0 to 1.4 represents clayey organic matter and quartz. Based on numerous fauna and, above all, on the basis of favrein

and superposition, these series are classified into older Lower Cretaceous deposits, or in other words, these correspond to Aptian-Barremian age. Their thickness is estimated at 500 m. (Šerifović and Smailbegović, perc. Commun.)

2C1 - Cretaceous, a part of Barremian-entire Albian-a part of Albian

These are found in several separate zones (2K1 Limestones with orbitolins and salpingoporela) that follow the formations of older Cretaceous limestones and dolomites with favreins over which they continuously lie, these formations are strongly disturbed and fractured, represented by limestones and less often by dolomites. Limestones occur more frequently in the lower part of the series while dolomites as interlayers are more common in the upper part of the series. The main feature of this series is good stratification that ranges in the range of 20 to 60 cm and a high content of $CaCO_3$ up to 99.99% and not dissolved residue are clay particles and rarely quartz. Petrographically they are alohemo sparitic, alohemo micritic and micritic limestones. According to the microfossil community, which is not equally widespread everywhere and the superpositions of this deposit cover part of the bar, the whole apt and one part of the alba, the thickness is estimated at about 450 m. (Šerifović and Smailbegović, perc. Commun.)

C1,2 - Cretaceous, Albian-Cenoman

These are singled out as they follow the series of older Cretaceous in the NW-SE direction, along the stretch Ravno – Grmljani, then west on the stretch Češljari – Orahov Do and less distorted masses along the stretch Grabov Do – Rupni Do. They occur predominantly as dolomites and dolomitic limestones, these are predominantly micrograined and fine-grained dolomites in which there are many calcite grains. The limestones that appear in this series are dark brown and light brown, petrographically these are micrites, fossil-bearing micrites, biomicrites, dolomitic micrites and intramicrites. Although these series are the cutoff in the gradual transition between older and younger deposits, the authors of basic geologic maps Ston and Trebinje singled them out as Albian-Cenomanian creations, estimating a thickness at 450

m. (Šerifović and Smailbegović, perc. Commun.)

C 1, 2 - Cretaceous, Cenoman-Turonian

Continuous sedimentation continues in the Upper Cretaceous and on the map they are in the SE part on the stretch Galinčići – D. Grmljani – Šiljevac. They are presented with well-layered limestones that often alternate with dolomites and dolomitic limestones. The thickness of the layers varies from 30 to 60 cm, they have a high content of CaCO3 and up to 99.98%; undissolved residue is represented by organic-clay matter and rarely quartz, cornea, and silicon matter. The age was determined on the basis of fossils and super positions and they were singled out as Cenoman-Turonian and their thickness was estimated at about 400m. (Šerifović and Smailbegović, perc. Commun.)

C 3 - Cretaceous, Senonian

Singled out as two smaller masses in the SI part of the map, they are represented by banked or massive limestones of light yellow to white colour, light yellow thin-layered limestones are partially marly. Of the fauna, they contain the most poorly preserved rudists shells, singled out as Senonian. (Šerifović and Smailbegović, perc. Commun.)

Pc, E - Paleocene-Eocene

Paleocene Eocene formations are singled out as a narrow zone north of Veličani, lying discordantly over the Senonian formations of the Upper Cretaceous. It is presented with alveolinic numulitic limestones, organogenic-detrital layered to banked limestones, sometimes with the appearance of calcareous oozes, light brown to white in colour. (Šerifović and Smailbegović, perc. Commun.)

Q - Quaternary ts, pr, al

The Quaternary formations are represented by ts (terra rosa) redness registered east of Kijev Dol, pr - proluvial formations near Orahov Dol and alluvium of the Popovo polje. (Šerifović and Smailbegović, perc.Commun.)

Tectonics

The wider area of the Vjetrenica cave system is located in the area of the Navlaka high karst; the area is intersected by numerous faults, two main directions of faults being as follows (J. Marić):

1. Longitudinal faults NW-SE

2. Meridional faults N-S

The first group includes the most common regional faults (often reverse) that have a characteristic Dinaric direction; this group also includes numerous faults of local character. Faults taken from basic geological maps and faults determined by remote detection are placed on the prepared geological map. Faults of local character that are present in the NW-SE stretch and with less stability in the massif above Vjetrenica itself are probably the most responsible for the formation of the Vjetrenica cave system. From the regional and reverse ones, there is a wide zone of pulling and rolling in the direction, Grabov Do-Češljari-Golubinac-Belenići.

The second group of faults in the N-S direction are characteristic from the aspect of intersecting and horizontally dislocating the masses contoured by the first group of reverse faults; on the map these would be the following faults: Čvaljina-Golubinac (Dubrave) which provided the basis for the development of the valley through which the road to Slano (CRO) passes, Zavala-Belenići, Kijev Do.

Analysing the geological map from the aspect of tectonics, it is possible to clearly distinguish the Vjetrenica block which is separated by a reverse fault (zoning zone) passing south of the Golubinac-Belenići section, and two faults of the Čvaljina-Golubinac extension and a fault of the same extension passing through Kijev Dol. The block itself was intersected by the Budin Do-Belenići fault, which according to the set provision of the cave system in combination with numerous smaller faults, so far determined only by remote detection, “provided” tectonic preconditions for the formation of Vjetrenica. The Kijev Do fault passes through the bed of the Brekovac creek, although basic geological map lists Trebinje as “photogeologically” noticeable. This fault, as seen on the ground, brings into lateral contact the Jurassic J dolomites

J 2,3-Kimmeridgian- Portlandian with Cretaceous limestones 1C1 - Aptian-Barremian (Šerifović and Smailbegović, perc. Commun.)

The wider area of Vjetrenica is a part of the Trebišnjica river basin, that is, the Adriatic basin. Large amounts of water flow out at the springs and either accumulate in the vast carbonate-karst underground or sink in the Popovo polje and other karst fields. Due to the predominant limestone-dolomite structure of the parent rock substrate, the surface river network is poorly developed, with the exception of the Popovo polje where the river Trebišnjica built a surface river flow with merely an occasional hydrological function. Previous hydrological research in the area of the Popovo polje has not established the existence of permanent springs. Significant disappearing springs belonging to the group of water caves have been recorded, and their activity is related to the existence of a dolomite barrier between the Popovo polje and the sea. In the area around Zavala, several such springs appear: Spring Pokrivenik, Lukavac below the entrance to the Vjetrenica cave, and Čvaušnik and the Čvostik spring near Čvaljina.

Groundwater mainly flows towards the Pokrivenik spring. Pokrivenik Spring has a total catchment area of about 8 km^2, and its waters flow towards the Trebišnjica River. The Lukavac spring basin is larger than the Pokrivenik spring basin with its 14 km^2, together with the overflow waters towards the Adriatic Sea. The catchment area of the Čvašnik spring and the Čvaošnik spring of 3.7 km^2 is significantly smaller than the previous two. The results of the chemical analysis performed at 11 localities of Vjetrenica and the spring of Lukavac indicate the presence of rocks through which groundwater seeps. These are waters with increased hardness of magnesium, which is further indicative of the flow of water through limestone rocks. The increased hardness of magnesium was registered on the stream of the High Hall and the lake of the lower Vjetrenica. The ratio of magnesium and calcium hardness of water at the spring Lukavac indicates a constant inflow of groundwater from the direction of Vjetrenica. Vjetrenica Cave is a hydrologically active, flowing speleological object with as many as four autonomous watercourses and dozens of smaller, periodic flows. There are also underground lakes, the largest of which is the Great Lake, 180 meters deep.

In the hydrogeological analysis of rock masses, four units can be distinguished, differing in porosity, conductivity and reservoir characteristics:

- Rocks of intergranular porosity and very good yield include quaternary unbound or very weakly bound deposits of gravel and sand covered with clayey carbonate powder, as well as conglomerates and siparic material. The total mass of these alluvial deposits is dominated by gravel, sand, loam and humus cover on the soil surface.
- Rocks of intergranular porosity and moderate yield include quaternary unbound or very weakly bound clastic deposits, fluvial-glacial deposits, and carbonate karst with redness, deluvium, glacial and fluvioglacial material and most often fill depressions (cavities, caverns and caverns in large karsts).
- Cavernous and fissure porosity rocks, very good conductivity include limestones with sparse ice and dolomite interlayers. Most of the mentioned limestones are Jurassic and Cretaceous limestones, which mainly fill most of the area proposed for protection. Within the terrain, their role is reflected in the function of the karst collector, the relatively deep base of the karst and the primary directions of flow along medium, large and very large

regional faults.

- Rocks with predominant crack porosity, and the appearance of caverns is mainly related to large faults. This type of rock involves solid carbonate rocks built of dolomitic limestones and dolomites and are mainly Upper Jurassic and somewhat smaller Lower Cretaceous deposits of dolomite and limestone, which occur in intermittent and elongated zones.

Climatological features

According to the Management Plan, the wider area of the Vjetrenica protected area is located in the extreme northern part of the northern subtropical climate zone, in its periatlantic landscape sector. The dominance of meteorological influences of the mentioned zone, along with the relief predispositions of the wider area, presents the basic determinant of the formation of climate specificities both at the main and the climate subtypes level.

More specifically, in the wider area, moisture-rich air masses of the southwestern circulation, originating from the Gulf of Menov (Depression) and subtropical warm and dry air masses from the African North (North African anticyclone) alternate. These atmosphere centres of action for this region are of a seasonal character, since they are dominant in certain parts of the year, and in the second part of the year their influence is weakening. The aforementioned atmosphere centres of action alternate with each other. During the summer part of the year, the North African anticyclone is dominant, which weakens during the winter so that it is replaced by the dominant Gulf of Menov depression, which brings an abundance of moist and warm air originating from the Atlantic. Occasionally, during the winter period of the year, during certain, non-standard meteorological situations, cold and dry air masses originating from the continental interior arrive in this area, forming very cold and dry weather that usually lasts for several consecutive days. Such scheme in the spatial and temporal dynamics of centres of action directly reflects on the radiation and circulation processes in a wider part of the protected area, which results in forming of a larger number of local climates. The mountainous parts of the terrain have a pronounced vertical and horizontal disintegration with relatively high angles of slope and in general quite pronounced total energy of the relief. On the contrary, depressions of Popovo polje are characterised by low degree of total disintegration, as well as larger complexes of levelled soil of reduced karst-corrosion plateau, at altitudes between 500m and 800m. In the wider arch of the protected area of Vjetrenica, various meteorological phenomena can be formed during the winter part of the year, such as: radiation and advection fogs, weaker temperature inversions, etc. Based on the above, it can be concluded that the climatological characteristics of the protected area Vjetrenica-Popovo polje are the result of the interaction of quantitative values of climatic elements and the influence of climatic factors. The most important climatic elements of the protected area Vjetrenica - Popovo polje are insolation, air temperature, relative humidity, cloudiness, precipitation and wind. The most important climatic factors are physical geographic position, relief, and degree of continentality, frequency and directions of cyclonic and anticyclonic routes. In the wider area, one main climatic type can be singled out - Cs, which means Mediterranean climate with hot summer. Within the climatic type Cs, two subclimatic types Csa and Csb are distinguished. Csa climatic subtype is

characteristic in the area of Popovo polje and Zavala with altitudes up to 500m above sea level and implies a Mediterranean climate with hot summers. Csb climate subtype is dominant on the area where the altitude is over 500 meters above sea level and implies a Mediterranean climate with warm summers. The mean annual temperature is 13 °C - 16 °C. The period with mean monthly temperatures above 20 °C refers to June, July, August and September, which is why this area also shows subtropical features. The mean annual relative air humidity is about 70% at lower and up to about 80% at higher hypsometric levels, with the values being the highest during the winter part of the year and decreasing towards the summer period. The annual

precipitation is quite high and ranges between 1,900 mm in the lower, up to about 2,100 mm in the highest hypsometric levels with one main precipitation maximum and one main precipitation minimum (Chart 1). Rainfall dominates (about 130 days), while snowfall is rare, and it is mostly linked with only certain synoptic situations. The wider area of Vjetrenica is dominated by winds of a regional character, which alternate according to the seasons. North, northwest and northeast winds are dominant, which is defined by the morphological openness from the area of Popovo polje.

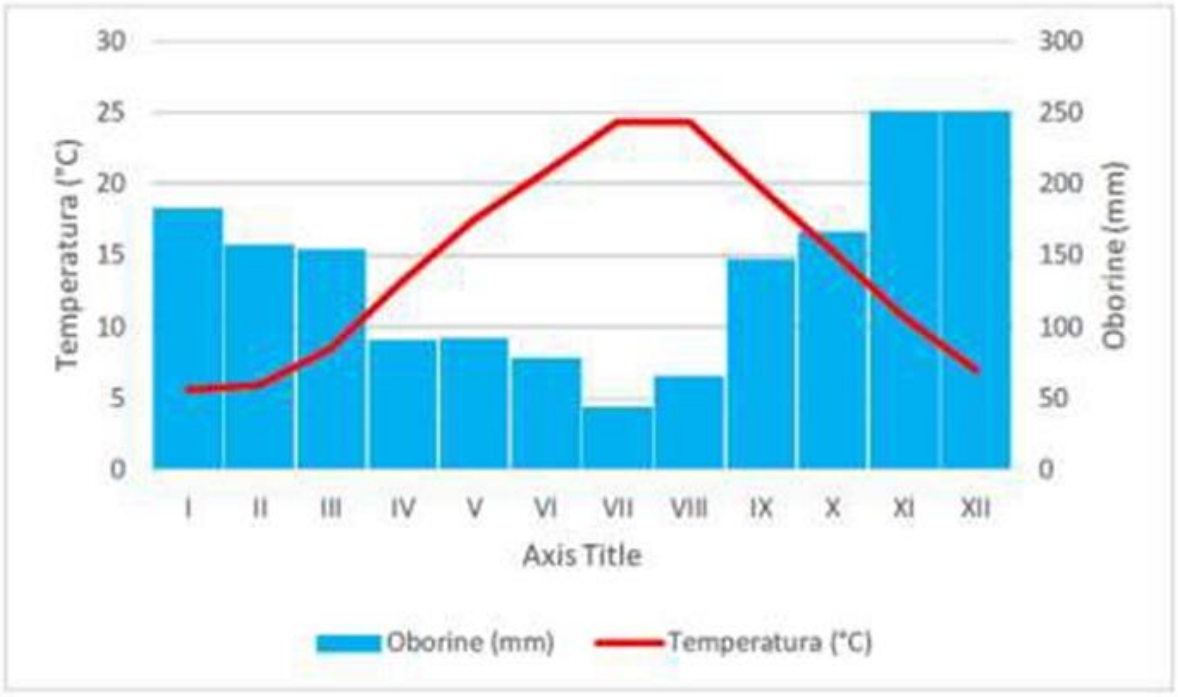


Chart 1 *Climate diagram for Trebinje station, Popovo polje (time period 1981 - 2010) (source: rhmzrs.com)*

Vjetrenica was named after a strong wind at the entrance to the cave, but also inside the cave, especially pronounced in the summer and winter months. The strongest current was recorded at the very entrance to the cave, where it occasionally reaches over 15 m/s in the summer months. The air flow in the interior part of the cave arranged for tourists is weak to moderate, depending on the location, and the strongest flow was recorded at the entrance to the Vjetroviti klanac

('windy gorge'). The mean temperature of the cave is about 11 °C, and the humidity is up to 100%. All these characteristics are typical only for karst phenomena such as the Vjetrenica cave.

Pedological features

The basic pedological characteristics of the wider area of Vjetrenica are a consequence of the dominant limestone and partly dolomite mineralogical-perographic composition of the rock masses that make up the mountain terrain. The exception is the area of the Popovo polje, whose pedogenetic features are related to the presence of flysch Paleocene-Eocene deposits which are located at the base of Quaternary deposits and which were the basis for the development of the crust of decay at the bottom of the field. An additional factor that influenced the dynamics of soil development is the bioclimatic complex, that is, the influences of the Mediterranean climate and vegetation of this area. The magnitude of their influence on the rock mass decomposition process is quite pronounced due to the fact that in this area there are limestone rock masses (which dominate in surface distribution) with a high percentage of calcium carbonate which is very susceptible to karst dissolution and leaching. Given the above facts, the structure of the pedological cover is dominated by soils on limestones from the automorphic division of the soil, while only a small part (the area of the Popovo polje) is represented by alluvial carbonate soils. Automorphic soils in the area of Vjetrenica were formed by dissolving and decomposing the limestone-dolomite rock complex by rainwater. Depending on the percentage composition of minerals, primarily $CaCO_3$, $MgCO_3$ and SiO_2, the intensity of biological decomposition and chemical decomposition of rock masses was determined, and thus the quality and speed of the pedological substrate. Automorphic soils are the most undeveloped soils in this area, except in the area of Zavala, which also does not have a continuity of surface distribution, but these are most often rocky terrains or lithosol, composed mainly of loose skeleton whose depth is not more than 20 cm. The paedogenetic process is mainly based on the physical destruction and erosion of limestone-dolomite rock mass. The main types of automorphic soils that appear in this area are regosol, colluvium, calcomelansol and rendzina. Regosol (sirozem) is a undeveloped or poorly developed soil that is formed on loose substrates. It mainly occurs by physical erosion of the previously mentioned rock masses or rock terrain erosion. Colluvial soils are also underdeveloped or completely undeveloped soils formed by geomorphological processes of leaching and destruction of the parent rock substrate. Eroded and washed off material is further sedimented and conditions are created for the formation of pedological soil. Calcomelanosol can also be detected in the parent rock mass, and it is formed mainly by an acid reaction on hard and pure limestones or dolomites.

The depth of the substrates in the area of interest is mostly chalk up to 30 cm. Limestone-dolomite black soil can very often form at the bottom of larger karst forms or smaller karst inlets, but very rarely substrate formation occurs. Rendzina is a type of soil that is formed in the later and advanced stages of the paedogenetic process and, therefore, has a more complex pedological profile than the previously mentioned types. This type of soil is characterized by the impossibility

of mobilizing organic matter due to the small quantity of residues, so humus is mainly formed as a consequence of the accumulation of mineral components (Burlica and Vukorep, 1980).

In the protected area, these types of soils generally mix with each other, so that the types of transitional soil as well as the characteristic soil types can be clearly seen. Hydromorphic soils in the area of Vjetrenica are presented as alluvial carbonate clay soils formed under the influence of groundwater and flood waters of Trebišnjica, which bring a larger amount of paedogenetic material into the substrate. The spatial distribution of these materials is defined by the transport power of the Trebišnjica river flow. Due to the flooding of rivers and the deposition of new material every rainy season, the development of this soil is hindered. Alluvial soils are suitable for growing all agricultural crops and they give high yields with regular irrigation. Along the coastal belt of Trebišnjica, the coarsest gravelly-sandy material is deposited, which is to a lesser extent combined with fine particles, the so-called clay fractions that serve as "fixatives" of the aforementioned loose material. As it moves away from the coastal area, the number of clayey, fine particles increases, and the number and quantity of particles of loose gravel material decreases, so that the finest material is deposited in the central zone where the presence of organic matter is at a high leel and the humus horizon reaches 100 cm. depth.

Biological features of the area

Diversity of genetic resources – There was no research done on genetic resources in the area of Protected landscape Vjetrenica-Popovo polje. However, as this area is a typical locality for 38 invertebrate species only in the underground part, many of which are endemic to the Balkan Peninsula, it can be concluded that a significant diversity of genotypes of species inhabits this area.

Ecosystem and habitat diversity

According to the data from the Management Plan for the Protected Landscape "Vjetrenica-Popovo polje", the ecosphere of this area consists of the atmosphere, pedisphere, hydrosphere and lithosphere. Each of these spheres has living organisms, representatives of five great kingdoms: bacteria (*Regnum Prokaryotae*), protists (*Regnum Protocista*), fungi (*Regnum Fungi*), plants (*Regnum Plantae*) and animals (*Regnum Animalia*).

According to its phytogeographical position, the area of interest Vjetrenica-Popovo polje belongs to the forest area of Europe. However, the consequence of centuries of human activity in the protected area of Vjetrenica-Popovo polje has led to the differentiation of various habitat types and degradation of certain primary ecosystems-forests. Thus, habitats such as forests, all types of shrubs, karst grasslands, meadows and pastures, gardens, fields, arable land are now clearly differentiated in this area.

The flooding of the soil, wind impacts, summer droughts and fires had generated dry grasslands characteristic of this area. Such are for the most part the grasslands of the protected area, sparsely overgrown, resembling rocky deserts.

On the other hand, grasslands with more soil retained are more densely overgrown and richer in biological species. At higher altitudes, a special type of rocky grasslands has developed, characterised by an extremely large number of biological species, including a significant number of endemic species.

Coastal grasslands are extremely important due to the fact that they have two growing seasons a year, in the spring after the rains and in the fall. These grasslands are especially botanically interesting due to the fact that up to 100 plant species can be determined on some 100 square meters, which makes them the most biologically diverse habitats in Europe. At the same time, these types of pastures form the basis of economic activities such as cattle breeding and beekeeping. Today, many of these grassland habitat types, belonging to the proposed protected area Vjetrenica-Popovo polje, are on the list of endangered and rare habitats as a result of depopulation, neglect, outmigration and non-use of machinery. The consequences are reflected in the overgrowth of mountain grasslands, covered with shrubs and forests, leading to a significant loss of biological diversity. On the other hand, grasslands in the valleys are increasingly under anthropogenic pressure, which leads to their degradation and ultimately a reduction in the number of species that were characteristic of such grasslands. Extremely important habitats of the area of interest Vjetrenica-Popovo polje are cave habitats within which

terrestrial and aquatic habitats and transitional habitats are distinguished. Amphibian karst cave habitats are transitional habitats, with a permanent or occasional thin layer of water that overflows over the parent rock. There are two types of these habitats: hygropetrica, habitats of a thin layer of water that flows over the walls of caves and flowstone, and habitats of marifugic deposits.

Landscape - areas of protection

The overall quality of a space is the diversity and preservation of landscapes, their aesthetic and economic value and biological diversity of ecological systems, habitats and species, but also the implementation of scientific and expert research and protection and restoration measures, as an element of ethical responsibility for maintaining space for our descendants and the overall community. In the protected area Vjetrenica-Popovo polje there are two basic landscapes:

a. Mediterranean-Mountainous landscapes
b. Sub-Mediterranean landscapes

Within the sub-Mediterranean landscape, there is one exceptional ecosystem: a complex ecosystem of karst fields and fields in karst, which is consisted of the western part of Popovo polje with a hydrogeological-morphological phenomenon - the Vjetrenica cave. Each of these landscapes is characterized by its characteristic visual identity, but also by numerous diverse habitats that often give a recognizable landscape identity. The protected area continues in its southernmost part to the Mediterranean landscape of the coastal area of Southern Dalmatia (Republic of Croatia), the Mediterranean-Mountainous landscape, which in the northern part continues to the sub-Mediterranean landscape. The final, northernmost part of the protected area descends into the western part of Popovo polje, a complex ecosystem in which the entrance to the

Vjetrenica cave is located. This entire environmental unit, from the southern edge of the western part of Popovo polje to the Adriatic Sea is indivisible and forms one hydrological, geomorphological, tectonic and cultural karst unit, which the famous Czech explorer called Paleoombla, alluding to the river that once flowed from Popovo polje to the present Ombla.

Biodiversity and habitats of the Protected landscape Vjetrenica - Popovo polje is divided into underground and above-ground part.

Architectural interventions have left their mark on the image of the researched landscape, which is acceptable for traditional buildings made of natural and original materials, primarily stone, incorporated into the space, but often also architecturally incompatible settlements, roads, industrial complexes. However, some of our landscapes have exceptional architectural value, especially in the karst area, and one of the important factors in creating the landscape as we know it today was the impact of man-herders and domestic animals on the environment, which is highlighted in the wider area of the Popovo polje. According to the historical development of the landscape of the Protected landscape Vjetrenica - Popovo polje, we can highlight three prominent phases. By the 17th century, there was a balance between the carrying capacity of the natural environment and human activity. In the second phase from the 17th to the 20th century, the processes of immigration, sedentarization and intensified farming stood out, which significantly increases the pressure on the natural environment. The third phase from the beginning of the 20th century was marked by depopulation, which led to succession and deforestation, that is, deforestation and erosion. Depopulation process was particularly pronounced after the Homeland War from 1991 to 1996, resulting in almost entire and permanent abandonment of space, but also a reduction in pressure on natural resources. At the same time, a new danger emerged as a result of war and depopulation ranging from the remaining minefields and toxic chemical remnants of warfare to the uncontrolled use of natural resources (quarries) and the selection of sites for waste disposal. The direct impact of the elements of agrobiodiversity, that is, traditional breeds and varieties on the ecological systems of karst grasslands and karst arable land should be stressed, but with a large, mostly negative impact on forests, wetlands and waters. Existing landscapes owe much of their current appearance to years long human influence in the area – the men engaged in land reclamation, drained swamps, cut down forests, burned macchia, grazed cattle, created ponds and wells, mowed karst meadows, built dry stone walls and thus cleaned and created arable land, fields and sinkholes and created characteristic karst ecosystems. Thus, preservation of the landscape so far is the result of centuries of traditional management of protected space, that is, traditional landscape anthropogenic equilibrium. Although traditional management is not exclusively positive for the preservation of landscape values and in the past there have been major or minor devastations within these systems, especially between the 17th and 20th century, it can be said that the positive elements of landscape conservation prevail. With the start of an intensified depopulation of rural areas, coupled with the neglect of the existing landscapes, the second half of the 20th century clearly showed that the area management is not a default mechanism. There are many reasons in favour of management of the existing landscapes in the Protected landscape Vjetrenica - Popovo polje and their preservation in the interest of the entire local community, but also the whole of Bosnia and Herzegovina. Eight basic reasons can be defined as follows:

1. Primary quality of space
2. Aesthetic value of space
3. Economic value of space
4. Preservation of ecological systems
5. Habitat conservation
6. Conservation of biodiversity
7. Ethical duty towards generations to come
8. Ethical duty towards the international community

The primary quality of space is the overall diversity of landscapes and all elements of their preservation, in contrast to the overall quality of space, which consists of all elements of landscape management. The primary quality of space is a value that can be measured by objective methods and by which we determine that the protected area is of better quality, and thus more important and valuable in relation to a large number of European countries that had devastated (meliorated) their space irreversibly. The vast majority of developed European countries is dominated by artificial or only to a lesser extent semi-natural landscapes; it is, therefore, that these preserved landscapes are of special value for Europe. Within the primary quality of the area, the western part of the Popovo polje with the Vjetrenica cave stands out for its value and uniqueness. The aesthetic value of the space is an important element of preserved and diverse landscapes and is especially valuable for the promotion of the landscape. Aesthetic value refers not only to natural but also to anthropogenic elements, especially architectural ones, and is often the basis for some of the most important economic activities, such as tourism. Thus, we must point out certain preserved architectural units, settlements built of stone houses, suitable for evolution into ethno villages, the Orthodox monastery of Zavala, units of karst fields, such as Orahov do and other. The economic value of preserved landscapes has so far been assessed through the sum of the values of primary resources, the so-called raw materials that can be used in industry, and the existing economic and human infrastructure. Today we can define economic value through the market value of space or even absolute value. We believe that the economic value of the Protected landscape Vjetrenica - Popovo polje is above all in tourism, primarily recreational and rural. There are ecological systems within the landscape of this area, consisting of numerous habitats or biotopes, ut similarly as with the discovery of new species for our living world, further research and more detailed analysis is sure to identify new ones. All these habitats do not have the same importance or biodiversity, nor are these equally endangered; it is, therefore, very important to develop and apply mechanisms for objective recognition of the value of habitats and protection of those most endangered. The most important cosystems of the protected area Protected landscape Vjetrenica - Popovo polje are underground cave ecosystems with an extremely high number of cave habitats, aquatic and terrestrial. Each habitat in ecological terms is built of numerous ecological niches with special abiotic factors and, most importantly, inhabited by numerous species – members of all five known kingdoms of the living world. The richness of species makes up the biological diversity or biodiversity of an individual ecological niche, their sum, the biodiversity of habitats, and finally the biodiversity of the landscape. The underground cave habitats of the Protected landscape Vjetrenica - Popovo polje stand out with their massive number of endemic and relict cave species, the largest in the world. In ethical terms, it is our duty to preserve the landscapes of the Protected landscape Vjetrenica - Popovo polje for generations to come, who also inherit this duty. In order

to preserve, we need to know what we have, so research must precede each element of protection. Thus, this study is but a guideline for future research and complete valorisation of space. Preservation of existing landscapes is also our obligation towards international community, because we are the immediate heirs of our space, and thus responsible for all elements of the landscape. This obligation is defined by a number of instruments, in particular the Convention on Biological Diversity proclaimed in 1992 in Rio de Janeiro. Due to the extremely valuable cave water habitats and the associated extremely rich fauna, preventive action should be taken and the protection zone should certainly include a wider hydrological area in which no hydro-technical interventions or waste disposal can take place. Finally, the most endangered habitats of the protected area Vjetrenica-Popovo polje should be highlighted. Among the numerous habitats, the habitats of karst pastures and meadows, aquatic habitats of springs, ponds and wells, and traditional agricultural systems are especially endangered: arable land, orchards and vineyards. The most effective measure for the maintenance and preservation of these habitats and the associated wildlife is the encouragement of traditional agriculture and animal husbandry, combined with the tourist offer of premium products.

Basic biological values - flora, fauna and habitats

The biosphere, the entire living world, together with all inanimate elements of living space (biotope) makes up the ecosphere of the Protected landscape Vjetrenica - Popovo polje, divided into atmosphere, pedosphere, hydrosphere and lithosphere. Each of these spheres has living organisms, representatives of five large kingdoms: bacteria (*Regnum Prokaryotae*), protists (*Regnum Protoctista*), fungi (*Regnum Fungi*), plants (*Regnum Plantae*) and animals (*Regnum Animalia*).

Protists

As many as 37 species from the following classes were identified for the group of protists in Vjetrenica: *Lobosoa (23), Filosia (5)* and *Ciliatea (9).* In total, representatives of as many as 24 genera have been identified, including most common genera: *Amoeba (3), Difflugia (8), Nebella (2), Arcella (4).*

Research on protozoa in the Vjetrenica cave is mentioned in the Hydro-biological Study on Subterranean Water Connections in the Trebišnjica River Basin by M. Georgijevski, M. Gligić,

S. Karaman and T. Petkovski from 1956. It is a comparative study of protists, and fauna in the Trebišnjica River Basin complemented by hydrological and hydrogeological data. It is a unique and highly valuable comparative study of both underground and surface habitats. There is a total of 36 protozoan species recorded for the Vjetrenica cave, belonging to the following groups: naked amoebae (gymnamoebae) and testate amoebae, sun-animalcules (*Heliozoa*), and the ciliates. Gymnamoebae types recorded by Georgijevski et al. (1956) are *Amoeba proteus, Trichamoeba villosa* (sin. *Amoeba villosa*), and *Pelomyxa palustris*. Testate amoebae are a polyphyletic group of protozoa with common feature of an outer shell (house) presence. Pseudopodia serve the

amoeba to move and to feed. In the Vjetrenica Cave Georgijevski et al. (1956) have recorded the highest biodiversity of gymnamoebae – a total of 21 species. The largest in numbers are gymnamoebae with finger-shaped pseudopodia (lobopodia), among which 19 species have been recorded.

From the *Difflugia* genus, there are following species recorded in the Vjetrenica Cave: *Difflugia pyriformys, Difflugia acuminata, Difflugia globulosa, Difflugia urceolata, Difflugia corona* and *Difflugia manicata*. They are typical to be found in a whole range of terrestrial waters and moss habitats (especially the genus *Sphagnum*).

Algae

Algae have been explored so far only sporadically in the area of Herzegovina as part of lichen research, where they come in the community with fungi while, as far as is known, they have not been explored in the area around the Vjetrenica cave. According to the existing data for Herzegovina, we can expect a variety of green algae (*Chlorophyta*), especially epiphytes, which appear the bark of trees. Epilithic silicate algae (*Bacillariophyta*) grow on limestone rocks, and numerous green, silicate and gold (*Chrysophyta*) algae grow in the soil. We can also expect very interesting endolytic algae that live in closed cavities of limestone rocks, as well as very interesting and potentially endemic algae in caves and pits. Freshwater planktonic algae and freshwater benthos algae occur in ponds and wells.

Flora

Research on the flora of the aboveground part of the wider area of the Vjetrenica cave recorded 484 taxa, of which 42 were previously known from the research area (Beck-Mannagetta, 1903- 1924, 1927; Beck-Mannagetta and Maly, 1950; Beck-Mannagetta et al., 1967, 1974, 1983).

Of the previously recorded species, 12 have not been confirmed, 30 have been confirmed, while some species have been recorded for the first time (442). Among these recorded species, 21 species are endemic to the Balkans, while according to the Red List of Flora 38 taxa (10 vulnerable, 12 endangered, 5 critically endangered, 7 nearly endangered and 4 for which data are missing). A review of the data from literature as well as the results of research from Annexes 104 and II of the Habitats Directive discovered the amethyst meadow squill (Scilla litardierei Breistr. (1954), while only *Ruscus aculeatus* L. and *Galanthus nivalis* L. were confirmed from Annex V.

Figure 4 *Ruscus aculeatus* L. (picture left) and *Galanthus nivalis* L. (picture right*) (photo: A. Boškailo)*

Plant communities

The subject area is phytogeographically located in the southern Adriatic province of the Mediterranean biogeographical region, which covers most of the southern areas of Bosnia and Herzegovina. The narrower category of forest land includes high beech forests, mixed beech and fir forests, mixed beech and fir forests with spruce and pure fir and spruce forests, pine forests, high sessile oak forests, forest crops, coppice forests of beech, oak, and mixed coppice forests, non-reproductive forests and usurpations. The distribution of vegetation types is influenced by a number of other factors, such as orographic, edaphic, but also by man, who contributes to the local formation of vegetation cover by the dynamics and scope of his activities. The vegetation of this area was investigated by, among others: Ritter-Studnička and Grgić (1975), Lakušić et al. (1982), Lovrić (1988), Redžić (2007), etc.

The main vegetation types that can be distinguished in the area include:

Forest and shrub vegetation - The area of the valley from Zavala to Češljari and further to the west of the state border with the Republic of Croatia, as well as the hills of Popovo polje above Čvaljina, and the relief indented area south of Zavala are overgrown with mostly low thermophilic shrubs and bushes, while no significant forest areas are recorded here, although in climate and zonal terms, the forest represents the ultimate vegetation phase (Figure 6.). This area is a transitional area between the Mediterranean and sub-Mediterranean zones. The relief indentation of the area introduces diversity and partly conditions the microclimatic conditions, which, including altitude and exposure, affect the distribution of vegetation. In the wider area of Vjetrenica, outside the influence of groundwater, the vegetation of low shrubs and bushes is formed mainly by elements of the order *Paliuretalia*. The vegetation of xerothermic deciduous forests and shrubs is built primarily by the communities of *Ostryo-carpinion orientalis* association. On milder slopes of the terrain, within the *Ostryo-Carpinion orientalis* association, and with

further degradation of shrubs, as their final degradation stage, sub-Mediterranean dry grasslands of the order *Scorzonero-Chrysopogonetalia* are developed H- ić.et Ht. (1956) 1958. The mentioned communities of thermophilic shrubs are joined to the west by an increasing share of the Mediterranean elements of evergreen forests and matorral of the *Quercion ilicis* association, which is especially pronounced west of Orahov dol. Namely, evergreen forests and holm oak matorral also include forests of the epimediterranean belt in which holm oak is mixed with deciduous species. The thermal character of the area's climate determines the development of these vegetation forms characteristic of the belt of evergreen forests and holm oak shrubs of the *Querceteai licis* order/class No.-Bl.1947, and the appearance of elements of the Eumediterranean rocks of the *Thero-Brachypodietea* order No.-Bl.1947 within dry grasslands.

Figure 5 *Vegetation of forests and shrubs within the Protected landscape Vjetrenica - Popovo polje (photo: A. Boškailo)*

Vegetation of dry grasslands - In the former forest habitats, under the influence of man, by pasturing, clearing and fires, various forms of thermophilic rocks and xerothermic meadows developed secondarily. Vegetation of sub-Mediterranean xerothermic grasslands of this area belongs to the order *Scorzonero-Chrysopogonetalia* H-ić et Ht. (1956) 1958 (syn. *Scorzoneretalia villosae*) of the class *Festuco-Brometea* Br.-Bl. & R. Tx. 1943, and the most significant are the sub-Mediterranean rocks of the association *Chrysopogoni-Koelerion splendentis, Satureion subspicatae, Peucedanion neumayeri, Scorzonerion villosae*, present in the area of the climate and zonal vegetation of the *Ostryo-Carpinion orientalis* association. The most widespread sub-Mediterranean rocky communities recorded in the wider area of Popovo polje are: the sage and sagebrush community (*Stipo-Salvietum officinalis*), the fescue and keleria community (*Festuco-Koelerietum splendentis*), the asphodel and karst community (*Asphodelo-Chrysopogonetum grylli*), and the community of sedge and yellow knapwee (*Carici-Centaureetum rupestris*).

Due to the pronounced influence of the Mediterranean climate on this area, for the same reason that causes changes in composition of forest and shrub vegetation, an increased share of typically Mediterranean species can be observed in the vegetation of dry grasslands in this area. Thus, in the vegetation of dry grasslands of this area, there are elements of vegetation of eumediterranean rocks of the class *Thero-Bracyhpodietea*, and they include communities of *Cymbopogo-Brachypodionramosi* association, from the order *Cymbopogo-Brachypodietalia* H-ić. (1956) 1958 and the association *Thero-Brachypodionretusi*, from the order *Thero- Brachypodietalia* Br.-Bl.1947. The Euro-Mediterranean grasslands of the order *Thero-Brachypodietea* Br.-Bl.1947 are open, low grasslands, built mainly of annual plants, that is, the plants that complete their life cycle before summer droughts (therophytes and geophytes), which is why in the dry part of the year it is not possible to notice the richness of their plant composition. They develop on shallow carbonate soils, but also on deeper washed calcified soils throughout the Mediterranean. They are mainly used for pasturing, only to a lesser extent combined, but the use of medicinal, spicy, aromatic and wild edible plants should not be neglected. With succession, and cessation of use, they grow into bushes and matorral.

Figure 6 *Vegetation of dry habitats in which widely used and well-known medicinal, aromatic and honey species Salvia officinalis L. - sage finds its optimum (photo: A. Boškailo)*

Vegetation of poorly grown terrestrial areas - Areas outside the constant water inflow with specific conditions of structure and wear of the geological base and slope, which includes vertical rocks and accumulations of mainly slightly movable rocks at their base, are overgrown with sparse vascular vegetation of rockery and scree plants. Rock vegetation is maintained as a natural permanent stage due to the specific conditions of vertical rocks with cracks in which fine soil and water are accumulated (Figure 8.). Due to the pronounced influence of the Mediterranean climate

in the wider area of Popovo polje, the vegetation of this area is overgrown with vegetation of Adriatic coastal screes on a carbonate base of the order of the alliance Peltarionalliaceae (order *Arabidetalia flavescentis* Lakušić 1966, order *Thalaspietea rotundifolii* Br.-Bl.19) while the carbonate rocks with chasmophytic vegetation belong to the class *Asplenietalia rupestris* H.Meier) Br. - Bl. 34, that is, the orders *Moltkietalia petraea*e Lakušić 1968 and *Amphoricarpetalia* Lakušić 1968.

In the area subject of research, habitats with chasmophytic vegetation can be found on steep rock sections, for example at the foot of Ilija hill, north of Orahov dol, and elsewhere where conditions in the form of constant rock wear and substrate removal do not allow soil development, and thus the plants which are not adapted to such conditions. Habitats were identified with elements of communities of the order *Moltkietalia petraeae* Lakušić 1968.

Figure 7 *Vegetation of rock cracks on which a large number of endemic and endangered species found their place to live (photo: A. Boškailo)*

Vegetation of part of Popovo polje with a review of the area around the Vjetrenica cave Popovo polje is a typical karst field with various karst phenomena and a rich underground karst network. It is located at an altitude of about 220 - 250 m.a.s.l. According to its ecoclimatic characteristics, it is classified in the lower karst fields of eastern Herzegovina, and it is strongly influenced by the Mediterranean climate.

As opposed to the already described dry rocky pastures, which are maintained as a permanent stage by pasturing, wet karst meadows of the Mediterranean and sub-Mediterranean area develop

in floodplain karst fields and river valleys, which are used mainly as meadows. At the same time, the grass vegetation of karst fields requires regular flooding in the wet part of the year, and then, by summer, the soil dries out significantly.

Special natural relations and processes created optimal ecological conditions for this area. This primarily refers to the presence of specific ecological factors that enabled a great diversity of habitats and species that are an integral part thereof. For natural balance in the connection of all components of nature or its biotic and physical factors, this area is a mosaic of different habitat types, and it is dominated by low thermophilic forests and underbrush, rocky terrains, dry karst pastures and underground habitats. This diversity is conditioned by geographical position, natural processes, but also by long-term anthropogenic influences. It is this mosaic that provides living conditions for a large number of species, both plant and animal.

The vegetation of thermophilic and hydrophilic and mesophilic meadows of Popovo polje generally belongs to the alliances of *Deschampsion mediae* (order *Holoschoenetalia vulgaris* Br.-Bl. ex Tchou 1948), *Molinio-Hordeionsecalini* and *Trifolionresupinat*i (order *Trifolio-Hordeetalia,* Horvatić 1960). Meadows covered with clover and clusters (*Trifolio-Hordeetum secalini* alliance) develop on moist soils with base reaction with high groundwater levels. They represent sub-Mediterranean moist low clover grasslands. They are mowed once a year, which, with the appropriate water regime, is an important condition for their maintenance. Small bushes (*Deschampsion mediae* community) meadows are also a significant type of grassland in the karst fields of the sub-Mediterranean area of Bosnia and Herzegovina and neighbouring areas, and they develop on mineral-wetland soil.

In summer, the soil dries out and cracks in some places. Characteristic species of these meadows is the small bush (*Deschampsia media* (Gouan) Roem. & Schult.). In the past, the grasslands of small bushes were used much more than today as meadows, and after mowing as pastures. Part of Popovo polje east of the current course of Trebišnjica is largely cultivated and intensively processed. On the contrary, the part of Popovo polje west of the current course of Trebišnjica in the area around the Vjetrenica cave is mostly neglected and only some parts are used as pastures.

Along the old course of Trebišnjica and other periodical and permanent flows, and in depressions of the terrain where water is retained longer and the soil remains sufficiently moist, swamp vegetation with reeds and sedges develops. Wetland vegetation belongs to the order *Phragmitetalia* W. Koch 1926, that is, amphibious communities of the order *Isoëto- Nanojuncetea* Br.-Bl et Tx 1943, which inhabit the contact zones of water and land, where occasional (natural) flooding and drying of habitats takes place.

Figure 8 *Vegetation of the Protected landscape Vjetrenica - Popovo polje in which there are wet meadows of the Mediterranean and sub-Mediterranean area (photo: A. Boškailo)*

Hygrophilous forests and shrubs of willow, poplar and wicker of the orders *Populetalia albae* Br-Bl 1931 and *Salicetalia purpureae* Moor 1958 develop in similar conditions). Developed remains of such willow bushes can be seen along the old riverbed of Trebišnjica (vegetation of hydrophilic forests and bushes of the *Salicion albae*, *Salicion purpureae* and *Viticion agni- casti*).At the same time, *Salicion albae* alliances represent a form of flood thermophilic forests and shrubs, which overgrow the shores of permanent or periodical watercourses and wetlands of the Mediterranean and sub-Mediterranean belt.

Vegetation of the entrance area of Vjetrenica - At the very entrance to the cave, the specific microclimatic conditions of increased humidity, shading and (in summer) the cold air currents from inside the cave are prerequisites for a kind of inversion of vegetation. Namely, the stone base at the entrance to the cave is overgrown with plants characteristic of wetland rock habitats, such as some ferns of the *Aspleniaceae* family, or vegetation elements of carbonate rocks of the mountain belt, such as mossy merinka (*Moehringia muscosa L.*). The presence of mature mountain maple trees (*Acer pseudo platanus L.*), a species characteristic of the forests of the continental regions, is interesting, as opposed to the sub-Mediterranean vegetation of the surrounding above-ground area of Vjetrenica.

In the belt above the entrance, in addition to the vegetation of forests and underbrush similar to that of the wider area of Vjetrenica, some woody species are found to grow here by man action, such as evergreen cypress (*Cupressus sempervirensL.*), Acacia (*Robinia pseudacaciaL.*) and tree of heaven - *Ailanthus altissima* (Mill) Swingle.

Impact of man on vegetation - Land improvement interventions in Popovo polje, along with the conversion of land into agricultural land, and the abandonment of traditional agriculture led to major changes in the layout of the field. In the entire area subject of research, there is a significant share of areas that are neglected nowadays. Today, the central part of Popovo polje has turned into agricultural land. Intensively cultivated surfaces in the area of Čvaljina and Zavala are located east of the river Trebišnjica, and vineyards and orchards are the most common forms of land cultivation. The area subject of research in Popovo polje probably used to be more utilized for traditional forms of agriculture, and nowadays only a few smaller vineyards and pastures are maintained in it. The vegetation of arable and abandoned areas of Popovo polje belongs to the orders *Atriplici-Chenopodietalia albi* Tx. 1937, *Chenopodietalia muralis* Br.-Bl. et al. 1936 and *Thero-Brometalia* Br.-Bl. 1947 of the class *Stellarietea mediae* Br.-Bl. 1921, while the vegetation of thermophilic abandoned habitats belongs to the order *Carthametalia lanati* Brullo & Marceno 1985 of the class *Artemisietea vulgaris* Lohm., Prsg. et R. Tx. in R. Tx. 1950.

In the area of the surrounding smaller karst fields and right next to the settlements, only smaller plots under vegetable gardens and traditional olive groves and vineyards were observed.

Figure 9 *Vineyards containing also autochthonous grape varieties (photo: A. Boškailo)*

Since recently, a considerable attention is also paid to the issue of the spread of allochthonous invasive plant species. Thus, for example, the occurrence of the species *Ailanthus altissima* (Mill.) Swingle (tree of heaven) was observed in some places in the area under research, the spreading of which may pose a risk to the local natural vegetation due to rapid spreading by vegetative propagation. It grows well particularly in the southern parts, and spreads quickly along roads, forest edges and undershrubs, and in neglected ruderal and other open areas.

Habitat types according to NATURA 2000 classification

The presence of a significant number of endangered and endemic plant species and typical and well-preserved habitat types of importance for the EU Habitats Directive, support the fact that the area Vjetrenica-Popovo polje is of global importance for the protection of European natural heritage (Council Directive 92/43/EEC, 1992; Milanović et al., 2015).

According to data on habitats in the wider area of the Vjetrenica cave, the following habitats types are found as shown in Table 2.

Table 2 *Habitat types according to Natura 2000 in the wider area of the Vjetrenica cave*

NATURA 2000 CODE	**LOCAL NAME**
8310	Caves not open to the public
62A0	Eastern sub-mediterranean dry grasslands (*Scorzoneretalia villosae*)
6510	Lowland hay meadows
6540	Sub-Mediterranean grasslands of the *Molinio-Hordeion secalini*
8210	Calcareous rocky slopes with chasmophytic vegetation
*3180	Ephemeral karstic lakes
5210	Arborescent matorral with *Juniperusoxycedrus* and *J. phoenicea*
91F0	Lowland riparian hardwood forests
9250	Quercus trojana woods
9340	Quercus ilex woods

Fauna

The fauna of the area can be divided into two main groups:

A. Epigean or aboveground fauna

It lives at the contact of the atmosphere and the pedosphere, hydrosphere and lithosphere, which predominates in the area planned for protection. Animal communities (zoocenoses) are often associated with plant communities (phytocenoses). Many herbivorous species (phytophagous), especially beetles and butterflies, are associated with only a few host plants, sometimes a single one. Due to the pronounced karstification of the area, the water flows mainly underground, and the above-ground flows (hydrosphere) are less represented. Rare karst springs, occasional torrents, and ponds and wells are present.

Terrestrial fauna is represented by numerous invertebrates, of which the typical are snails (Gastropoda), earthworms (Oligochaeta), crustaceans (Crustacea), centipedes (Myriapoda), arachnids (Arachnida) and insects (Insecta). Of the vertebrates, amphibians (Amphibia), reptiles (Reptilia), birds (Aves) and mammals (Mammalia) are represented.

Aquatic fauna is rich in species, although aquatic habitats are rare, but they are poorly explored. The typical fauna includes planarian (Tricladida), leeches (Hirudinea), crustaceans (Crustacea), while when it comes to aquatic insects, particularly pronounced are caddisflies (Trichoptera), aquatic flowers (Ephemeroptera), dragonflies (Odonata), aquatic beetles (Coleoptera), and when it comes to vertebrates, they include amphibians (Amphibia) and fish (Pisces).

Invertebrates

When it comes to the aboveground fauna of invertebrates, field research and review of data from literature for the wider area of the protected area Vjetrenica - Popovo polje identified a total of 248 invertebrate taxa (Ozimec et al., 2021), of which seven (7) species are endangered categories included on the Red List of the Federation of BiH, as well as (3) three species that are included in Annexes II and/or IV of the EU Habitats Directive (Table 3.).

Table 3 *List of endangered species according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV (Insecta) in the area of Popovo polje*

	Species	Degree of threat according to the Red Lists of Europe and the Red List of FBiH	Degree of threat and protection according to the Habitats Directive (Annexes II and IV)	IUCN threats
1.	*Ammobatoides abdominalis* (Eversmann, 1852)	IUCN EN		**7.3.**

2.	*Cerambyx cerdo* Linnaeus, 1758– great capricorn beetle	IUCN VU	HD II and IV	
3.	*Lucanus cervus* (Linnaeus, 1758) – European stag beetle	Europe NT VU on the FBiH Red List	HD II	**5.3.5.**
4.	*Gonepteryx cleopatra* (Linnaeus, 1758)	Europe LC VU on the FBiH Red List		
5.	*Iolana iolas* (Ochsenheimer, 1816)	Europe NT EN on the FBiH Red List		**2.1.3., 2.3.2,** **2.3.3., 7.3.**
6.	*Aricia anteros* (Freyer, 1838)	Europe NT EN on the FBiH Red List		**1.3., 2.1.1., 2.1.2.** **2.2.1., 2.2.2.** **2.3.2., 2.3.3., 6.1.,** **7.1.3., 7.3., 8.1.1.** **9.3.4., 11.1., 11.2.**
7.	*Polyommatus admetus* Esper, 1783	Europe LC EN on the FBiH Red List		
8.	*Charaxes jasius* (Linnaeus, 1767)	Europe LC VU on the FBiH Red List		
9.	*Hipparchia statilinus* (Hufnagel, 1766)	IUCN LC VU on the FBiH Red List		

Vertebrates Fish

In the area of Popovo polje, the presence of 9 species of freshwater fish was recorded, of which five (5) are endemic to this area (*Delminichthys ghetaldii, Telestes metohiensis, Phoxinus karsticus, Chondrostoma phoxinus* and *Squalius svallize*) (Kottelat and Freyhof, 2007; Redžić, 2007; Sofradžija, 2009; Glamuzina et al., 2010; Ozimec et al., 2021. Ray-finned fish (*Delminichthys ghetaldii* (Steindachner, 1882)) is an endemic freshwater fish species typical of Popovo polje, where it once had huge populations during the existence of the flood

It is the oldest fish population in Europe. Today, it is reduced to only a few smaller sites and is considered endangered species (EN). It is interesting that in Trebišnjica, the Lukavac spring and other springs there are other endemic and relict fish species such as Neretva chub (*Squalius svallize* (Heckel & Kner, 1858), white chub (*Leuciscus cavedanus*, (Bonaparte, 1838)) and others (Table 4.).

Table 4 *List of endangered fish species according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV in the area of Popovo polje*

Latin name	Endemic	Degree of threat according to the Red Lists of Europe and the Red List of FBiH	Degree of threat and protection according to the Habitats Directive (Annexes II and IV)	IUCN threats
Alburnus arborella **(Bonaparte, 1841)**		Europe LC LC on the FBiH Red List		
Delminichthys ghetaldii **(Steindachner, 1882)**	X	IUCN VU EN on the FBiH Red List	HD II and IV	**7.2.8.,** **8.1.1.,** **11.2.**
Oncorhynchus ***Mykiss*** **(Walbaum, 1792)**		LC on the FBiH Red List		
Phoxinus lumaireul **(Schinz, 1840)**		IUCN LC LC on the FBiH Red List		
Phoxinus karsticus **(Bianco& De Bonis, 2015)**	X			

Telestes metohiensis **(Steindachner, 1901)**	X	IUCN VU CR on the FBiH Red List	HD I and IV	**7.2.8.,** **8.1.2.,** **9.3.4.,** **11.2.**
Pomatoschistus ***Canestrinii*** **(Ninni, 1883)**		IUCN LC LC on the FBiH Red List	HD II	
Chondrostoma phoxinus **(Heckel, 1843)**	X	IUCN EN CR on the FBiH Red List		**7.2.8.,** **7.2.11.,** **11.2.**
Squalius svallize **(Heckelet Kner, 1852)**		**IUCN VU** **VU on the FBiH Red List**		**7.2.8.,** **7.2.11.,** **11.2.**

Amphibians and reptiles

In the fauna of amphibians and reptiles, based on the results of field research and review of available literature (Lelo, 2007, Redžić, 2007; Lelo et al., 2015; Lelo and Zimić, 2020; Silajdžić et al., 2020; Ozimec et al., 2021), the presence of 28 species was determined in this area, of which 5 species are classified under the endangered categories on the Red List of the Federation of BiH, as well as 20 species that are included in Annexes II and/or IV of the EU Habitats Directive (Table 5.).

Table 5 *List of endangered amphibians and reptiles according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV in the area of Popovo polje*

Species name		Lit.	Threat status		IUCN threats
NO.		Species known from the literature	Degree of threat according to the Red Lists of Europe and the Red List of FBiH	Degree of threat and protection according to the Habitats Directive (Annexes II and IV)	IUCN threats
AMPHIBIA					
1.	*Proteus anguinus* Laurenti, 1768	X	IUCN VU; VU on the EU RL EN on the FBiH Red List	HD II and IV	1.1., 1.3., 2.1.3, 5.1.1., 5.3.5., 6.1., 9.2.3., 9.3.4.
2.	*Lissotriton vulgaris* (Linnaeus, 1758)	X	IUCN LC VU on the FBiH Red List		5.3.5., 7.2.8., 8.1.1.
3.	*Lissotriton graecus* (Wolterstorff, 1906)	X			
4.	*Bombina variegata* Linnaeus, 1758 – yellow-bellied toad	X	IUCN LC	HD IV	1.1., 1.2., 2.1.3., 2.3.3, 3.2., 5.3.5., 9.2.3., 9.3.4.
5.	*Bufo bufo* (Linnaeus, 1758) – common toad	X	Europe LC		2.1.3., 8.1.2., 8.2.2., 9.3.4.
6.	*Bufo viridis* (Laurenti, 1768) – European green toad	X	IUCN LC	HD IV	2.1.3., 2.3.3., 4.1., 9.2.3., 9.3.4.

7.	*Hyla arborea* (Linnaeus, 1758) – tree frog	X	IUCN LC	HD IV	1.1., 1.2., 1.3., 2.1.2., 2.1.3., 2.2.1., 2.3.3., 5.1.1., 5.3.5., 8.1.1., 9.1.3., 9.2.3., 9.3.4.
8.	*Rana dalmatina* Bonaparte, 1839	X	IUCN LC	HD IV	1.1., 2.1.3., 2.2.1., 2.2.2., 2.3.3., 5.3.5., 9.3.4.
9.	*Pelophylax ridibundus* (Palas, 1771)	X	IUCN LC		
REPTILIA					
10.	*Testudo hercegovinensis* (Werner, 1899) – Dalmatian tortoise	X	IUCN NT VU on the FBiH Red List	HD II and IV	1.1., 1.3., 2.1.2., 2.1.3., 2.1.4., 2.3.4., 4.1., 5.1.1., 7.1.3., 7.3., 8.1.1., 9.3.3.
11.	*Testudo hermanni* (Gmelin, 1789)	X	IUCN NT	HD II	1.1., 1.3., 2.1.2., 2.1.3., 2.1.4., 2.3.4., 4.1., 5.1.1., 7.1.3., 7.3., 8.1.1., 9.3.3.
12.	*Hemidactylus turcicus* (Linnaeus, 1758)	X	IUCN LC		
13.	*Ophisaurus apodus (*Pallas, 1775)	X	IUCN LC	HD IV	2.1.3., 2.3.3., 5.1.3.

14.	*Archaeolacerta oxycephala* (Duméril&Bibron, 1839)	X		HD IV	
15.	*Lacerta trilineata* (Bedriaga, 1886)	X	IUCN LC	HD IV	2.1.3., 7.1.3.
16.	*Lacerta viridis* (Laurenti, 1768)	X	IUCN LC	HD IV	
17.	*Podarcis melisellensis* (Werner, 1891)	X	IUCN LC	HD IV	
18.	*Coronella austriaca* (Laurenti, 1768)		IUCN LC	HD IV	1.1., 2.1.3., 5.1.3., 7.1.1., 11.1.
19.	*Hierophis gemonensis* (Laurenti, 1768)	X	IUCN LC		2.1.3., 2.1.4., 2.3.4., 5.1.3., 9.3.4.
20.	*Platyceps najadum* (Eichwald, 1831)	X	IUCN LC	HD IV	2.1.3., 4.1., 5.1., 7.1.3.
21.	*Telescopus fallax* (Fleischmann, 1831)		IUCN LC	HD IV	1.2., 2.3.3., 4.1., 5.1.3.
22.	*Zamenis longissima* (Laurenti, 1768)	X		HD IV	
23.	*Zamenis situla* (Linnaeus, 1758)	X	IUCN LC VU on the FBiH Red List	HD II and IV	2.1.4., 2.3.4., 5.1.1., 5.1.3.
24.	*Natrix natrix* (Linnaeus, 1758)	X	IUCN LC		
25.	*Elaphe quatuorlineata* (Lacépede, 1789)		IUCN NT VU on the FBiH Red List	HD II and IV	1.1., 1.3., 2.1.3., 5.1.3.

26.	*Natrix tesselata* (Laurenti, 1768)	X			
27.	*Vipera ammodytes* (Linnaeus 1758)	X	IUCN LC	HD IV	5.1.1., 5.1.3.
28.	*Elaphe situla* (Linnaeus, 1758)	X	IUCN LC	HD II AND IV	2.1.4, 2.3.4., 5.1.1., 5.1.3.

Birds

From the available data from literature, in the area of the Protected landscape Vjetrenica - Popovo polje the presence of 78 bird species was established (Kitonić and Sackl, 2008/2009; Dervović and Kotrošan, 2011/2012; Topić and Kotrošan, 2011/2012; Silajdžić et al., 2020; Ozimec et al, 2021), of which 75 species are on the Red List of the Federation of BiH and 22 species on the list of the EU Directive on the Conservation of Wild Birds (Table 6.).

Table 6 *List of endangered birds according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV in the area of Popovo polje*

No.	Latin name	Common name	Status (makes nests, does not make nests)	Red list of fauna of FBiH	IUCN status	EU Birds Directive	IUCN threat
1.	*Alauda arvensis* Linnaeus, 1758	Eurasian skylark	Makes nests	LC	LC	BD IIb	
2.	*Alcedo atthis* Linnaeus, 1758	Common kingfisher	Does not make nests	NT	LC	BD I	
3.	*Alectoris graeca* Meisner, 1804	Rock partridge	Does not make nests	DD	NT	BD I, IIa	1.3., 2.1.3., 5.1.1., 8.1.2., 11.1., 11.4.

4.	*Anas platyrhynchos* Linnaeus, 1758	Wild duck	Makes nests	LC	LC	BD IIa, IIIa	
5.	*Anthus campestris* Linnaeus, 1758	Tawny pipit	Makes nests	NT	LC	BD I	
6.	*Anthus trivialis* Linnaeus, 1758	Tree pipit	Does not make nests	LC	LC	-	
7.	*Apus melba* Linnaeus, 1758	Alpine swift	Makes nests	NT	LC	-	
8.	*Aquila chrysaetos* Linnaeus, 1758	Golden eagle	Does not make nests	EN	LC	BD I	2.2.2., 3.3., 4.2., 5.1.3., 8.5.1., 9.3.3., 11.1.
9.	*Ardea cinerea* Linnaeus, 1758	Grey heron	Does not make nests	VU	LC	-	2.1.4., 5.1.1., 5.1.3., 5.3.4., 8.1.1., 8.1.2., 8.5.2., 9.3.2.
10.	*Buteo buteo* Linnaeus, 1758	Common buzzard	Makes nests	LC	LC	-	3.3., 5.1.2., 5.1.3., 8.5.2., 9.3.3.
11.	*Carduelis cannabina* Linnaeus, 1758	Common linnet	Makes nests	LC	LC	-	
12.	*Carduelis carduelis* Linnaeus, 1758	European goldfinch	Makes nests	LC	LC	-	5.1.1., 5.1.2
13.	*Carduelis chloris* Linnaeus, 1758	European greenfinch	Makes nests	LC	LC	-	
14.	*Carduelis spinus* Linnaeus, 1758	Eurasian siskin	Makes nests	LC	LC	-	

15.	*Cecropis daurica* Laxmann, 1769	Red-rumped swallow	Makes nests	VU	LC	-	8.2.1.
16.	*Circaetus gallicus* J. F. Gmelin, 1788	Short-toed snake eagle	Does not make nests	VU	LC	BD I	2.1.3., 2.3.2., 3.3., 4.1., 4.2., 5.1.3., 5.3.3., 7.1.1., 9.3.3.
17.	*Circus aeruginosus* Linnaeus, 1758	Western marsh harrier	Does not make nests	VU	LC	BD I	2.3.2., 3.3., 5.1.2., 5.1.3., 5.3.3., 7.2.4., 9.2.3., 9.3.3.
18.	*Columba livia* J. F. Gmelin, 1789	Common pigeon	Makes nests	LC	LC	BD IIa	
19.	*Corvus corax* Linnaeus, 1758	Common raven	Does not make nests	LC	LC	-	
20.	*Corvus cornix* Linnaeus, 1758	Hooded crow	Makes nests	LC	LC	-	
21.	*Cuculus canorus* Linnaeus, 1758	Common cuckoo	Makes nests	LC	LC	-	
22.	*Cyanistes caeruleus* Linnaeus, 1758	Eurasian blue tit	Makes nests	LC	LC	-	
23.	*Delichon urbicum* Linnaeus, 1758	Common house martin	Makes nests	LC	LC	-	8.2.2., 11.4.
24.	*Egretta garzetta* Linnaeus, 1766	Little egret	Does not make nests	VU	LC	BD I	
25.	*Emberiza calandra* Linnaeus, 1758	Corn bunting	Makes nests	LC	LC	-	

26.	*Emberiza cia* Linnaeus, 1766	Rock bunting	Makes nests	LC	LC	-	
27.	*Emberiza cirlus* Linnaeus, 1766	Cirl bunting	Makes nests	LC	LC	-	
28.	*Emberiza melanocephala* Scopoli, 1769	Black-headed bunting	Makes nests	NT	LC	-	
29.	*Erithacus rubecula* Linnaeus, 1758	European robin	Makes nests	LC	LC	-	
30.	*Falco naumanni* Fleischer, 1818	Lesser kestrel	Does not make nests	CR	LC	BD I	1.1., 1.2., 2.1.3., 2.2.3., 5.1.1., 5.1.3., 9.3.3., 11.2., 11.4.
31.	*Falco peregrinus* Tunstall, 1771	Peregrine falcon	Makes nests	DD	LC	BD I	2.3.2., 3.3., 5.1.1., 5.1.3., 5.3.3., 6.1., 7.1.1., 9.2.1., 9.3.3.
32.	*Falco tinnunculus* Linnaeus, 1758	Common kestrel	Makes nests	LC	LC	-	2.1.3., 2.3.2., 3.3., 5.1.1., 5.3.3., 7.1.1., 9.3.3.
33.	*Falco vespertinus* Linnaeus, 1766	Red-footed falcon	Does not make nests	-	NT	BD I	2.1.3., 2.3.2., 3.3., 5.1.1., 5.3.3., 7.1.1., 9.3.3.
34.	*Fringilla coelebs* Linnaeus, 1758	Common chaffinch	Makes nests	LC	LC	-	

35.	*Garrulus glandarius* Linnaeus, 1758	Eurasian jay	Makes nests	LC	LC	BD IIb	

36.	*Hippolais pallida* Hemprich & Ehrenberg, 1833	Eastern olivaceous warbler	Makes nests	DD	LC	-	
37.	*Hirundo rustica* Linnaeus, 1758	Barn swallow	Makes nests	LC	LC	-	2.3.3., 5.1.1., 5.1.3., 7.2.3., 8.1.2., 9.3.3., 11.3.
38.	*Jynx torquilla* Linnaeus, 1758	Eurasian wryneck	Makes nests	LC	LC	-	
39.	*Lanius collurio* Linnaeus, 1758	Red-backed shrike	Makes nests	LC	LC	BD I	
40.	*Lanius excubitor* Linnaeus, 1758	Great grey shrike	Makes nests	NT	LC	-	
41.	*Lanius senator* Linnaeus, 1758	Woodchat shrike	Makes nests	DD	LC	-	
42.	*Larus michahellis* Naumann, 1840	Yellow-legged gull	Does not make nests	-	LC	-	5.1.1., 5.1.3.
43.	*Luscinia megarhynchos* C. L. Brehm, 1831	Common nightingale	Makes nests	NT	LC	-	
44.	*Melanocorypha calandra* Linnaeus, 1766	calandra lark	Makes nests	-	LC	BD I	
45.	*Merops apiaster* Linnaeus, 1758	European bee-eater	Does not make nests	NT	LC	-	
46.	*Monticola saxatilis*	Common rock thrush	Makes nests	NT	LC	-	

	Linnaeus, 1758						
47.	*Monticola solitarius* Linnaeus, 1758	Blue rock thrush	Makes nests	DD	LC	-	
48.	*Motacilla alba* Linnaeus, 1758	White wagtail	Makes nests	LC	LC	-	11.5.
49.	*Motacilla cinerea* Tunstall, 1771	Grey wagtail	Makes nests	LC	LC	-	

50.	*Oenanthe hispanica* Linnaeus, 1758	Western black-eared wheatear	Makes nests	NT	LC	-	
51.	*Oenanthe oenanthe* Linnaeus, 1758	Northern wheatear	Makes nests	LC	LC	-	1.1., 2.1., 2.1.3., 5.1.1., 11.2.
52.	*Oriolus oriolus* Linnaeus, 1758	Eurasian Golden Oriole	Makes nests	LC	LC	-	
53.	*Otus scops* Linnaeus, 1758	Eurasian Scops Owl	Makes nests	NT	LC	-	2.1.4.
54.	*Parus major* Linnaeus, 1758	Great tit	Makes nests	LC	LC	-	11.5.
55.	*Passer domesticus* Linnaeus, 1758	House sparrow	Makes nests	LC	LC	-	
56.	*Passer hispaniolensis* Temminck, 1820	Spanish sparrow	Makes nests	NT	LC	-	9.3.3.
57.	*Phalacrocorax carbo* Linnaeus, 1758	Great cormorant	Does not make nests	VU	LC	-	2.4.3., 3.3., 5.1.1., 5.1.3., 6.1., 7.3.,

							8.5.2., 9.2.1., 9.2.3., 9.3.3., 11.2.
58.	*Phoenicurus ochruros* S. G. Gmelin, 1774	Black redstart	Makes nests	LC	LC	-	
59.	*Phylloscopus sibilatrix* Bechstein, 1793	Wood warbler	Makes nests	NT	LC	-	
60.	*Phylloscopus trochilus* Linnaeus, 1758	Willow warbler	Does not make nests	DD	LC	-	
61.	*Pica pica* Linnaeus, 1758	Eurasian magpie	Makes nests	LC	LC	BD IIb	
62.	*Picus viridis* Linnaeus, 1758	European green woodpecker	Makes nests	LC	LC	-	
63.	*Poecile lugubris*Temminck, 1820	Sombre tit	Makes nests	LC	LC	-	
64.	*Ptyonoprogne rupestris* Scopoli, 1769	Eurasian crag martin	Makes nests	LC	LC	-	
65.	*Saxicola rubetra* Linnaeus, 1758	Whinchat	Does not make nests	LC	LC	-	
66.	*Saxicola rubicola* Linnaeus, 1766	European stonechat	Makes nests	LC	LC	-	
67.	*Serinus serinus* Linnaeus, 1766	European serin	Makes nests	LC	LC	-	
68.	*Streptopelia decaocto* Frivaldszky, 1838	Eurasian collared dove	Makes nests	LC	LC	BD IIb	

69.	*Streptopelia turtur* Linnaeus, 1758	European turtle dove	Makes nests	LC	LC	BD IIb	2.1.3., 5.1.1., 5.1.2., 8.2.2., 9.3.3.,11.2., 11.3.
70.	*Sturnus vulgaris* Linnaeus, 1758	Common starling	Makes nests	LC	LC	BD IIb	2.3.3., 5.1.1.
71.	*Sylvia atricapilla* Linnaeus, 1758	Eurasian blackcap	Makes nests	LC	LC	-	
72.	*Sylvia borin* Boddaert, 1783	Garden warbler	Does not make nests	DD	LC	-	
73.	*Sylvia cantillans* Pallas, 1764	Eastern subalpine warbler	Makes nests	DD	LC	-	
74.	*Sylvia communis* Latham, 1787	Common whitethroat	Makes nests	LC	LC	-	
75.	*Sylvia melanocephala* J. F. Gmelin, 1789	Sardinian warbler	Makes nests	DD	LC	-	
76.	*Tachybaptus ruficollis* Pallas, 1764	Little grebe	Makes nests	NT	LC	-	
77.	*Turdus merula* Linnaeus, 1758	Common blackbird	Makes nests	LC	LC	BD IIb	2.1.3., 5.1.1., 6.3., 8.2.1., 11.3.
78.	*Turdus philomelos* C. L. Brehm, 1831	Song thrush	Makes nests	LC	LC	BD IIb	

Bats (Chiroptera) are an extremely numerous groups of mammals in the area of the Protected landscape Vjetrenica – Popovo polje (Mazija, 2010; Mazija and Rnjak, 2016; Ozimec et al., 2021), where several endangered species have been registered (Table 7.). According to earlier research conducted in this area, the most important colony was recorded in the railway tunnel near Čvaljina - a large colony of females with offspring of approximately 10,000 individuals of the species of Greater mouse-eared bat (Myotis myotis), and there are also species of Lesser mouse-eared bat (Myotis) and Common bent-wing bat (Miniopterus schreibersii). This colony and the structure itself are an extremely important aspect of the protection of the area at the local, national and international level.

Four species have been identified in the Bjelušica cave: lesser horseshoe bat (Rhinolophus hipposideros), Geoffroy's bat (Myotis emarginatus), Natterer's bat (M. natterii) and Kolombatovic's long-eared bat (Plecotuskolombatovici).

In addition, in the lower part of the monument (underground part) in the vicinity of the Vjetrenica cave (Zavala), a colony of bats of the Mediterranean horseshoe bat (Rhinolophuseuryale) was found, with about 45 individuals and 25 individuals of the Greater horseshoe bat (Rh. Ferrumequinum) and some specimens of Geoffroy's bat (Myotis emarginatus).

A bat skeleton was found in the first hall of the Vjetrenica cave, which indicates that although during previous and new research the presence of living bat individuals inside the structure has not been discovered, they still use it at least individually for a short time.

Table 7 *List of endangered mammals according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV in the area of Popovo polje*

Latin name	Species known from the literature	Degree of threat according to the Red Lists of Europe and the Red List of FBiH	Degree of threat and protection according to the Habitats Directive (Annexes II and IV)	IUCN threat
Rhinolophus euryale (Blasius, 1853)	X	EN on the FBiH Red List	HD II and IV	2.3.3., 5.1.2., 6.1., 6.3., 9.3.4.
Rhinolophus ferrumequinum (Schreber, 1774)	X	VU on the FBiH Red List	HD II and IV	2.1.3., 6.1., 7.3., 9.3.4.

Rhinolophus hipposideros (Bechstein, 1800)	X	EN on the FBiH Red List	HD II and IV	7.3., 9.3.4.
Miniopterus schreibersii (Kuhl, 1817)	X	EN on the FBiH Red List	HD II and IV	1.3., 3.3., 4.1., 5.1.3., 5.1.4., 6.1., 6.3., 8.5.1., 9.3.3.
Myotis myotis (Borkhausen, 1797)	X	EN on the FBiH Red List	HD II and IV	
Myotis blythii (Tomes, 1857)	X	EN on the FBiH Red List	HD II and IV	1.1., 2.1.2., 5.1.3., 6.1., 6.3., 9.3.4.
Myotis emarginatus (Geoffroy, 1806)	X	VU on the FBiH Red List	HD II and IV	5.1.1., 5.1.3., 6.1., 6.3., 7.1.3., 7.3.
Myotis capaccinii (Binaparte, 1837)	X	VU on the FBiH Red List	HD II and IV	1.1., 5.1.1., 6.1., 6.3., 7.1.3., 7.2.8., 9.1.3., 9.2.3., 9.3.4.
Myotis nattereri (Kuhl, 1817)	X		HD II and IV	1.1., 1.2., 1.3., 2.3.3., 4.1., 5.3.3., 5.3.4., 6.1., 6.3., 7.1.1., 9.6.1., 11.1.
Hypsugo savii (Bonaparte, 1837)	X	VU on the FBiH Red List	HD II and IV	
Pipistrellus kuhlii (Kuhl, 1817)	X	VU on the FBiH Red List	HD II and IV	
Pipistrellus nathusii	X		HD II and IV	

(Keyserling & Blasius, 1839)				
Plecotus cf. kolombatovici (Đulic, 1980)	X	Europe NT	HD II and IV	6.1.

Other mammals

The biodiversity of mammals of the Protected landscape Vjetrenica - Popovo polje has not been systematically investigated so far. Most of the data comes from yet unpublished inventory data, preliminary reviews of individual groups within the project and a small number of published research papers. The most representative one is the Balkan snow vole (*Dinaromys bogdanovi* (V. et E. Martino, 1922)), which is endemic to the Dinarides and a relict, tertiary monotypic genus, which often enters caves and has been recorded for the Bjelušica cave. Interestingly, it is also inhabited by endemic fleas of the genus *Chthenophthalmus*.

The highest count in this area were recorded for wild boar, fox and brown rabbit. These species are common and their survival in this area is not endangered. Other species of wild animals, primarily mammals, are rare or sporadic (Table 8.).

Table 8 *List of mammals according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV in the area of Popovo polje*

No.	Species	Red list FBIH	Habitats Directive	Natura 2000	Bern Convention	CITES	IUCN threats
1	*Sus scrofa* (Linaeus, 1758)	LC on the FBiH Red List					2.3.1., 2.3.3., 5.1.1., 5.1.3., 8.1.2.
2	*Capreolus capreolus* (Linaeus, 1758)	LC on the FBiH Red List			Annex 3		2.2.3., 2.3.1., 2.3.2., 5.1.1.,

							5.1.3., 8.1.2., 8.3.
3	*Canis lupus* (Linneaeus 1758)	EN on the FBiH Red List					2.3.2., 2.3.3., 5.1.3.
4	*Vulpes vulpes* (Linneaeus 1758)	LC on the FBiH Red List					
5	*Martes foina* (Erxleben, 1777)	LC on the FBiH Red List			Annex 3		2.1.3., 2.3.3., 5.1.1.
6	*Meles meles* (Linneaeus 1758)	LC on the FBiH Red List			Annex 3		5.1.1.
7	*Erinaceus concolor* (Martin, 1837)	EN on the FBiH Red List					
8	*Lepus europaeus* (Pallas, 1778)	LC on the FBiH Red List					1.1., 2.1.3., 9.3.4.
9	*Dinaromys bogdanovi* (V. et E. Martino, 1922)	VU on the FBiH Red List	HD II AND IV	yes			

Underground or hypogeanic fauna

It is divided into soil fauna (edaphic) and cave fauna (cavernicol), which inhabits the basic rocks, that is, the lithosphere.

Soil fauna (Edaphic fauna) is almost unknown in the area planned for protection. However, the famous German entomologist Edmund Reitter described in 1913, on the basis of a specimen collected in the vicinity of Ravno, the edaphic species of carabidae from the subfamily Scaritinae - *Reicheadella* (*Chaetomargoreicheia*) *zoufali* Reitter, 1913. After the description, this species was never found again and is considered endemic for this area. The edaphic habitats of karst sinkholes are particularly interesting.

Cave fauna (cavern-dwelling fauna) inhabits micro and macro cavities formed in the parent substrate, limestone. Cavities can be filled with air, so we are talking about cave terrestrial fauna (troglobionts) or with water inhabited by aquatic cave fauna (stigobionts). Cave fauna is one of the most pronounced elements of the fauna of the protected area. So far, over 231 cave taxa (Ozimec et al., 2021) have been identified, of which over 65 stenoendemic, out of which as many as 41 species have been described from the protected area, 38 from Vjetrenica and three further species from Baba cave near Čvaljina and Benetina cave. With each new research, numerous taxa new to science are discovered, which are yet to be described.

Underground habitats of the Vjetrenica cave

Vjetrenica Cave with over 7 kilometres of underground dry and submerged canals, is extremely rich in different habitat types. Caves with a large number of different habitats have the largest biodiversity in the world, that is, the largest number of underground, cavernous organisms has been identified there.

Hygopetric of Vjetrenica

A special habitat present in Vjetrenica is hygropetric, a combination of aquatic and terrestrial habitat. Hygropetric is a specific underground habitat in which a thin layer of water flows over the parent limestone rock or excrete flowstone. It usually appears very deep in the karstic lithosphere, that is, in the deepest parts of karst pits and under a thick layer of limestone in caves, above which groundwater accumulates and permanently seeps vertically.

For life in such a habitat, some organisms developed peculiar adaptations. It is primarily a diet, by which organisms are most often fed by filtration of running water, and their oral apparatus evolved into a filtration system. As the flow of water can be very strong periodically, additional adaptations happened in the evolution of gripping for solid ground, be it with strong grips in leeches or strong and long claws in springtail or beetles.

For the time being, three species from the hygropetrics have been identified in Vjetrenica: *Typhlogammarus mrazeki* Schäferna and underground beetles: *Hadesia vasiceki*, described in 1911, and *Nauticiella stygivaga*, described in 2002, 90 years after hadesia. With the development

of speleological techniques and following the conquest of deeper and deeper pits, every year more and more species specialized in hygropterics are discovered from the depths of the Dinarides, from more and more faunal groups. Representatives of underground beetles (Leptodirini) are especially largely represented, along with those of Vjetrenica *Croatodirus*, *Deelemaniella*, *Kircheria*, *Radziella*, *Tartariella* and *Velebitodromus*; leeches: *Croatobranchus* and *Trocheta*; springtail: *Tritomurusvellesi*, and as research progresses, numerous others will certainly folow (Ozimec et al., 2021).

Biodiversity and endemism of the fauna of the area for protection is still insufficiently known, but initial analysis shows an exceptional richness. In addition to a large number of Dinaric endemics, many endemics are very narrowly distributed, only in the area south of the Neretva, the wider area of Popovo polje or so far exclusively known from the area planned for protection. Endemics of such a narrow area are called stenoendemics, and among them there are mainly cave, relict species (living fossils). Their closest relatives became extinct in this area long time ago, and they survived in a kind of shelters (refuges) to this day. In the area planned for protection we find numerous tertiary, and some ancient species are even pre-tertiary relics.

Overview of underground habitats of Vjetrenica

According to the European classification of Natura 2000 habitats, most of the habitats of the Vjetrenica cave system belong to the habitat type 8310 – Caves not open to public. According to the *National Habitat Classification and the Manual for the determination of underground habitats in Croatia according to the EU Habitats Directive* (Gottstein, 2010), habitats primarily belong to the main habitat H: underworld with three habitat subtypes with a total of 14 different habitats. In addition to the cave, there is also a habitat type A.2.1 Springs, with the spring Lukavac, which can also be periodical or permanent habitat of cave fauna. Spatial analysis of the collected fauna and identified various living communities and according to the hydrological function (and sediment occurrence) of some submerged canals, two subtypes were defined for habitats: H.1.1.4. Caves and cave systems with troglobitic invertebrates, H.1.1.5. Caves with troglophilic invertebrates and H.1.3.1. Underground streams (Table 9.).

Table 9 *Habitat system overview of Vjetrenica cave*

H.1. Karst cave and pits	H.1.1. Terrestrial karst cave habitats	H.1.1.1. Semi-caves and entrance (illuminated) parts of caves	H.1.1.1.1. Subtroglophile invertebrate caves
		H.1.1.3. Caves and cave systems with subtroglophile vertebrates	
		H.1.1.4. Caves and cave systems with troglobitic invertebrates	H.1.1.4.1. Caves with moderate conditions with troglobiontic invertebrates
		H.1.1.5. Caves with troglobitic invertebrates	H.1.1.5.1. Caves with troglobitic invertebrates
	H.1.2. Amphibious karst cave habitats	H.1.2.1. Amphibious karst cave habitats	H.1.2.1.1. Hygropetric
	H.1.3. Aquatic (freshwater) karst cave habitats	H.1.3.1. Underground streams	H.1.3.1.1. Subterranean rapids
			H.1.3.1.2. Endogenous subterranean rivers
			H.1.3.1.3. Exogenous subterranean rivers
		H.1.3.2.	H.1.3.2.1.

			Subterranean lakes
		Subterranean standing water	H.1.3.2.2. Stones
			H.1.3.2.3. Ponds
H.3. **Subterranean interstitial spaces**	H.3.1. Interstitial terrestrial habitats	H.3.1.1. Interstitial terrestrial habitats	H.3.1.1.2. Rock cracks
	H.3.2. Interstitial aquatic habitats	H.3.2.1. Interstitial aquatic habitats	H.3.2.1.1. Phreatic zone
H.4. **Anthropogenic subterranean habitats**	H.4.1. Anthropogenic terrestrial subterranean habitats	H.4.1.1. Mines and underground passages *	

*It primarily refers to parts of the main canal with a pronounced anthropogenic impact due to the construction

2.b History and Development

Natural values and special features of the object and the area of protection

In his work Historia Naturalis published in 77, Pliny the Elder makes a first reference to Vjetrenica in the mid-1st century a.d., with many references to follow by other authors, such as Getaldić. In the first half of the 20th century, the growing interest in cave fauna and karst geomorphology and hydrology resulted in scientific research of the cave. Karel Absolon was one of the most important explorers of the cave. The Czech geographer, zoologist and paleontologist discovered new passages in the cave, described the threeglobite fauna and was the first to suggest that the length of Vjetrenica could be 15 to 20 kilometers, all the way to the coast or under the sea (Absolon 1916). He was also the first to argue that Vjetrenica is an underground drainage canal from the Popovo polje. Jovan Cvijić, a renowned geomorphologist, in his work published 23 years after his death (Cvijić 1950) agreed with Absolon that the waters from the Popovo polje flowed through Vjetrenica and other underground passages to the Adriatic Sea and the Neretva River. Milojević (1928) has a different view of the hydrological function of Vjetrenica. He classified the cave as a former underground tributary in the Popovo polje. The first scientific discussion of Vjetrenica (Radovanović 1929) was a detailed morphological and hydrological

study of a cave with a map of the entire cave, including cross- sections of passages known at the time. Radovanović assumed that Vjetrenica was formed as a drainage passage of a lake that was created in the Popovo polje. Milojević (1938) did not agree with Radovanović's position on hydrological function of the cave and challenged its map; as a result, he performed a precise trigonometric alignment of the Main Passage, from the entrance to the Great Lake. Contrary to the map drawn by Radovanović (1929), Milojević (1938) stated that the entrance was lower than the Great Lake and that Vjetrenica could only be a tributary of water in the Popovo polje. Based on the slope towards the entrance and erosion markings on the cave walls, Zubčević and Gašparović (1958) concluded that Vjetrenica is an older tributary of Popovo Polje, today in the phase of its losing hydrological function. The cave was explored by Mirko Malez in 1954, 1957 and 1967 (Malez 1970 a). The complete plan with the use of theodolites was developed in 1958 by the Energoinvest Company and the Speleological Association Bosnian-Herzegovinian Karst. The latest speleological research conducted since 2000 by speleologists with the Zagreb-based Speleological Society Velebit has resulted in the discovery of new passages and the most accurate topographic design. Following the visit to Vjetrenica cave in 1967 (Harvey 1967), speleologists from the South Wales Caving Club discovered two new passages in Vjetrenica in 1968. In one passage, later named Leopard Passage, they discovered the skeleton of a carnivore from which they gathered a head and lower jaws. In the other part of the cave they found traces of carnivorous paws. The results of their work in Vjetrenica were written in an unpublished report (Caving Club South Wales, 1968). The head and lower jaws collected by speleologists from Wales were identified as leopard (*Panthera pardus*, Linnaeus, 1758) by Malez & Pepeonik (1969).

In their work, they also give a brief description of the cave and the rest of the leopard skeleton based on photographs by Welsh speleologists. Malez (1971) published almost the same work in the yearbook of the Yugoslav Academy of Sciences and Arts. In a brief description of the paleontological findings in Vjetrenica, Slišković (1979) concluded that a leopard fell through a pit and died at the site where it was found. The geological description of one part of the cave was made by Petrović et al. (1979). In the same year, Gašparović (1979) gives an overview of speleological work in Vjetrenica. After several seasons of paleontological research in Vjetrenica, Malez (1985) was able to find the skeletal remains of a leopard, but his team could not find the remains of a skeleton from the Leopard Passage due to the high water level. He also identified the paleontological findings discovered by a tourist guide in Vjetrenica as the bear *Ursus sp.* and *Ursus arctos priscus* (Goldfuss, 1818), rodents (Microtinae) and bats (Rhinolophus ferrumequinum (Schreber, 1774)). The bibliography on the Vjetrenica cave from 1585 to 1985 as compiled by Kapel (1986). Lučić and Sket (2003) published a discussion on Vjetrenica as a compilation of all previous scientific papers on the cave combined with new data from recent speleological research of the cave. Miculinić (2007; 2008) gives a brief description of the paleontological research in Vjetrenica when the bones and teeth of three leopards (one was the remnant of the skeleton of a previously collected head and jaw) and one bear was collected. Research conducted by the Zagreb paleontologist Kazimir Miculinić from 2007 to 2012 identified three more leopard skeletons and parts of the cave bear skeleton (*Ursus spelaeus* Rosenmüller, 1794).

Figure 10 *Panthera pardus spelaea* Bächler, 1936 - Vjetrenica Ca*ve (source: National Museum of Bosnia and Herzegovina)*

According to the Law on Nature Protection from 2013 (Official Gazette of FBiH, No. 66/13), which is partially harmonized with EU legislation, the Vjetrenica cave with part of Popovo polje is marked as the Protected Landscape "Vjetrenica-Popovo polje". Assembly of the Herzegovina-Neretva Canton, at the session held on March 22, 2021. passed the Act on the Proclamation of the Vjetrenica Cave Area with a Part of Popovo Polje as a Protected Landscape (Vjetrenica - Popovo Polje) (Official Gazette of the HNC No. 2/2021). Protected landscape "Vjetrenica - Popovo polje" covers an area of 4,710.17 ha. From the aspect of administrative position, the area of coverage belongs to the municipality of Ravno or Herzegovina-Neretva County.

In 2021, the Municipality of Ravno held a session on 31.08.2021. (OV-III.60 / 21) adopted the Protected Landscape Management Plan "Vjetrenica-Popovo polje", and a proposal to place the wider area around the cave under protection and define it as a 'Special Natural Area', and the entrance to the cave as 'World Heritage'.

Biospeleological research of Vjetrenica

Biospeleological research of Vjetrenica began in the late 19th century with the visit of the German zoologist Karl Verhoeff and the Austrian beetle expert (Coleoptera), Gustav Paganetti Hummler, who called the cave ‘a cave in Zavala’ (Höhle bei Zavala). Only one hundred years ago, Vjetrenica was considered biologically very poor (Absolon, 1916). However, after the cave spider *Stalagtia hercegovinensis* (Nosek, 1905) (Figure 12.) and the underground beetles (Coleoptera, Choleviniae, Leptodirini) *Antroherpon apfelbecki* (Müller, 1910) and *Hadesia vasiceki* (Müller, 1911) (Figure 13.) were described, Vjetrenica drew interest of biologists; in particular, Czech biospeleologist Karel Absolon, who visited Vjetrenica at least 27 times in the period from 1908 to 1922 and discovered a large number of taxa that are already known elsewhere, but also many new species for science. Unfortunately, Absolon never published his list of species, nor his biospeleological cadastre Biospeläologica Balcanica. The number of identified organisms was subsequently published, 47 taxa for Vjetrenica and 51 for smaller

Bjelušica (Pretner, 1976), which is considered part of the Vjetrenica cave system. Interest in Vjetrenica did not cease throughout the 20th century. Most research was conducted in the 1930ies and then in the 1950ies.

Figure 11 *Cave spider Stalagtia hercegovinensis (Photo: R. Ozimec)*

Figure 12 *Cave beetle Hadesia vasiceki (Photo: R. Ozimec)*

The author of the first published list is the German biospeleologist Benno Wolf in his catalog Animalium Cavernarum Catalogus, printed in the period from 1934 to 1938, where he listed 35 species from Vjetrenica based on 32 references, with an additional eight from Bjelušica. The second list of habitats was publishedin 1951 by the Bosnian biologist Adem Buturović with 13 taxa from Vjetrenica and 12 from Bjelušica. One professional hydrobiological study from 1956 registers 64 species, including all known members of the Protozoa group (Georgijevski et al., 1956). A much longer list was published by the Slovenian biospeleologist Egon Pretner in 1963 with 54 species, while the Bosnian biologist Sofija Mikšić (1979) published a list of 25 species. In 2003, Slovenian biospeleologist Boris Sket, together with Bosnian speleologist Ivo Lučić, published a comprehensive list of fauna, which includes the Vjetrenica and Bjelušica caves, and the Lukavac spring with 111 taxa, including 75 troglobionts. The list was published as part of the monograph Vjetrenica - a look into the soul of the Earth, describing each higher and lower taxon of Vjetrenica, with analysis of various aspects of habitat and underground fauna of the entire Popovo polje plains, including its vulnerability.

Among the authors, Stanko Karaman leads in the number of described taxa with nine taxa, followed by Karel Absolon (independently and together with others) and Karl Verhoeff, followed by Janez Matjašič with seven taxa, F. Kiefer and L. Kulczynski with five taxa each, and numerous others. It should be noted that the biospeleological research of Vjetrenica for the first time in the world determined the habitat of hygroperia or cave habitats of rocks with thin water layers and described the first organism specialised in this habitat and the beetle *Hadesia vasiceki*, J.Müller, 1911.

Since 2004, systematic biospeleological research of Vjetrenica has been organised by the Speleological Association Vjetrenica from Ravno and the Croatian Biospeleological Society. In addition to microclimatic measurements, collection of fauna, macro photographs of cave organisms in the cave itself (in situ), a computer database for cave fauna was created and systematically supplemented with literature data and the latest field research data, including new taxa for cave fauna. Research has identified numerous new taxa for the fauna of Vjetrenica, including some new taxa for science. Numerous taxa were macro photographed for the first time. The microclimate of the property was periodically measured and the CO_2 content of the building was measured for the first time. The latest list of fauna of the Vjetrenica cave from 2021, includes 231 taxa of living organisms: two types of bacteria, 14 fungi, 35 protista and 180 animals, with 96 cave-dwelling taxa. Vjetrenica has both archaeological and paleontological significance. At the entrance to the cave there are two drawings typical of medieval tombstones known as stećak (Figure 14.), and the latest research has established the first archaeological finds for the cave, a piece of pottery (Figure 15.) and a bone needle (Figure 16.). A summer house of an unknown Roman aristocrat was built at the entrance to Vjetrenica, and the air flow from the cave served as one of the first cooling systems (Grmek & Balabanić 2000).

Figure 13 *Piece of pottery found in Vjetrenica (source: Vjetrenica Public Company, 2010)*

Figure 14 *One needle (source: Vjetrenica Public Company)*

Figure 15 *Medieval tombstone stećak at the exit from Vjetrenica Cave (source: Vjetrenica Public Compan, 2010)*

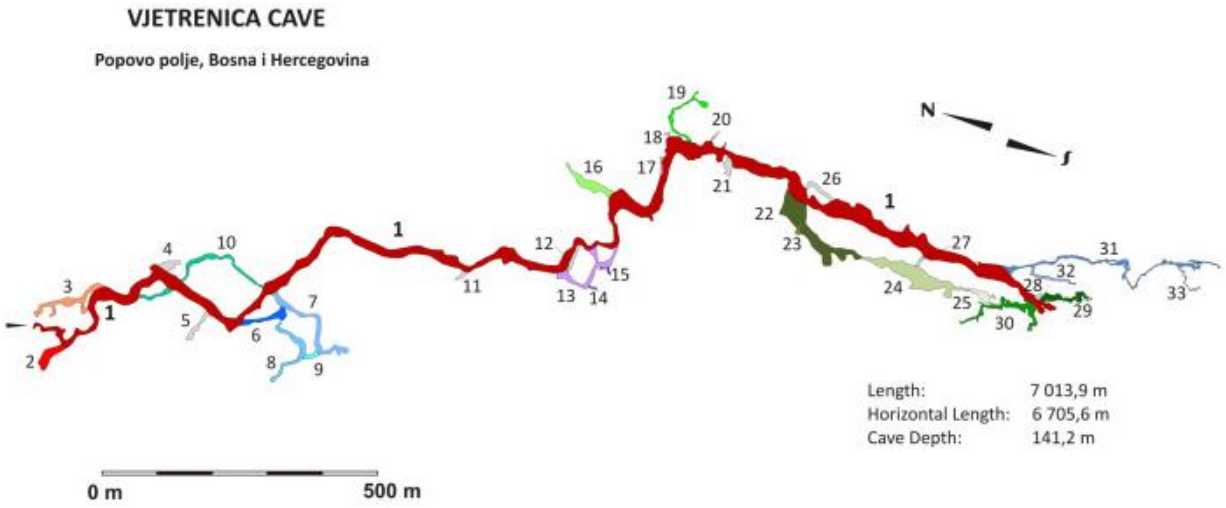
In 1952, Vjetrenica was for the first time placed under protection, under a decision of the Institute for the Protection of Cultural Monuments and Natural Rarities of the People's Republic of BiH, under No. 979/52. Since 1965, in accordance with the Law on Nature Protection (Official Gazette of SR BiH, No. 4/65, dated 5 February 1965), Vjetrenica has been placed in the category of "special geological reserves". In 2004, Vjetrenica was nominated for a preliminary list of UNESCO World Heritage. Vjetrenica Cave was adjusted for tourist purposes even before 1940, with extensive works and lighting introduced in 1964, including a passageway of as many as 1800 meters long, and lighting in the length of 1050 meters, including a nearby motel built to accommodate tourists. It suffered major devastation in the period from 1991 to 1996 during the war.

Cultural and historical values; monumental, architectural and cultural heritage

Despite the almost complete absence of systematic research of cultural and historical heritage in the Ravno Municipality or the narrower area of the planned Vjetrenica Nature Park, cultural and historical assets of exceptional importance from all historical periods are found on the ground. Archaeological methodology has located only a dozen sites based solely on accidental finds and reconnaissance, except for systematic archaeological research at Crkvina site in Zavala and a part of the monastery complex in Zavala. The prehistoric period is currently marked by accidental finds of pottery (Vjetrenica, Orlovica) and Bronze and Iron Age sites with typical settlements – hillforts and graves in the shape of stone mounds. This type of immovable

monumental heritage belonged to the so-called Posušje and Cetina culture, inhabiting mainly the area of Herzegovina and Central Dalmatia in the Early and Middle Bronze Age, organising smaller rural agglomerations of open and fortified type, which is indicative of a nomadic farming and cattle breeding population. Absence of knowledge on the Paleolithic and Neolithic periods can be attributed to the state of exploration or unexplored areas. The caves that served as shelters and temporary dwellings are potential archaeological sites of Paleolithic man, and the Mesolithic and Neolithic populations that followed. Without systematic research, it is difficult to date fortified settlements, which have a common position on the hill, protection by a dry stone wall and the appearance of their characteristic pottery. In these hillforts, the continuity of living can often be traced from the Bronze and Iron Ages to the establishment of Roman rule. The forts settlements were recorded in Čvaljina, Orahovo Do, Golubinac and Zavala. The find of a late antique-early Christian tomb in Golubinac is a testament to the continuity of settlement in this area. Most material evidence preserved in the protected area of Vjetrenica dates back to medieval period in the form of cemeteries under stećak tombstones. Most of the stećak tombstones are of quality workmanship and various ornaments, which is a testament to the high spiritual and material achievements of the medieval population, and their number indicates a significant population of this area in the pre-Turkish period. All characteristic forms of this type of stone tombstones are represented, from amorphous specimens to superbly worked chests, gables and slabs, with a diverse repertoire of motifs used. The necropolises of stećak tombstones from this area are Zavala-Crkvina, Belenići-Groblje, Kijev Do-Groblje, Orahov Do-Donje polje, Golubinac-Groblje, and medieval graves in front of the caves Vjetrenica and Orlovica, with about eighty monuments.

The pre-Romanesque church dedicated to St. Peter located at Crkvina in Zavala was the original home to stone pluteus with motifs of the Eucharist of exceptional artistic value, now kept in the Museum of Herzegovina in Trebinje, and is one of the most important sites of its kind in general. The complex of the Orthodox monastery in Zavala, mentioned in early 16th century, has frescoes from the 17th century, which are considered to be the highest quality paintings in BiH from the Ottoman period. The Zavala-Crkvina Archaeological Site and the Architectural Ensemble of the Presentation of the Blessed Virgin Mary in Zavala (Zavala Monastery) have the status of a National Monument of BiH.



Map 13 *Cave Vjetrenica*

3. Justification for Inscription

3.1.a Brief synthesis

Vjetrenica is a complex cave system with passage length of 7.323,9 m; as such, it is the second longest cave in Bosnia and Herzegovina. The cave consists of the main passage of Upper Vjetrenica, about 2,500 m in length, and numerous side passages, the most important being: Lower Vjetrenica, Absolon's upper and lower passage, Radovanović's passage, Leopard's passage, Wales passage and Ravno passage named after the nearby settlement of Ravno.

It is located within the protected landscape "Vjetrenica-Popovo polje". Cave Vjetrenica sits in the area of the south Dinaric karst, in a karst hill stretching from the outhern edge of the western part of the Popovo polje plains (Eastern Herzegovina) to the Adriatic Sea. Its entrance is located on the very edge of the Popovo polje plains, 300 meters east of the central part of the village of Zavala, at 260 meters above sea level, 12 km by air to the Adriatic Sea (Republic of Croatia). The main direction of the cave passages is south – southeast, or in the direction of the coast. Noteworthy, the cave is located in the immediate hinterland of the city of Dubrovnik, a leading tourist hub. In addition to Vjetrenica, the cave system includes the Lukavac spring, located below the entrance to Vjetrenica, and the smaller Bjelušica cave, above the entrance to Vjetrenica.

The cave has several permanent and disappearing streams and lakes, the largest some 180 m in length. It abounds in countless stalactites, flowstone, draperies, cascades and other cave formations. Also, it is it is one of the richest caves in the world in terms of its biological diversity, officially ranked as second, with 85 troglobionates. So far, over 231 cava taxa have been identified, of whitch over 65

stenoendemic. The remains of eight fossilised animals have been recovered in the cave, the largest being the cave bear (Carnivoria, *Ursus spelaeus* Rosenmüller, 1794) and one full skeleton of a leopard (Carnivoria, *Panthera pardus* (Linnaeus, 1758)). The rocks at the entrance to the cave have two carved stones, with drawings typical of medieval tombstones in the region. In scientific terms, Vjetrenica has been the site of numerous different forms of research, dating as far as back to the 16th century. In his work Historia Naturalis published in 77, Pliny the Elder makes a first reference to Vjetrenica in the mid-1st century a.d., with many references to follow by other authors, such as Getaldić. Systemic scientific research, however, will start only in late 19th century with Groller (1889), Vavrović (1893), Katzer (1903) and others. Vjetrenica Cave was adjusted for tourist purposes even before 1940, with extensive works and lighting introduced in 1964, including a passageway of as many as 1800 meters long, and lighting in the length of 1050 meters, including a nearby motel built to accommodate tourists. The cave suffered major devastation in the period from 1991 to 1996, during the war.

3.1.b Criteria under which inscription is proposed

Criterion vii

- The cave system of Vjetrenica and its surroundings are exceptional and well-conserved manifestations of Karst topography. It reveals a broad range of karst features with its exceptional scale and aesthetic quality. Almost all passages in Vjetrenica are wide and high in their entire length. The cave consists of several passages that could be grouped into four levels: Main Level, Upper Level, Lower Level and Vertical Level. The Main Level is semi-horizontal and the longest in the cave. It runs from the cave entrance almost to the furthermost point of the cave. This is also the level with the longest and widest passages in the cave: Main Passage (Glavni kanal) and Main Hidden Passage (Skriveni glavni kanal). Even with the debris on the cave floor, untypical horizontality of that level caused differences in views over the direction of the slope (and the direction of the former water flow) of the main part of the cave. The Lower Level is approximately 10 to 30 meters lower than the Main Level, comprising the Lower Lake (Donje jezero), Karaman's Lake (Karamanovo jezero), Absolon's Lower Passage (Donji Apsolonov kanal), Absolon's Upper Passage (Gornji Absolonov kanal) and Radovanović's Passage (Radovanovićev kanal). These passages are grouped in the first part of the cave, up to approximately 600 meters from the entrance.

The Upper Level consists of five passages – the Leopard Passage (Leopardov kanal), High Flowstone Passage (Visoki zasigani kanal), Platy Passage (Pločasti kanal), Wales Passage (Velški kanal) and Ravno Passage (Ravanjski kanal). These passages are some dozens and up to 120 meters higher than the Main Level, and sit at 1700 to more than 2500 metres from the entrance. An assumed, but undetected, fourth level – the Vertical Level of the cave is believed to consist of deep pits that lead from the surface of the terrain to the cave. Despite speleologists' efforts, none of these pits were found. The main proof of the pits' existence is the air movement at the entrance and inside the cave. Milosavljević (1979), from an unknown source, references 13 m/s as the highest speed of the wind at the entrance, while the highest recorded speed during the recent mapping of Vjetrenica was 8.5 m/s (Lučić & Sket 2003). Such a strong 'wind cave' is possible only in caves

with multiple entrances situated at different heights. The movement of air is caused by differences in air pressures and temperatures between the open atmosphere and underground cavities and air velocity is fastest in narrow passages (Bögli 1980). During high waters, when the sump in the Main Passage is completely flooded, there is no wind at the entrance (I. Lučić, 2009, pers. comm.). In other words, pits are connected with a cave beyond the approximate 1000 metres from the entrance, where the sump is. Due to the topography of the hill above the cave, those pits should be at least 160 m deep to be connected with the known parts of the cave.

Several smaller streams, both permanent and intermittent, exist in the cave. Directions of the flows are on course towards or opposite of the entrance. There are also several water pools, the largest of which is the Great Lake (Veliko jezero) with some 180 m in length, and a few sumps that occasionally close some of the passages (Lučić & Sket 2003). The walls and ceiling of the cave are only sporadically covered with flowstone, in the form of thinner or thicker flowstone coating. Dripstones (stalactites and stalagmites) are rare in the cave due to the most prominent process present in the cave – breakdown. Breakdown is a mechanical failure of rocks comprising the walls and ceiling of the underground cavities (Ford & Williams 1989).

The floor of almost the entire cave is covered with angular rocks of different size mixed with clayish sediment. Several sizable chambers are almost entirely filled with rock blocks, slabs and chips, in the form of piles tens of meters high. It is almost certain that rock breakdown at some points choked the passages by completely filling these and cutting the way into other unexplored parts of the cave. A good example of a breakdown choking the passages is the entrance into the widest passage – the Main Hidden Passage. The entrance that leads through the boulders is only some 50 x 50 cm. In addition to carbonate clasts, large quantities of clay are also found on the cave floor. According to Radovanović (1929) and Malez (1985) there are two different ages of clay. The older clay lays under the breakdown rocks, covered by the more recent clay. Scallops are spoon-shaped depressions created by a fast-turbulent water flow. Their shape could be used to determine the direction of paleoflow in relict caves (Ford & Williams 1989). In front of the cave entrance is a karst plain named Popovo polje. The Trebišnjica River, the largest European sinking river, passes through the plain. Before hydrotehnical interventions in the middle of the 20th century, Popovo Polje was flooded on an average 253 days a year (Milanović 2006). The hydrological function of Vjetrenica in the past caught attention of many researchers. Some of the authors agree that Vjetrenica had a function of a swallow hole for water from the Popovo Polje (Absolon 1916, Radovanović 1929, Cvijić 1950, Malez 1985, and that the cave spread all the way to the Adriatic coast. Milojević (1928 1938 and Zubčević & Gašparović (1958, however, argue the opposite – that water from Vjetrenica flows into the Popovo polje. The main argument in both points was the topography of the cave bottom from the entrance to the Great Lake. The problem was that the map drawn by Radovanović (1929) shows a slope in the direction inside the cave while maps drawn by Milojević (1938) and Zubčević & Gašparović (1958) show a slope in the direction of the cave entrance. The last map of the cave is the one published by Lučić & Sket (2003). According to that map, the entrance of the cave lies at some 8 metres above the Great Lake which is further at a distance of 1200 metres. In the Four-state Model (Ford & Williams 1989) of differentiation of phreatic and water table types of caves, Vjetrenica belongs to caves with a mixture of phreatic and water table levelled components, close to the ideal water table cave.

Criterion x - *to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.*

Vjetrenica is a remarkable and the most unique cave, located in the Popovo polje, a karstic plain in the south of Bosnia and Herzegovina. It is quite a sizable cave – more than 6000 meters have been explored, with several subterranean lakes (one is 180 meters long); and it has been known since Antiquity (Pliny the Elder makes a reference to the cave in his Historia Naturalis). It earned its name (vjetar = wind) thanks to a strong cold wind at almost all times. Yet, biodiversity is what gives it its uniqueness: while most caves on the planet harbour only a handful of animal species, Vjetrenica has the unique feature of sheltering more than a hundred, and is likely the richest in the world in terms of biodiversity. Among these cave species, more than half are endemic in the Popovo polje, while others are only know to inhabit Vjetrenica.

Vjetrenica has attracted the interest of biologists for some time. It was highly praised by the Czech, Karel Absolon, and was later visited by the first expedition of the Slovenian Caving Club in 1932. It was frequented by foreigners (e.g. Remy, 1940), and after World War II there were numerous expeditions by biospeleologists from Ljubljana.

Vjetrenica is one of the most faunistically rich caves in the world (Culver & Sket, 2000), due to its biogeographical position in the Dinaric karst, its size, and ecological heterogeneity. It is also one of the world's most prominent biodiversity hotspots for cave-dwelling fauna. In fact, 231 taxa were detected in Vjetrenica: two types of bacteria, 14 fungi, 35 protista and 180 animals, with 96 cave-dwelling taxa Nitrospira (1), Gammaproteobacteria (1), Trematoda (1), Enopla (1), Gastropoda (11), Bivalvia (1), Hydrozoa (2), Amphibia (1), Myriapoda (8), Insecta (11), Entognatha (4), Crustacea (36), Arachnida (9), Polychaeta (1), Oligochaeta (7), Hirudinea (1). Vjetrenica is also a type of typical locality for 38 species, including 14 endemics and three monotypic genera: Zavalia vjetrenicae (Radoman,1973) (Gastropoda), Troglomysis vjetrenicensis (Stammer, 1933) (Crustacea) and Nauticiella stygivaga (Moravec & Mlejnek 2002) (Coleoptera). Together with Lukavac spring and Bjelušica Cave, as parts of its system, Vjetrenica is a type locality for 38 taxa, of which 14 are strictly endemic, and tree are monotypic: *Zavalia vjetrenicae* ((Radoman,1973))(Gastropoda), *Troglomysis vjetrenicensis* ((Stammer, 1933)) (Crustacea) and *Nauticiella stygivaga* ((Moravec & Mlejnek 2002)) (Coleoptera). Vjetrenica is inhabited by more than 49 troglobites and 56 stygobites.

Further monotypic genera, found in other speleological objects of the Popovo polje include: *Spelaeoconcha paganetti* (Sturany, 1901) (Gastropoda), *Marifugia cavatica* (Absolon & Hrabe, 1930) (Polychaeta) (Figure 17.), *Velkovrhia enigmatica* (Matjasic & Sket, 1971) (Hydrozoa), *Stalitella noseki* (Absolon & Kratochvíl, 1933) (Araneae), *Dinaria vjetrenicae* (Hadži, 1932) (Opiliones) (Figure 18.), *Typhlogammarus mrazeki* (Schaferna, 1907) (Crustacea), *Spelaeocaris pretneri* (Matjasic, 1956) (Crustacea) and *Proteus anguinus* (Laurenti, 1768), (Vertebrata, Amphibia).

Figure 16 *Tube worm Marifugia cavatica (Photo: R. Ozimec)*

Figure 17 *Harvestman Dinaria vjetrenicae (Photo: R. Ozimec)*

The border zone of the main passage and its sides contain some entrance fauna characteristic of the region. The parietal fauna (on the cave walls) consists of resting moths *Triphosa sabaudiata* (Duponchel, 1830) and large numbers (up to 10 specimens per square metre) of *Limonia nubeculosa* (Meigen, 1804). Cave crickets *Troglophilus spp.* (Figure 19.) and *Dolichopoda araneiformis* (Burmeister, 1838) and the large odoriferous centipede *Apfelbeckia sp.* are scarce. *Trogulus torosus* (Simon, 1885), a regional endemic, is rare.

Figure 18 *Cave cricket Troglophilus sp. recorded on 27 November 2016 (Photo: R. Ozimec)*

Young crickets and centipedes can be found up to 400 m from the entrance. The most common troglobite of the main passage and remote parts is the large and highly troglomorphic beetle *Antroherpon apfelbecki*; some other beetles (*Speonesiotes spp., Neotrechus spp., Aphaenopsis spp.)* are less common to extremely rare. *Typhloglomeris caeca* (Verhoeff,.1898) is limited to larger clay deposits. Single specimens of the harvestman *Travunia vjetrenicae* (Hadži, 1932) (Laniatores: Travuniidae) can be found in the active passage known as the Absolon's passage. Particularly interesting is the hygropetric-like habitat (a thin film of water flowing down the rock) on walls with extensive flowstone, inhabited by the specialized leptodirine beetle *Hadesia vasiceki* (J.Müller, 1911) and also by the large amphipod *Typhlogammarus mrazeki* (Karaman, 1972).

Figure 19 *Mrazek amphipod Typhlogammarus mrazeki (Photo: R. Ozimec)*

Among the veterinary fauna, some taxa stand out, in particular: *Velkovrhia enigmatica* (Matjasic & Sket, 1971), the only one species of the genus, the only freshwater species of the family Bougainvilliidae and the only troglobiont species of Hydrozoa (Sket 2003). *Congeria kusceri* (Bole, 1962) is a living fossil, the only one of the hundred or so extinct species of congeria that peaked in the Upper Miocene, and which inhabited the freshwater remnants of the Dinaric and Pannonian seas in the Pliocene, and the only stigobiont shellfish (Bivalvia). *Marifugia cavatica* (Absolon & Hrabe, 1930) is the only freshwater serpulide (Serpulidae) and the only stigobiont tubeworm (Polychaeta) (Sket 2003).

Pholeoteras euthrix (Sturany, 1904) is the only known snail from the Cyclophoridae family in Europe, a relic of old tropical fauna (Sket, 2003). *Dina absoloni* (Johansson, 1913) is the first discovered stigobiont species of leech (Hirudinea) in the world; *Proteus anguinus* (Laurenti, 1768) the well-known olm, is the only European troglobiont vertebrate. With as many as ten species of the genus Niphargus (Amphipoda), biological diversity of Vjetrenica is explained as a phenomenon of local radiation, not yet recorded in the world underground (Sket 2006). *Hadzia fragilis* (Karaman, 1932) (Amphipoda) is a typical species of crustacean for the genus *Hadziidae*. Vjetrenica is home to three troglobiont species of ten-legged crustaceans (Decapoda), of which two species of the genus *Troglocaris* (*T. anophthalmus* (Kollar 1848), *T. hercegovinensis* (Babić, 1922)) and the only species of the genus *Spelaeocaris, Spelaeocaris pretneri* (Matjasic, 1956).

Animal communities in cave waters are very diverse. In the past, shallow pools in the main passage had carried abundant populations of shrimps (*Troglocaris spp.)* and amphipods *Hadzia fragilis* (Karaman, 1932). However, it appears that this fauna was destroyed indirectly by activities related to tourism. In the lakes of Donja Vjetrenica (Lower Vjetrenica), the large, spiny, and extremely troglomorphic amphipod *Niphargus balcanicus* (Absolon, 1927) is particularly characteristic, and according to the Encyclopedia of Caves and Karst Science, this

site is also the only known locality for *Troglomysis vjetrenicensis* (Stammer, 1933). The rapidly flowing small stream in the Absolon's passage is particularly abundant, with— among others— the predatory amphipod Typhlogammarus, rich colonies of tiny gastropods Iglica absoloni, and occasionally *Proteus anguinus* (Laurenti, 1768). The Great Lake is particularly characterised by the specialised digger amphipod *Niphargus trullipes* and the less specialized but similarly large *N. vjetrenicensis* (Karaman, 1950). Shrimps are also common. It should be mentioned that as many as three, and maybe even four, species of Atyidae shrimps are present in Vjetrenica (*Spelaeocaris pretneri* (Matjasic, 1956), *Troglocaris cf. anophthalmus* (Kollar, 1848), *T. hercegovinensis* (Babić, 1922) and an undescribed *Troglocaris sp*.). A summary of the identified cave organisms of Vjetrenica is given in Table 10.

Table 10 *Summary of identified cave organisms of Vjetrenica (according to: Ozimec et al., 2021)*

R.	Ph	Razred, Podrazred / Classis, Subclassis	Sp.	Špiljske / Cave Sp.
Animalia (180/94)	ANNELIDA (14/10)	Clitellata, Hirudinea	1	1
		Clitellata, Oligochaeta	12	8
		Polychaeta	1	1
	ARTHROPODA (127/68)	Arachnida	26	9
		Crustacea	44	36
		Entognatha	4	4
		Insecta	37	11
		Myriapoda	15	8
	CHORDATA (13/1)	Amphibia	1	1
		Mammalia	8	0
		Reptilia	1	0
		Pisces	3	0
	CNIDARIA (2/2)	Hydrozoa	2	2
	MOLLUSCA (23/11)	Bivalvia	1	1
		Gastropoda	23	11
	NEMATODA (5/0)	Adenophorea	3	0
		Secernentea	2	0
	NEMATOMORPHA (1/0)	Gordioida	1	0
	NEMERTINA (1/1)	Enopla	1	1
	PLATHELMINTHES (7/7)	Turbellaria	5	5
		Rhabditophora, Tricladida	1	1
		Trematoda	1	1
Bacteria (2/2)	ACTINOBACTERIA	Gammaproteobacteria	1	1
	NITROSPIRAE	Nitrospira	1	1
Fungi (14/0)	ASCOMYCOTA	Leotiomycetales	13	0
	ZYGOMYCOTA	Zygomycetes	1	0
Protista (35/0)	AMEBOZOA	Lobosoa	23	0
	CERCOZOA	Filosia	1	0
	CILIOPHORA	Ciliatea	10	0
	Heterokontophyta	Actinochrysophyceae	1	0
	OCROPHYTA	Heliozoa	1	0
Σ = 4	18	28	231	96

Tiny hydrobioid gastropods, *Lanzaia vjetrenicae* (Kuščer, 1933), and the serpulid worm, *Marifugia cavatica* (Absolon & Hrabe, 1930), are characteristic of small streams in remote parts of Vjetrenica. A number of genera and species have a holo-Dinaric distribution: *Proteus*, *Marifugia*, *Zospeum amoenum* (Frauenfeld, 1856), *Congeria kusceri* (Bole, 1962.), two species of *Troglocaris* shrimps and other. *Titanethes hercegowinensis* (Verhoeff, 1900), *Monolistra hercegoviniensis* (Absolon, 1916), *Spelaeocaris shrimps*, leech Dina *absoloni* (Johansson, 1913) and all of the beetle genera, have southeast mero-Dinari distribution. A number of

Niphargus species, some isopods, the beetle *Hadesia*, and the centipede *Typhloglomeris* are narrow endemics even within the southeast Dinarides. For the time being, some species may be regarded as endemics of the Vjetrenica Cave. Two species are particularly enigmatic; the amphipod *Hadzia* and the mysid *Troglomysis* are clearly species of coastal marine origin, but are incorporated here into a freshwater fauna not related to any recent or ancient seas. As described below, Vjetrenica cave is on the list of species.

Vjetrenica Cave is a typical site of many invertebrates that exclusively inhabit the Vjetrenica system (according to Ozimec et al., 2021). According to the data in the list below, as many as 14 of the 38 species for which the Vjetrenica system is a typical site are endemic to the Balkan Peninsula or are an endangered or vulnerable species.

Vjetrenica, Zavala

1. *Scutariella stammeri* Matjašič 1958 (Temnocephalida, Scutariellidae)
2. *Stygodyticola hadzii* Matjašič 1958 (Temnocephalida, Scutariellidae)
3. *Lanzaia vjetrenicae* Kuščer 1933 (Gastropoda, Hydrobiidae)
4. *Zavalia vjetrenicae* Radoman 1973 (Gastropoda, Hydrobiidae)
5. *Vitrea kiliasi* Pinter 1972 (Pulmonata Zonitidae)
6. *Eukoenenia remy* Conde 1974 (Palpigradi, Eukoeniidae)
7. *Stalagtia (Stalagtia) hercegovinensis* (Nosek 1905) (Araneae, Dysderidae)
8. *Stalitella noseki* Absolon & Kratochvil 1933 (Araneae, Dysderidae)
9. *Tegenaria conveniens* Kulczynski 1914 (Araneae, Agelenidae)
10. *Lephtyphantes spelaeorum* Kulczynski, 1914 (Araneae, Linyphiidae)
11. *Chthonius (C.) occultus* Beier 1939 (Pseudoscorpiones, Chthoniidae)
12. *Neobisium (Blothrus) vjetrenicae* Hadži 1933 (Pseudoscorpiones, Neobisiidae)
13. *Dinaria vjetrenicae* (Hadži, 1932) (Laniatores, Travuniidae)
14. *Diacyclops karamani* (Kiefer 1932) (Cyclopidae)
15. *Eucyclops inarmatus* Kiefer 1932 (Cyclopidae)
16. *Acanthocyclops troglophilus* (Kiefer 1932) (Cyclopidae)
17. *Pseudocypridopsis hartmanni* Petkovski et all. 2009 (Ostracoda, Cyprididae)
18. *Troglocaris hercegovinensis* (Babić 1922) (Decapoda, Atyidae)
19. *Troglomysis vjetrenicensis* Stammer 1936 (Mysidacea, Mysidae)
20. *Monolistra (P.a) hercegoviniensis* Absolon 1916 (Isopoda, Sphaeromatidae)
21. *Proasellus hercegovinensis* (S. Karaman 1933) (Isopoda, Asellidae)
22. *Armadillidium absoloni* Strouhal 1939 (Isopoda, Armadillidiidae)
23. *Niphargus balcanicus* (Absolon 1927) (Amphipoda Niphargidae)
24. *Niphargus boskovici* S. Karaman 1952 (Amphipoda Niphargidae)
25. *Niphargus vjeternicensis* S. Karaman 1932 (Amphipoda Niphargidae)
26. *Niphargus trullipes* Sket 1958 (Amphipoda Niphargidae)
27. *Niphargus factor* G. Karaman & Sket 1991 (Amphipoda Niphargidae)
28. *Niphargus cvijici* S. Karaman 1950 (Amphipoda Niphargidae)
29. *Niphargus zavalanus* S. Karaman 1950 (Amphipoda Niphargidae)
30. *Hadzia fragilis* S. Karaman 1932 (Hadziidi, Hadziidae)
31. *Lithobius (T.) sketi* Matic et Darabantu 1968 (Chilopoda, Lithobiidae)

32. *Typhloiulus (A.) edentulus* Attems 1951 (Diplopoda, Julidae)
33. *Plusiocampa (Stygiocampa) remyi* Conde 1947 (Diplura, Campodeidae)
34. *Hadesia vasiceki* (J. Müller 1911) (Coleoptera Cholevidae)
35. *Nauticiella stygivaga* Moravec et Mlejnek 2002 (Coleoptera Cholevidae)
36. *Speonesiotes (S.) schweitzeri* Jeannel 1941 (Coleoptera Cholevidae)
37. *Aphaenopsis (A.) pretneri* Scheibel 1935 (Carabidae, Trechini)
38. *Aphaenopsis (S.) arenstorffianus* Absolon 1913 (Carabidae, Trechini)

Table 11 Vjetrenica Biodiversity (Sb- stygobitic, Sx- stygoxene, Tb – troglobite, Tx - trogloxene, sTf - subtroglophile , Tf - troglophile) (according to: Ozimec et al., 2021)

Carstvo	Koljeno	Razred, PodRaz	Red	Porodica, PodP	Vrsta/podvrsta	E
ANIMALIA	ARTHROPODA	Crustacea	Copepoda Podrzr.	Cyclopidae	*Acanthocyclops troglophilus* (Kiefer 1932)	Sb
ANIMALIA	ARTHROPODA	Crustacea	Copepoda Podrzr.	Cyclopidae	*Acanthocyclops venustus venustus* (Norman & Scott, 1906)	Sb
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Enchytraeida	Enchytraeidae	*Achaeta n. sp. 1*	Sb
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Enchytraeida	Enchytraeidae	*Achaeta n. sp. 2*	Sb
PROTISTA	HETEROKONTOPHYTA	Actinochrysophyceae	Actinophryida	Actinophryidae	*Actinophrys sol* Ehrenberg, 1830	?
PROTISTA	OCHROPHYTA	Heliozoa	Actinophryida	Actinosphaeridae	*Actinosphaerium eichhornii* (Ehrenberg, 1840) Stein, 1857	?
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Carabidae, Trechini	*Adriaphaenops pretneri* Scheibel 1935	Tb
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Ferussaciidae	*Aegopis spelaeus* (A.J. Wagner 1914)	Tb
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Agarnidae	*Agardhiella biarmata* (Boettger, 1880)	Tf
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Trichoniscidae	*Alpioniscus (Illyrionethes) heroldi* Verhoeff 1931	Tb
PROTISTA	AMOEBOZOA	Lobosoa	Amoebida	Amoebidae	*Amoeba sp.*	?
ANIMALIA	ARTHROPODA	Insecta	Lepidoptera	Noctuidae	*Amphipyra effusa* (Boisduval, 1828)	sTf
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Callipodida	Schizopetalidae	*Apfelbeckia insculpta* (L.Koch, 1867)	Tf
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Arcellidae	Arcella artocrea Leidy, 1876	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Arcellidae	*Arcella discoides* Ehrenberg, 1843	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Arcellidae	*Arcella hemispharica* Perty, 1852	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Arcellidae	*Arcella vulgaris* Ehrenberg, 1830	?
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Armadillidiidae	*Armadillidium absoloni* Strouhal 1939	Tx
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Armadillidiidae	*Armadillidium vulgare* Latreille 1804	Tx
FUNGI	ASCOMYCOTA	Eurotiomycetes	Onygenales	Eurotiomycetidae	*Arthroderma cuniculi* C.O. Dawson	sTf
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Sclerosomatide	*Astrobunus dinaricus* Roewer, 1915	Tx
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Hydrobiidae	*Belgrandiella* sp.	Cr
ANIMALIA	ANNELIDA	Clitellata	Oligochaeta	Lumbricidae	Bimastos rubidus (Savigny, 1826)	Tx
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Polydesmida	Polydesmidae	*Brachydesmus zawalanus unciger* Attems, 1951	Tb

ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Polydesmida	Polydesmidae	*Brachydesmus zawalanus zawalanus* Attems, 1911	Tb
ANIMALIA	ARTHROPODA	Insecta	Diptera	Mycetophilidae	*Brevicornu crassicorne* (Stannius 1831)	Tf
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Staphylinidae, Pselaphinae	Bryaxis scapularis *(Reitter, 1881)*	Tf
BACTERIA	NITROSPIRAE	Nitrospira	Nitrospirales	Nitrospiraceae	Candidatus Troglogloea absoloni Kostanjšek et al. 2013	Sb
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Enidae	*Cecilioides veneta* (Strobel, 1855)	Tf
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Centropyxidae	*Centropyxis aculeata* (Ehrenberg, 1838)	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Centropyxis constricta* (Ehrenberg, 1841) Penard, 1890	?
FUNGI	ASCOMYCOTA	Sordariomycetes	Microascales	Hypocreomycetidae	Cephalotrichum microsporum (Sacc.) P.M. Kirk	sTf
FUNGI	ASCOMYCOTA	Sordariomycetes	Microascales	Hypocreomycetidae	Cephalotrichum purpureofuscum (Schwein.) S. Hughe	Tt
ANIMALIA	CNIDARIA	Myxozoa	Bivalvulida	Chloromyxidae	*Chloromyxum protei* Joseph, 1907	Sb
ANIMALIA	ARTHROPODA	Arachnida	Pseudoscorpiones	Chthoniidae	*Chthonius (Chthonius) occultus* Beier 1939	Tb
FUNGI	ASCOMYCOTA	Leotiomycetes	Helotiales		Cistella acuum	Tx
FUNGI	ASCOMYCOTA	Sordariomycetes	Hypocreales		Clonostachys rosea	sTf
ANIMALIA	ARTHROPODA	Insecta	Zygentoma	Nicoletiidae	Coletinia sp.	Tb
ANIMALIA	MOLLUSCA	Bivalvia	Eulamellibranchia	Dreissenidae	*Congeria kusceri* Bole 1962	Sb
FUNGI	ASCOMYCOTA	Pezizomycetes	Pezizales		Coprotus cf. leucopocillum	?
ANIMALIA	ARTHROPODA	Crustacea	Ostracoda (Subcl.).	Cypridídae	*Cryptocandona* sp.	Tx
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Cryptodifflugia oviformis* Penard, 1902	?
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Trichoniscidae	*Cyphonethes herzegowinensis* (Verhoeff 1900)	Tb
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Cyphophthalmi, Sironidae	*Cyphophthalmus* sp.	Tb
ANIMALIA	ARTHROPODA	Crustacea	Ostracoda (Subcl.)	Cypridídae	*Cypria* sp.	Tx
ANIMALIA	ARTHROPODA	Crustacea	Ostracoda (Subcl.)	Cypridídae	*Cypridopsis vidua* (O.F. Mueller)	Sx
FUNGI	ASCOMYCOTA	Leotiomycetes	Helotiales		Dasyscypheila nivea	Tt
ANIMALIA	CHORDATA	Actinopterigii	Clupeiformes	Cyprinidae	*Delminichthys ghetaldii* (Steindachner, 1882)	Sf
ANIMALIA	ARTHROPODA	Crustacea	Copepoda (Subcl.)	Cyclopidae	Diacyclops karamani (Kiefer 1932)	Sb
ANIMALIA	ARTHROPODA	Crustacea	Copepoda (Subcl.)	Cyclopidae	Diacyclops tantalus (Kiefer 1937)	Sb
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Discranolasmatidae	*Dicranolasma verhoeffi* Dahl, 1903	Tf
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia acuminata* Ehrenberg, 1838	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia corona* Wallich, 1864	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia globulosa* (Dujardin, 1837) Penard, 1902	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia labiosa* Wailes, 1919	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia manicata* Penard, 1902	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia pyriformis* Perty, 1849	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Difflugiidae	*Difflugia urceolata* Carter, 1864	?
ANIMALIA	ANNELIDA	Clitellata, Hirudinea	Arhynchobdellida	Erpobdellidae	*Dina absoloni* Johansson 1913	Sb

ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Laniatores, Travunliidae	*Dinaria vjetrenicae* (Hadži, 1932)	Tb
ANIMALIA	CHORDATA	Mammalia	Rodentia	Cricetidae	*Dinaromys bogdanovi* (Martino, 1922)	Tf
ANIMALIA	ARTHROPODA	Insecta	Orthoptera	Rhaphidophoridae	Dolichopoda araneiformis Germar 1838	Tf
ANIMALIA	NEMATODA	Adenophorea	Dorylaimida	Dorylaimidae	*Dorylaimus stagnalis* Dujardin, 1845	Tx
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Hydrobiidae	*Emmericia expansilabris* Bourguignat, 1880	Cr
PROTISTA	CILIOPHORA	Ciliatea	Peritrichida	Epistylidae	*Epistylis plicatilis* Ehrenberg, 1838	?
ANIMALIA	ARTHROPODA	Crustacea	Copepoda (Subcl.)	Cyclopidae	Eucyclops inarmatus Kiefer 1932	Sb
PROTISTA	AMOEBOZOA	Filosia	Aconchulinida	Euglyphidae	*Euglypha ciliata* Ehrenberg, 1871	?
ANIMALIA	ARTHROPODA	Arachnida	Palpigradi	Eukoeniidae	*Eukoenenia remy* Conde 1974	Tb
ANIMALIA	NEMATODA	Adenophorea	Monhysterida	Monhysteridae	*Eumonhystera vulgaris* (de Man, 1880)	Tx
PROTISTA	CILIOPHORA	Ciliatea	Hypotrichida	Euplotidae	*Euplotes charon* (Müller, 1786) Ehrenberg, 1830	?
ANIMALIA	ARTHROPODA	Arachnida	Scorpiones	Euscorpiidae	*Euscorpius feti* Tropea, 2013	sTf
ANIMALIA	ARTHROPODA	Insecta	Diptera	Mycetophilidae	Exechiopsis indecisa (Walker 1856)	Tf
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Enchytraeida	Enchytraeidae	Fridericia sp.	Tx
ANIMALIA	ARTHROPODA	Insecta	Hemiptera	Auchenorrhyncha	Gen/sp	Tf
ANIMALIA	ARTHROPODA	Insecta	Psocoptera		Gen/sp	Tf
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Haplotaxida	Lumbricidae	*Gen/sp.*	Tf
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Polydesmida	Macrosternode-smidae	Gen/sp. n.	Tb
ANIMALIA	CHORDATA	Mammalia	Rodentia	Gliridae	*Glis glis* (Linnaeus, 1766)	sTf
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Glomerida	Glomeridae	*Glomeris pulchra* Koch C.L., 1847	sTf
ANIMALIA	NEMATOMORPHA	Gordioidea		Gordiidae	*Gordius sp.*	Sf
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Cholevidae, Leptodirini	*Graciliella apfelbecki apfelbecki* (Müller, 1910)	Tb
ANIMALIA	ARTHROPODA	Insecta	Orthoptera	Gryllidae	Gryllomorpha dalmatina Ocskay 1832	Tf
FUNGI	ASCOMYCOTA	Eurotiomycetes	Onygenales		Gymnoascus sp.	?
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Cholevidae, Leptodirini	*Hadesia vasiceki* (J. Müller 1911)	Tb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Hadziidae	Hadzia fragilis S. Karaman 1932	Sb
PROTISTA	CERCOZOA	Granofilosea	Desmothoracida	Clathrulinidae	*Hedriocystis pellucida* Hertwig & Lesser, 1874	?
PROTISTA	AMOEBOZOA	Tubulinea		Heleoperidae	*Heleopera petricola* Leidy, 1879	?
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Enchytraeida	Enchytraeidae	Henlea nasuta (Eisen, 1878)	sTf
ANIMALIA	ARTHROPODA	Insecta	Diptera	Heleomyzidae	Heteromyza atricornis Meigen 1830	Tx
ANIMALIA	CHORDATA	Reptilia	Squamata	Colubridae	*Hierophis gemonensis* (Laurenti, 1768)	Tx
ANIMALIA	ARTHROPODA	Myriapoda	Chilopoda	Lithobiidae	*Himantarium gabrielis* Linne 1766	Tx
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Agelenidae	*Histopona conveniens* (Kulczynski 1914)	Tf
PROTISTA	CILIOPHORA	Ciliatea		Holophryidae	*Holophrya simplex* Schewiakoff, 1893	?

PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Hyalospheniidae	*Hyalosphenia papilio* Leidy, 1874	?
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Zonitidae	*Hypnophila pupaeformis* (Draparnaud 1801)	Tf
FUNGI	ASCOMYCOTA	Sordariomycetes	Hypocreales		Hypocrea minutispora	Tx
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Hydrobiidae	*Kerkia briani* Rysiewska & Osikowski 2020	Sb
ANIMALIA	ARTHROPODA	Arachnida	Acari	Labidostommatidae	Labidostomma longipes Willmann, 1940	Tb
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Phalangiidae	*Lacinius horridus* (Panzer, 1794)	Tx
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Phalangiidae	*Lacinus dentiger* (C.L. Koch, 1847)	Tx
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Carabidae, Harpalinae	*Laemostenus (Antisphodrus) cavicola* (Schaum 1858)	Tf
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Moitessieriidae	*Lanzaia vjetrenicae* Kuščer 1933	Sb
ANIMALIA	ARTHROPODA	Insecta	Diptera	Tipulidae	Limonia nubeculosa (Meigen 1818)	Tx
ANIMALIA	ARTHROPODA	Myriapoda	Chilopoda	Lithobiidae	*Lithobius (Troglolithobius) matulicii* Verhoeff 1899	Tb
ANIMALIA	ARTHROPODA	Myriapoda	Chilopoda	Lithobiidae	*Lithobius (Troglolithobius) sketi* Matic et Darabantu 1968	Tb
ANIMALIA	ARTHROPODA	Myriapoda	Chilopoda	Lithobiidae	*Lithobius* sp. 1	Tf
ANIMALIA	ARTHROPODA	Myriapoda	Chilopoda	Lithobiidae	*Lithobius* sp. 2	Tx
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Cyclophoridae	*Litthabitella chilodia* (Westerlund, 1886)	Cr
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Chordeumatida	Anthogonidae	*Macrochaetosoma troglomontanum* Absolon & Lang, 1933	Tb
ANIMALIA	ANNELIDA	Polychaeta	Sabellida	Serpulidae	*Marifugia cavatica* Absolon & Hrabe 1930	Sb
ANIMALIA	CHORDATA	Mammalia	Carnivora	Mustelidae	*Martes foina* (Erxleben, 1777	stf
ANIMALIA	ARTHROPODA	Insecta	Trichoptera	Limnephilidae	*Mesophylax aspersus* Rambur 1842	sTf
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Metidae	*Meta menardi* (Latreille 1804)	Tf
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Metidae	*Meta merianae* (Scopoli 1763)	Tf
FUNGI	ASCOMYCOTA	Sordariomycetes	Hypocreales		Metacordyceps chlamydosporia	Tt
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Microparasellidae	*Microcharon* sp.	Sb
ANIMALIA	ARTHROPODA	Insecta	Trichoptera	Limnephilidae	*Micropterna nycterobia* McLachlan 1880	sTf
PROTISTA	CILIOPHORA	Ciliatea	Rhabdophorina, podraz.	Didiniidae	*Monodinium balbianii* Fabre-Domergue, 1888	?
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Sphaeromatidae	*Monolistra (Pseudomonolistra) hercegoviniensis* Absolon 1916	Sb
ANIMALIA	NEMATODA	Adenophorea	Mononchida	Mononchidae	*Mononchus* sp.	Tx
FUNGI	ZYGOMYCOTA	Zygomycetes	Mucorales	Mucoraceae	Mucor mucedo	Tt
ANIMALIA	ARTHROPODA	Insecta	Diptera	Mycetophilidae	Mycetophila fungorum (Geer 1776)	Tf
ANIMALIA	CHORDATA	Mammalia	Chiroptera	Vespertilionidae	*Myotis emarginatus* (Geoffroy, 1806)	sTf
ANIMALIA	CHORDATA	Mammalia	Chiroptera	Vespertilionidae	*Myotis nattereri* (Kuhl, 1817)	sTf
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Haplotaxida	Naididae, Phallodrilinae	*n. sp.*	Sb
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Haplotaxida	Naididae, Tubificinae	*n. sp. 1*	Sb
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Haplotaxida	Naididae, Tubificinae	*n. sp. 2*	Sb
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Haplotaxida	Naididae, Tubificinae	*n. sp. 3*	Sb

FUNGI	ASCOMYCOTA	Eurotiomycetes	Onygenales		Nannizziopsis sp.	sTf
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Hydrobiidae	*Narentiana vjetrenicae* (Radoman 1973)	Sb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Cholevidae, Leptodirini	*Nauticiella stygivaga* Moravec et Mlejnek 2002	Tb
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Nebelidae	*Nebela bohemica* Taranek, 1882	?
PROTISTA	AMOEBOZOA	Tubulinea	Arcellinida	Nebelidae	*Nebela bursella* Vejdovsky, 1881	?
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Phalangiidae	*Nelima troglodytes* Roewer, 1910	Tf
ANIMALIA	ARTHROPODA	Arachnida	Pseudoscorpiones	Neobisiidae	*Neobisium (Blothrus) vjetrenicae* Hadži 1933	Tb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Carabidae, Trechini	*Neotrechus dalmatinus dalmatinus* (Miller, 1861)	Tb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Carabidae, Trechini	*Neotrechus suturalis otiosus* (Obenberger, 1917)	Tb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus balcanicus (Absolon 1927)	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus boskovici S. Karaman 1952	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus cvijici S. Karaman 1950	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus factor G. Karaman & Sket 1991	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus hercegovinensis S. Karaman 1950	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus salonitanus S. Karaman 1950	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus steueri kolombatovici S.Karaman, 1950	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus trullipes Sket 1958	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus vjeternicensis S. Karaman 1932	Sb
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Niphargidae	Niphargus zavalanus S. Karaman 1950	Sb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Staphylinidae, Pselaphinae	*Nonveilleria* sp. nov.	Tb
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Phalangiidae	*Oligolophus tridents* (C.L. Koch, 1836)	Tx
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Phalangiidae	*Opilio dinaricus* Šilhavý, 1938	Tf
ANIMALIA	ARTHROPODA	Arachnida	Opiliones	Phalangiidae	*Opilio saxatilis* (C.L. Koch, 1839)	sTf
ANIMALIA	ARTHROPODA	Insecta	Diptera	Chirnomidae	Orthocladius barbicornis (Linne 1767)	Tx
ANIMALIA	ARTHROPODA	Insecta	Diptera	Chirnomidae	Orthocladius sordidellus (Zettarst.1838)	Tx
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Moitessieriidae	*Paladilhiopsis absoloni* (A. J. Wagner, 1914)	Sb
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Linyphiidae	*Palliduphantes spelaeorum* (Kulczynski, 1914)	Tf
PROTISTA	AMOEBOZOA	Archamoebae	Pelobiontida	Pelomyxidae	*Pelomyxa palustris* Greeff, 1874	?
FUNGI	ASCOMYCOTA	Eurotiomycetes	Eurotiales		Penicillium glandicola (Oudemans) Seifert & Samson 1985	sTf
FUNGI	ASCOMYCOTA	Eurotiomycetes	Eurotiales		Penicillium vulpinum	sTf
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Ellobiidae	*Pholeoteras euthrix* Sturany 1904	Tb
ANIMALIA	CHORDATA	Actinopterigii	Clupeiformes	Cyprinidae	*Phoxinus lumaireul* Schinz, 1840	Sf
ANIMALIA	ARTHROPODA	Insecta	Diptera	Mycetophilidae	Phronia exigua (Zetterstedt 1852)	Tf
PROTISTA	AMOEBOZOA	Lobosoa	Arcellinida	Phryganellidae	*Phryganella hemisphaerica* (Penard, 1890) Penard, 1902	?
ANIMALIA	PLATYHELMINTHES	Trematoda	Plagiorchiida	Allocreadiidae	Plagioporus protei Prudhoe, 1945	Sb
ANIMALIA	CHORDATA	Mammalia	Chiroptera	Vespertilionidae	*Plecotus cfr. kolombatovici* Đulić, 1980	sTf
ANIMALIA	ARTHROPODA	Entognatha	Diplura (Subcl.)	Campodeidae	*Plusiocampa (Stygiocampa) remyi* Conde 1947	Tb

ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Polydesmida	Polydesmidae	*Polydesmus complanatus illyricus* Verhoeff, 1898	Tx
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Asellidae	*Proasellus anophthalmus* (S. Karaman 1934)	Sb
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Asellidae	*Proasellus hercegovinensis* (S. Karaman 1933)	Sb
ANIMALIA	NEMERTINA	Enopla	Hoplonemertea	Tetrastemmatidae	*Prostoma hercegovinense* Tarman 1961	Sb
ANIMALIA	CHORDATA	Amphibia	Urodela	Proteidae	*Proteus anguinus* Laurenti 1768	Sb
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Hydrobiidae	*Pseudamnicola troglobia Bole, 1961*	Sb
ANIMALIA	ARTHROPODA	Crustacea	Ostracoda (Subcl.)	Cypridídae	*Pseudocypridopsis hartmanni* Petkovski et all., 2009	Sb
ANIMALIA	ARTHROPODA	Crustacea	Ostracoda (Subcl.)	Cypridídae	*Pseudocypridopsis sywulai* Petkovski et all., 2009	Sb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Staphylinidae, Staphylininae	*Quedius mesomelinus kraussi* Penecke, 1904	Tf
ANIMALIA	MOLLUSCA	Gastropoda	Prosobranchia	Hydrobiidae	*Radomaniola montana* (Radoman, 1973)	Cr
ANIMALIA	NEMATODA	Secernentea	Rhabdita	Rhabditidae	*Rhabditis sp. 1*	Tx
ANIMALIA	NEMATODA	Secernentea	Rhabdita	Rhabditidae	*Rhabditis sp. 2*	Tx
ANIMALIA	ARTHROPODA	Arachnida	Acari	Rhagidiidae	*Rhagidia* sp.	Tf
ANIMALIA	CHORDATA	Mammalia	Chiroptera	Rhinolophidae	*Rhinolophus ferrumequinum Schreber, 1774*	sTf
ANIMALIA	CHORDATA	Mammalia	Chiroptera	Rhinolophidae	*Rhinolophus hipposideros* (Bechstein, 1800)	sTf
ANIMALIA	ANNELIDA	Clitellata, Oligochaeta	Haplotaxida	Naididae, Rhyacodrilinae	*Rhyacodrilus cf. subterraneus* Hrabe 1963	Sb
ANIMALIA	PLATYHELMINTHES	Rhabditophora	Tricladida	Geoplanidae	Rhynchodemus sp.	Tb
ANIMALIA	ARTHROPODA	Arachnida	Pseudoscorpiones	Neobisiidae	*Roncus* cf. *anophthalmus* (Ellingsen 1910)	Tb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Carabidae, Trechini	*Scotoplanetes arenstorfflanus* Absolon, 1913	Tb
ANIMALIA	PLATYHELMINTHES	Trepaxonemata	Neoophora	Scutariellidae	*Scutariella stammeri* Matjašič 1958	Sb
ANIMALIA	ARTHROPODA	Crustacea	Decapoda	Atyidae	*Spelaeocaris hercegovinensis* (Babić, 1922)	Sb
ANIMALIA	ARTHROPODA	Crustacea	Decapoda	Atyidae	*Spelaeocaris pretneri* Matjašič, 1956	Sb
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Pupillidae	*Spelaeoconcha paganettii polymorpha* Wagner, 1914	Tb
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Cholevidae, Leptodirini	*Speonesiotes (S.) narentinus latitarsus* (Apfelbeck, 1919)	Tf
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Cholevidae, Leptodirini	*Speonesiotes (S.) schweitzeri* Jeannel 1941	Tf
ANIMALIA	ARTHROPODA	Crustacea	Ostracoda (Subcl.)	Entocytheridae	*Sphaeromicola stammeri* Klie 1930	Sb
ANIMALIA	CHORDATA	Actinopterigii	Clupeiformes	Cyprinidae	*Squalius svallize* (Heckel & Kner, 1858)	Sx
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Dysderidae	*Stalagtia (Stalagtia) hercegovinensis* (Nosek 1905)	Tb
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Dysderidae	*Stalitella noseki* Absolon & Kratochvil 1933	Tb
PROTISTA	CILIOPHORA	Ciliatea			*Steinia platystoma* (Ehrenberg, 1831) Diesing, 1866	?
PROTISTA	CILIOPHORA	Ciliatea	Stichotrichida	Spirofilidae	*Stichotricha secunda* Perty, 1849	?
ANIMALIA	PLATYHELMINTHES	Trepaxonemata	Neoophora	Scutariellidae	*Stygodyticola hadzii* Matjašič 1958	Sb

PROTISTA	CILIOPHORA	Ciliatea			*Stylonychia mytilus* (O. F. Müller, 1773)	?
ANIMALIA	PLATYHELMINTHES	Trepaxonemata	Neoophora	Scutariellidae	*Subtelsonia perianalis* Matjašič, 1958	Sb
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Agelenidae	*Tegenaria annulata* Kulczynski 1912	Tf
PROTISTA	CILIOPHORA	Ciliatea	Suctorida	Dendrosomatidae	*Tokophrya cyclopum* (Claparède & Lachmann, 1859) Bütschli, 1889	?
PROTISTA	AMOEBOZOA	Lobosoa	Amoebida	Amoebidae	*Trichamoeba villosa* (Wallich, 1863)	?
ANIMALIA	ANNELIDA	Clitellata	Oligochaeta	Lumbricidae	Trichodrilus sp.	Sb
ANIMALIA	ARTHROPODA	Crustacea	Isopoda	Trichoniscidae	*Trichoniscus (Chalconiscus) matulicii* Verhoeff 1901	Tf
ANIMALIA	ARTHROPODA	Insecta	Lepidoptera	Geometridae	*Triphosa sabaudiata* (Duponchel 1831)	sTf
ANIMALIA	ARTHROPODA	Insecta	Coleoptera	Staphylinidae, Pselaphinae	*Troglamaurops gangibaueri* (Winkler, 1925)	Tb
ANIMALIA	PLATYHELMINTHES	Trepaxonemata	Neoophora	Scutariellidae	*Troglocaridicola capreolaria* Matjašič 1958	Sb
ANIMALIA	PLATYHELMINTHES	Trepaxonemata	Neoophora	Scutariellidae	*Troglocaridicola spelaeocaridis* Matjašič 1958	Sb
ANIMALIA	ARTHROPODA	Crustacea	Decapoda	Atyidae	*Troglocaris anophthalma periadriatica* Jugovic, Jalžić, Prevorčnik & Sket, 2012	Sb
ANIMALIA	ARTHROPODA	Arachnida	Araneae	Linyphiidae	*Troglohyphantes salax* (Kulczynski 1914)	Tb
ANIMALIA	ARTHROPODA	Crustacea	Mysida	Mysidae	*Troglomysis vjetrenicensis* Stammer 1933	Sb
ANIMALIA	ARTHROPODA	Insecta	Orthoptera	Rhaphidophoridae	Troglophilus cavicola Kollar 1833	Tf
ANIMALIA	ARTHROPODA	Insecta	Orthoptera	Rhaphidophoridae	Troglophilus neglectus Krauss 1879	sTf
ANIMALIA	ARTHROPODA	Insecta	Orthoptera	Rhaphidophoridae	Troglophilus ovuliformis Karny 1907	Tf
ANIMALIA	ARTHROPODA	Arachnida	Opillones	Trogulidae	*Trogulus torosus* Simon 1885	Tf
ANIMALIA	ARTHROPODA	Crustacea	Amphipoda	Gammaridae	Typhlogammarus mrazeki Schaeferna 1906	Sb
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Glomerida	Glomeridae	*Typhloglomeris caeca* Verhoeff 1898	Tb
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/Julida	Julidae	*Typhloiulus edentulus* Attems, 1951	Tb
PROTISTA	CILIOPHORA	Spirotrichea		Urostylidae	*Urostyla grandis* Ehrenberg, 1830	?
ANIMALIA	ARTHROPODA	Myriapoda	Diplopoda/ Polydesmida	Trychopolydesmidae	*Vehoeffodesmus* n. sp.	Tb
ANIMALIA	CNIDARIA	Hydrozoa	Anthoathecata	Bougainvilliidae	*Velkovrhia enigmatica* Matjašič & Sket 1971	Sb
ANIMALIA	ARTHROPODA	Entognatha	Collembola (Subcl.)	Entomobridae	*Verhoeffiella longicornis* (Absolon 1900)	Tb
ANIMALIA	ARTHROPODA	Entognatha	Collembola (Subcl.)	Entomobridae	*Verhoeffiella verdemontana* Lukić & Deharveng, 2018	Tb
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Zonitidae	*Vitrea botterii* (L. Pfeiffer, 1853)	Tx
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Zonitidae	*Vitrea illyrica* (A.J. Wagner, 1907)	sTf
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Zonitidae	*Vitrea kiliasi* Pinter 1972	Tf
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Zonitidae	*Vitrea kutschigi* (Walderdorff 1864)	Tf
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Zonitidae	*Vitrea spelaea* (A.J. Wagner 1914)	Tb
BACTERIA	ACTINOBACTERIA	Gammaproteobacteria			zidne kopnene kolonije	Tb
ANIMALIA	MOLLUSCA	Gastropoda	Pulmonata	Cochlicopidae	Zospeum troglobalcanicum Absolon, 1916	Tb

3.1.c Statement of Integrity

The area of the Vjetrenica cave and its surroundings adequately represents both natural and cultural, terrestrial and aquatic features, as well as processes of importance for the long-term conservation of the rich biodiversity and exceptional natural beauty. Vjetrenica Cave is the most important and unique element of biodiversity of this part of the region. The area around the Vjetrenica cave also protects all major terrestrial vegetation species and important species habitats. The nomination of the Vjetrenica cave will include all the features that make up the outstanding universal value of the property. In addition to an internationally renowned site of Vjetrenica Cave, the nominated area includes lesser-known and as yet unexplored sites. We are thus in a position to permanently maintain the integrity of the designated property with the help of existing protective measures and safeguard provisions.

Vjetrenica Cave is a complex underground system that has not yet been fully explored, offering exceptional opportunities for further exploration of the karst underground of the Dinarides, primarily along the lines of physical speleology, geology, hydrology, ecology, biospeleology, paleontology, archeology; but also underground climatology, tectonics and more. Research brings us new insights about caves themselves, hydrogeological and ecological relations, the present living world extremely rich endemic species and many other aspects important for this area, but also for the community as a whole.

The main threats to the integrity of the property include a wide range of anthropogenic influences (physical devastation, changes in the habitat and ecology of the cave, waste accumulation, collection and disturbance of cave fauna, uncoordinated urban development, population growth in the area above and around caves, old infrastructure, illegal interventions at springs and tourist pressure). Total property compliance, and in particular the relationship between urban projects and landscapes, is sensitive to lack of proper control of new development.

Structural integrity

The individual components of the nominated area are fully taken into consideration and include the findings, different life forms, habitat structures and localities, as well as the immediate surrounding landscape. Moreover, thanks to speleological research, several other new species are well known within the areas of the nominee. Other undiscovered places protected by the category Protected Landscape.

Visual integrity

The position of the Vjetrenica cave is set in the valley of Popovo polje within the Protected landscape "Vjetrenica-Popovo polje", which enables unobstructed access view of the area. The open visual axes from the very first meters of the Popovo polje to the cave itself were instrumental for the area. In the last ten thousand years, the morphology of the valley segment has changed dramatically due to geological and pedological processes. Given the remarkable

view extending from all the cave sites to corresponding segments of the valley, it can be assumed that the visual axes at the Paleolithic period were relatively unobstructed.

Geographic integrity

The geographical area is defined based on the position of the cave, the Protected landscape "Vjetrenica-Popovo polje"and the largest European sinking river of Trebišnjica. Vjetrenica cave is a unique phenomenon in geological sense in that it most likely served in the past as a canal for sinking rivers. Today, it is admired for its unique geological phenomenon of strong winds.

3.1.d Protection and management requirements Framework for protection and management

Vjetrenica Cave belongs to the system of karst area that is the most environmentally endangered in Bosnia and Herzegovina. The natural beauty of this cave has been recognised since ancient times. However, systematic forms of protection of Vjetrenica appeared only in 1952 when, in accordance with the then law, it was declared a natural monument (Decision of the Institute for the Protection of Cultural Monuments and Natural Rarities of the People's Republic of Bosnia and Herzegovina, No. 979/52 of 25 December 1952). The 1981-2000 Spatial Plan of BiH for the period, which remains in force until the adoption of the Spatial Plan for the Federation of BiH, due to its cultural and natural heritage significance, protects the wider area of the Zavala-Slano wave as a special natural landscape (Article 115, Official Gazette of the Federation BiH, No. 2/06).

The Ravno Municipality has adopted the Spatial Plan, as a basis for the protection of Vjetrenica. It protects a wider area surrounding the cave and defines it as a "special natural area", and its irregularly shaped entrance as a "landmark world heritage".

Despite the lack of documentation required for all World Heritage sites, the Vjetrenica Cave was inscribed on the UNESCO Provisional Natural Heritage List on 22 November 2004 as a natural good.

According to the current 2003 Law on Nature Protection, which is in line with the EU Directives, the Vjetrenica cave is entrusted to the competence of the regional administration or cantons. Classification process in this category would require determining the status of the Vjetrenica cave as a protected area.

During the Project Achieving Biodiversity Conservation through the Establishment and Effective Management of Protected Areas and Capacity Building for Nature Protection in Bosnia and Herzegovina (BiH) aimed to increase the number of protected areas in Bosnia and Herzegovina (BiH), funded by GEF Environment Facility and implemented by UNEP (United

Nation Environment Programme - Agency) in Bosnia and Herzegovina, an expert reasoning/explanation was developed for the Vjetrenica cave. This expert explanation compiled all existing and new research on the basis of which a new coverage with an impact zone and a new protection category Protected Landscape - V IUCN category was determined. Previous coverage of the Vjetrenica cave had classified this natural phenomenon as the Monument of Nature and did not take the local population into the zone of influence as a driver of protection and preservation.

According to the Law on Nature Protection of the Herzegovina-Neretva Canton (Official Gazette of the Herzegovina-Neretva Canton No. 12/17) Vjetrenica cave with its surroundings in the wider area of the Popovo polje is declared a Protected Landscape. Such a change in the mode of protection of this area is a consequence of new findings and the coherence and connectivity of the area which is of importance for the Vjetrenica cave itself. Protected landscape according to the Law on Nature Protection of the Herzegovina-Neretva Canton is defined as:

> (1) a protected landscape is a natural or cultivated area of great landscape value and biodiversity and/or geodiversity or a landscape of preserved unique features characteristic of a particular area,
>
> (2) In a protected landscape, it is permitted to have interventions and activities that do not violate the characteristics based on which it was declared a protected landscape.

In 2021, with the decision to declare this area as a protected landscape "Vjetrenica - Popovo Polje", this area receives formal legal protection, respecting all legally formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina.

Zoning of a protected area is a key instrument and a basic step in planning the use and management of the space, which should ensure the preservation of the value of the protected area. The zoning process divides the areas into zones with different conditions of use according to the objectives of protection, existing use and needs for the development of the area. Zoning is performed from the degree of protection of the area in the range from the zone where almost no human influence is allowed, to the zones of more intensive use where the natural space within the zone can be significantly altered. Zones are determined in accordance with the degree of protection determined by natural habitats and animal communities and permitted human activities in a particular area. All zones provided for in the zoning system do not have to be represented in every protected area. Which was also adopted in the new Protected Landscape Management Plan "Vjetrenica-Popovo polje", which was adopted in 2021 by the municipal council.

The Vjetrenica Cave is located in the very nucleus and its protection is guaranteed by implementation of the Law on Protected Landscape Vjetrenica-Popovo polje.

Since the state of flora and fauna in caves depends on the quality of groundwater that flows into them, this segment of space was taken as an important criterion in defining boundaries and

zones. In addition, based on the analysis of natural and cultural values of the area, the priority components have been defined due to which the area is gaining in value and thus it is possible to include it in the wider local and international level.

Vulnerability, pressures and threats to the facility and area of protection

Vjetrenica remains rather protected and preserved, despite being a sizable speleological facility consisting of numerous habitats, especially aquatic ones, all under the hydrological influence of precipitation and groundwater from the surrounding topographic surface or impact area. In this regard, the area above Vjetrenica should be managed with due care, and so far no allogeneic watercourses have been observed. There are several smaller villages in the area of the impact zone, suffering from extreme depopulation and with very few older households remaining, dealing exclusively with the traditional agriculture. There is no significant use of pesticides or fertilisers with increased nitrate content. There is no developing industry or exploitation of natural raw materials in the impact area. Impact area also saw warfare in the period from 1991 to 1996, including combat techniques using heavy oils such as PCBs, but there is no data on the consequent impact. The zone area around the cave is to an extent mine contaminated on inaccessible terrain, although the area around the entrance to Vjetrenica was professionally cleared of mines. It has been see in the literature that shrimp (Decapoda) and some species of mussels (Amphipoda) cannot be found in the smaller lakes of the Main Channel in Vjetrenica, which is linked with the abandoned nearby accumulation section (Sket 2003), although this has not been proven. Although the masiff where Vjetrenica is located is free from significant pressures and threats, the very entrance to Vjetrenica represents the southern edge of the Popovo polje which has undergone fundamental hydrological changes. The Trebišnjica River, once the longest sinking river in Europe, serves four hydroelectric power plants with numerous kilometres of artificial tunnels. Since 1979, it has been converted into a large concrete canal, breaking off the connection with its environment. As a result, 4 billion cubic meters of water were taken away from underground habitats (Milanović 1983; 2006) of extremely rich cave fauna.

There are certain potential threats to the Vjetrenica area if not protected, as follows: not far from Vjetrenica, several quarries and landfills were built and planned, and there are also new ones in the pipeline. The intention of Bosnia and Herzegovina and Croatia is to build the so- called Adriatic-Ionian highway just above Vjetrenica. An additional problem is an entirely underdeveloped nature protection system in Bosnia and Herzegovina. All this poses a serious threat to the Vjetrenica cave. Research and popularisation of Vjetrenica and its rich fauna significantly contributed to a fuller perception of the cave and the area around it, but also to an increased public perception and the declared protected area and reduced vulnerabilities, removing pressures and threats to Vjetrenica and the wider area of protection.

At the level of BiH, there is a constitutional provision that was used to define the existing activities in the field of environment, specifically Article IV 4.a. According to the Constitution of the Federation of Bosnia and Herzegovina (Federation of BiH), Chapter III, Article 2, indent c., environmental protection policy is in the joint competence between the Federation of Bosnia and Herzegovina and cantons. The Federation of BiH has 10 cantons.

Vjetrenica Cave is located in the Federation of Bosnia and Herzegovina in the territory of the Herzegovina-Neretva Canton, within the boundaries of the Protected Landscape "Vjetrenica-Popovo polje". Competence for decision-making is thus divided between the Federation of Bosnia and Herzegovina and the Herzegovina-Neretva Canton, .

In the Federation of Bosnia and Herzegovina, the umbrella law on nature protection is the Law on Nature Protection of the Federation of Bosnia and Herzegovina (Official Gazette of FBiH No. 66/13), while in the Herzegovina-Neretva Canton it is the Cantonal Law on Nature Protection (Official Gazette of Herzegovina-Neretva Canton No. 12/17).

Vjetrenica cave is protected by legal powers of the Federation of Bosnia and Herzegovina, and the laws of the Cantonal Ministry. Activities that have an impact on the cave and the surrounding landscape are regulated by law.

The asset management system is comprehensive and far-reaching. It integrates all levels of government and authorities. Joint plans at the Entity and regional levels are coordinated and implemented through action plans. The exchange of information for research and the purpose of conservation and sustainable tourism management has been facilitated and promoted through the use of existing international and national networks and the creation of new ones.

The Ministry of Trade, Tourism and Environmental Protection of the Herzegovina-Nertva Canton monitors the implementation of the Law on Nature Protection. The body in charge of management is the Public Company Vjetrenica d.o.o., that implements the Management Plan and monitors the protection of biodiversity and the condition of the cave, but more importantly it manages tourist visits.

Management plan in the international practice of modern management of protected areas is a fundamental developmental organisational and economic document issued by the management of the protected area, which outlines guidelines for protection, operation and development and for the use of the protected area.

The law stipulates that the management of the protected area is carried out based on the Management Plan, as well as the Spatial Plan of the area of special features.

The protected area management plan aims to direct and control the management and use of assets, as well as the development of human resources, financial resources, facilities, equipment, and also programmes needed to support them in management and use.

The content of the Management Plan is prescribed by the Rulebook on the content and manner of preparation of management plans for protected areas (Official Gazette of FBiH No. 65/06).

According to this Rulebook, Management Plans are adopted for a period of 10 years, and can be revised after five years.

In accordance with the Law, the management of the protected area Vjetrenica (hereinafter: PA Vjetrenica or PA) is implemented based on the Management Plan of the Protected Landscape "Vjetrenica-Popovo polje", adopted for a period of ten years.

The public company has all the necessary legal, organizational, human and material capacities, resources and powers to manage the area and uses them to continuously improve all segments of management and organizational culture, thus building cooperation with stakeholders and its role in domestic and international circles. Its objective is to improve the area management system:

- All documents relevant to management drafted and adopted
- The manager has sufficient management capacity
- Project team for monitoring and implementation established
- The manager has technical management equipment
- Developed integrated information database for Protected Landscape Vjetrenica - Popovo polje

The public company has five (5) employees and a director.

- Director
- Office manager
- Museum worker
- Two Guides

Considering the Law on the proclamation of the area of the Vjetrenica cave with a part of Popovo polje as a protected landscape “Vjetrenica - Popovo polje” and the entrustment of the management of this area to the public company Vjetrenica Ravno, it is necessary to update and supplement the governance documents of this Company. It is necessary to review the main tasks of the public company: a) regular activities which include inventory of natural values, protection and monitoring of biological diversity, monitoring of environmental parameters (water, soil, air), monitoring of the protected area, environmental education and other activities related to protected area management documents; b) program activities which include promotion and use of the area through marketing and development of products and services of protected area, supervision of plans and management and concessions awarded to sectors of economy, local communities, cooperation with professional institutions, state institutions, authorities and non-governmental sector, participation in research projects and programs, other program activities. In addition, it is necessary to conduct job classification and define the internal organization of the Company, including the number and qualifications of employees by means of the Rulebook on internal organization. In addition, it is necessary to create and update all regulations and internal documents. The Public company also has a council that has the responsibility to decide on the number and structure in order to achieve a balance in representing public/general and special/specific interests. The Public company must continuously take care of employees' training. As a special problem, the public company is facing issues in the process of continuous monitoring and implementation of projects, and therefore it is necessary to plan a special service that will perform these tasks. In addition to the above, equipment for the successful implementation of the protection is necessary. The public company owns part of the equipment needed for management, but a large investment is needed in this part. In the economic part, it is necessary to consider different models of financing the work of the public company. So far, the company's activity has been mostly financed from the municipal budget and project grants. The public company does not have a unified database and it is mostly partial, so it is necessary to

establish a database and complete it.

Identification of the current specific challenges

Due to the extensive tourist landscaping, the pre-cave part, the whole entrance part of the cave and the main cave passage have been almost entirely altered in anthropogenic terms.

The most important influences identifiable in Vjetrenica cave are the following:
1. Breaking of flowstone
2. Damage to flowstone by incisions, signatures and installation
3. Archaeological and paleontological probes (substrate excavations
4. Various objects brought in, numerous and various interventions on and along the tourist trail
5. Protective front door installed
6. Filling and concreting of the main cave passage
7. Devastation of numerous cave habitats along the tourist installations
8. Electrical installations along the entire cave and lighting of the cave
9. Microclimate change, primarily warming
10. Potential occurrence of green overgrowth (lampenflora) next to lighting fixtures
11. Potential fall and collapse of unstable rocks and stones on a tourist trail

Physical devastation

In speleological objects, we most often encounter the breaking and removal of speleothems, primarily stalactites and stalagmites, and the engraving and printing of various inscriptions and symbols. In those with smaller entrance openings, there is a deliberate closure of the entrance by backfilling and collapse, with stones, earth and other material inserted. Full destruction of a speleological object is relatively rare, almost exclusively due to extensive construction work and less often by quarrying when the objects are in the area of a quarry.

Special forms of devastation include archaeological and paleontological excavations, which significantly change the morphology, but also the ecology of speleological objects. Next in line are tourist installations in speleological objects with infrastructure (paths, installations, lighting), devastating the cave to a lesser or greater degree and affecting the ecology. Finally, installation of a protective door at the entrance to the speleological object is a smaller form of devastation.

Near Vjetrenica, almost all forms of physical devastation are found, with particularly evident impacts due to the infrastructural construction of the tourist trail.

Changes in habitat and cave ecology

Due to physical interventions and elements of spatial devastation, habitats can be affected, resulting in their physical devastation or changes in habitat ecology. This influence is found along several lines. First, cave habitats are physically changed by backfilling, rock rearrangement and concreting; there is an impact on the change or disruption of groundwater flow, closing the door reduces the entry of bat populations and thus the introduction of guano into the cave, and consequently the disappearance of guanophilic fauna, such as genus *Laemostenus*. The installation of bulky metal lighting fixtures led first to the heating of the air, and thus to the change of environmental factors, and subsequently rusting and the introduction of metal into the habitats, which has been corrected today.

A special type of impact on habitats is the periodic flooding of part of the cave, but this is a natural impact on the habitats and ecology of the cave.

Waste accumulations

Many speleological objects serve as landfills, especially cave structures near settlements and roads. In Vjetrenica, a smaller quantity of waste was found, primarily inorganic garbage along the tourist part of the cave, remaining from previous researchers and visitors, but also due to the physical arrangement of the cave. This certainly needs to be collected and removed.

Collection and disturbance of cave fauna

Some speleological objects, especially those easily accessible and tourist-arranged, but also biospeleologically rich and important, are under attack by professional collectors and collectors of fauna. In the area of the Dinarides, there are extremely frequent cases of collection and export of cave fauna outside the borders of the home countries. Although Vjetrenica today is closed and there is a public company attending to the cave, until recently, Vjetrenica was a site to hundreds of permanent traps for catching invertebrates, which can significantly reduce the population of cave fauna. This form of devastation, which is also legally regulated, should be limited to the minimum, scientifically necessary measure, while the local population and responsible services should be warned accordingly.

Identification of specific long-term challenges

The property has become endangered by a series of factors. Endangerment factors include the following: intensified tourism associated with the nomination, the pressure from development, natural disasters and the destruction of specific resources. The following sections lists the long-term challenges individually for the outstanding universal value of the nominated property Vjetrenica.

Intensified tourism

As Vjetrenica cave is located near Dubrovnik, facing massive tourism, many of these tourist are coming also to visit Vjetrenica cave. In addition, there is potential threat from tourist in search of speleoturism. The touristic use of the cave Vjerenica is sustainable and controlled. The sites open to the visitors are protected by stainless fences. Tourist visits to the cave are under supervision of trained personnel. Further measures should be undertaken in order to guarantee their protection in the future as well.

Insufficient mechanism for implementing management plans

Government is the founder of the Public Company Vjetrenica d.o.o. and authorised for decision making. A major problem for public enterprises is a vaguely defined business plan that is further burdened by political decision-making and political will. An additional problem is the lack of effective management control. In public enterprises, direct ownership function on behalf of citizens is often performed by weak institutions, which often set unclear or contradictory goals before public enterprises. Management structures are mostly composed of inadequate staff who do not meet the normative requirements for the implementation of basic plans. Supervision over the work of public companies is weak, and it is not uncommon to see political restrictions preventing dismissal of incompetent management. By building a strong foundation of the principles of management and applying the Principle of Cooperative Management, in the long run, the problems arising from inadequate management would be overcome, with a shift to adequate management.

Natural disasters / natural deterioration of the caves

Natural disasters represent a problem over the long-term. Indeed, they cannot be avoided; however appropriate preventive measures can be implemented. In the area of the nominated property, generally, there are no relevant immediate dangers posed by natural disasters. Neither flooding nor fire endangers the cave sites. Nevertheless, the caves are subject to natural processes of deterioration and erosion – which is always the case in rocky karst terrain, where they occur more often. The nominated valley areas are, however, located in an area that is almost completely free of earthquakes.

Efforts are continuously being made to monitor on a regular basis the stability and condition of the caves. Moreover, constant efforts are also being made in the management and control system to check the condition of the caves and eventually-occurring changes by means of regularly-scheduled inspections. In the process, the local associations and municipalities who are involved in the upkeep of the cave sites play a significant role.

Conservation and archiving discoveries and findings

The sites discovered at the archaeological excavations have to be preserved. Also, the still-existing archaeological strata in the sites have to be secured as archives. Strategy: Within the scope of the Management Plan, measures were designed intended to assure future archiving and preservation of the discoveries and sites by means of responsible institutions. These institutions possess capacities for restoration, professional storage and exhibition of the discoveries.

Construction plans in the area of the property (development pressures)

The area in the nominated property can be exposed to development pressure. Construction measures in the vicinity of the property could, for example, affect the landscape. Chapter 1 describes the cave surrounding and karst geology which makes this cave highly sensitive to the pressures form the ground and surrounding. Nature conservation laws guarantee that the nominated property would receive the highest level of protection in the future. The erection of buildings within the property, as well as those obstructing the view can be legally prevented. An appropriately-wide buffer zone with high standards of protection was determined in the scope of the nomination.

Changes in usage (development pressures)

The surrounding of the cave are currently being used primarily for land and forestry operations. A change in present usage could endanger both known and unknown natural sites. Nature conservation law guarantees that nominated property would receive the level of protection. A change in the current land utilisation requires legal authorisation. Any change in the protected area is the subject of the competent ministry and deviation from the provisions of this law is the subject of inspections and competent authorities. .

3.2 Comparative analysis

Vjetrenica Cave belongs to the system of karst area in Bosnia and Herzegovina. The natural beauty of this cave has been recognised since ancient times. Vjetrenica Cave is a candidate for the UNESCO list of outstanding sites thanks to its remarkable biodiversity and endemism in Europe and the world. This is especially important from the perspetive of development and adaptation of life in the conditions prevailing in the cave.

Vjetrenica Cave is nominated under the following criteria:

- (x) - to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation; and

• (vii) - contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;

The beauty and exceptional value of the Vjetrenica cave is the subject of many scientific and populist works describing the rich fauna of this cave. The karst area of Vjetrenica cave continues to attracts the attention of scientists who are still finding new species in the hidden passages of this outstanding natural creation.

This cave offers proof of the incredible natural beauty and richness of life.

The facts in support are the following (detailed attributes of nomination criteria for the cave are shown in Section 3.1):
a) Remarkable and well-preserved manifestations of karst topography
b) The cave in length of 7 km has four levels: Main Level, Upper Level, Lower Level and Vertical Level
c) Strong wind that occurs in caves with multiple entrances located at different heights
d) 231 species: two types of bacteria, 14 fungi, 35 protista and 180 animals
e) 47 troglobites and 56 stigobites
f) Typical locality for 38 species, of which 14 are strictly endemic, and three genera are monotypic.

3.2.a Hot Spots with richest biodiversity worldwide

The diversity of hypogean fauna is spatially very variable. Among regions of roughly the same area, the wider Dinaric (or Western Balkans) region has nearly 400 species and subspecies (according to data in Botosaneanu, 1986), which is by far the richest biodiversity worldwide (see Dinaric Karst: Biospeleology). The Dinaric region is followed by regions of the east Balkan, Pyrenean-Aquitanian, and Rhodano-Lotharingian regions, all of which are positioned along the belt where most European centres of high overall biodiversity occur. Some taxonomic groups may be even more concentrated - around 40% of all known stygobitic species of Gastropoda (Mollusca) inhabit the Dinaric region. Regions outside Europe with similar total numbers of stygobites are much larger in size, and mainly occur within the northern warm temperate belt. Stygobitic faunas in tropical regions are generally less diverse, although their paucity is not as striking as the relative scarcity of terrestrial troglobitic faunas in the tropics. High numbers of regional stygobitic species are also recorded in other rich local faunas. Of the 20 richest caves - where 20 or more specialized hypogean species have been recorded (Culver & Sket, 2000) - there are only 11 with 20 or more stygobites. Among the richest are the Vjetrenica Cave in Bosnia-Herzegovina (52 stygobites), the Postojna-Planina Cave System (49 stygobites) and the anchialine Walsingham Cave System in Bermuda (up to 37 stygobites). These three caves, each with their own encyclopedia entry, differ in interesting ways. Postojna-Planina Cave System has a rich assortment of non-stygobites in addition to the usual stygobites, as do the Walsingham Caves. In contrast, the aquatic fauna of Vjetrenica Cave is almost exclusively stygobitic. Why so many crustacea? Although the difficult environmental conditions, restricted accessibility, and relative ecological homogeneity of the hypogean realm severely limit the potential numbers of stygobitic species in general and also intrinsically

exclude some groups (like the Insecta), some other groups may locally be overrepresented when compared with epigean habitats. This is particularly the case with malacostracan groups. Since the under-representation of Insecta underground could possibly be explained by their higher energetic demands, the successful invasion and diversification of the Crustacea may be explained by a number of circumstances. First, the absence of insects has left a number of potential niches. Second, high speciation rates can be achieved by spatial partitioning within a region that has a high degree of spatial isolation. Third, the geographical co-occurrence of a number of species is possible if there is specialisation for different ecological niches. Fourth, temperatures in hypogean habitats are stable, and the absence of low winter temperatures allows the survival of species that entered the area in warmer times. Finally, a turbulent geological history may have influenced high speciation rates locally. High numbers of hypogean species for some groups are compensated for by their restriction to smaller areas. As many as 78% of the stygobitic taxa in the Dinaric region are endemic to that region (153400 km2) and 37 to 67% of the taxa may be endemic to one of its subregions, measuring only 3500 to 51000 km2 in area. According to data from Illies (1978), 50 stygobitic and only six epigean species of Copepoda: Cyclopoida were limited to one region in Europe (at 150000 to 350000 km2 in area), while only two stygobitic and 45 epigean species were distributed throughout six or more such regions. A number of stygobitic species were known from one locality only. Species may also be heterogeneously distributed within a cave system, according to their ecological needs, a fact neatly illustrated by the example of Vjetrenica (Sket, 1999a). It has been shown that the number of species in a cave system depends to a great degree on the region, but is positively correlated with the richness of food resources and with the size of the caves (Culver and Sket, 2000). The existence of hundreds of mostly stygobitic Niphargus species and subspecies in Europe is possible due to their extreme diversity of size and shape of all body parts (indicating a variety of ecological niches) as well as their highly restricted ranges. (Encyclopedia of Caves and Karst Science, 2004). The number of stiglophilic species in the regions with the greatest diversity is given in Table 12.

Biodiversity in Hypogean Waters: Numbers of stygobitic taxa (species and subspecies) in the regions with the highest diversity, according to data in Botosaneanu, 1986 (from Sket, 1999b). Marine interstitial taxa (labelled as “Q” or “Q, P”) are excluded. A: regions of highest diversity in Europe; B: richest regions outside Europe; C: subregions of the wider Dinaric region (first line in category A).

Table 12 *Numbers of stigobite taxa on the approximate surface (source: Encyclopedia of Caves and Karst Science, 2004*

Name or region	***Number of stigobite taxa***	***Approximate surface (km²)***
Western Balkans Province (= Dinaric Region; including Slovenia)	396	153 400
East Balkan Province Pyrenean—Aquitanian Province Slovenia (south and west)	245	205 000
Rhodano-Lotharingian Province	200	165 000
	169	14 900
	168	14 100
B Japan	212	369 661
Caribbean Islands	144	
Appalachian Highlands	136	900 000
Mexico	100	19 693 67
New Zealand	76	264 820
C Slovenia (south and west)	169 (113)	14 900
Istria	24 (9)	3 600
Croatia (southwest and south)	102 (60)	25 500
Bosnia and Herzegovina	99 (56)	51 100
Serbia (west)	15 (6)	33 800
Montenegro and Kosovo	55 (36)	24 500

3.2.b Ecological Diversity in the Dinaric karst

A high ecological diversity (variety of habitats) is characteristic of most larger cave systems in the area, resulting in very rich local faunas. Of 16 caves worldwide containing 20 or more troglobitic and stygobitic species, six are in the Dinaric karst (Culver & Sket, 2000). By far the richest within the Dinaric karst are the Postojna-Planina Cave System and Vjetrenica in Bosnia and Herzegovina. Some particularly interesting ecological entities in the Dinaric karst are worth mentioning.

1. An epizoic protozoan faunula of no less than seven Ciliata: Peritricha and two Suctoria were found on a single specimen of the isopodMonolistra spinosissima (Racovitza, 1929);

2. A hygropetric-like habitat (a thin film of water running down the rock) known from Vjetrenica in Herzegovina occurs in some other Dinaric (and south Alpine) caves, and is inhabited by some specialised eetles (Coleoptera: Catopidae: Leptodirinae) which are pholeuonoid in shape (with a spindle-shaped trunk and elongated appendages);

3. In very specialised conditions in the sink-cave Crnulja in Popovo polje, there are very dense and extensive colonies of the cave tube worm Marifugia and thick layers of its tubes have formed a type of hypogean tufa. This used to be inhabited by an interstitial fauna of oligochaetes, acarines, and some crustaceans. Flood prevention work in the polje prevented regular flooding of the cave, killing arifugia and its associated fauna;

4. In the vicinity of hypogean ice, rich beetle faunas may be found, including some specialised oligostenothermal (limited to low temperatures) fauna, such as Astagobius spp (Encyclopedia of Caves and Karst Science, 2004).

3.2.c Uniqueness of Vjetrenica compared to world-famous caves

Looking at the caves around the world that are included in the UNESCO World Heritage List, taking into account their characteristics by which they stand out, and because of which they are included in the same list, we find caves that are included with regard to their speleothematic formation. The Aggtelek Karst and Slovak Karst World Heritage Caves as “cross-border possessions” from Hungary and Slovakia have beautiful cave formations. The formations in these caves developed due to the climatic effects of tropical and glacial. While the Skocjan Caves in Slovenia are important for geological history, they are a source for terms such as “karst” and “valleys”. In addition, the Skocjan Caves presented well-preserved examples of karst topography. Ballıca Cave Nature Park in Turkey, in addition to its bright and attractive color, the cave also creates a rare geological landscape with the richness, diversity and beauty of its calcite speleothemic formations. Jeju Volcano Island and Lava Tubes from Korea are listed as World Heritage Sites with the same criteria. The caves at these sites are covered with colourful and generally dark lava walls. For example, a heritage area with dominant volcanic characteristics includes polymorphic rocks as well as Halla Hill, the highest mountain in Korea

with lavash pipes and a lake crater. This karst area is known for its wide belts consisting of lakes, rivers, karst and rocks. As can be seen from these examples, all caves and karst areas included in the World Heritage List have almost similar application criteria. They all witnessed the different phases the world went through during its geological and geomorphological formations. All cave and karst formations, as well as Vjetrenica itself, provide the most attractive geological and topographic beauties. In terms of geology, Vjetrenica cave, as a unique representative of karst, is distinguished from all other caves by the unique formation of its passages and caves that have not yet been fully explored to this day. Different levels of the Vjetrenica cave create a unique phenomenon, meaning the creation of wind throughout the cave. In addition, the windmill cave was created by the largest European sinkhole - Trebišnjica.

On the other hand, Koytendağ caves from Turkmenistan consisting of karst lakes, wells, caves known for endangered species, karst Evaporita and caves of the region Emilia Romagna in Italy consisting of hundreds of caves spread over a wide karst area, Historical complex / Cave Karaftoo from Iran nominated on the World Heritage List with its mixed status and the cave Vjetrenica from Bosnia and Herzegovina which attracts a lot of attention with its biodiversity and lakes with water levels that change according to the rainy season. These caves, apart from their universal interior, attract attention due to their unique ecosystem, biodiversity and endangered fauna and flora.

What sets Vjetrenica apart from all these world sites and what Vjetrenica owns, and these sites do not own, is certainly the result of biological research that undoubtedly has the greatest reach in the professional world. The abundance and curiosity of all species, along with their uniqueness, speaks of its significance for world science. The research of Vjetrenica has borne valuable scientific fruits, and further research that is already being carried out promises to reveal an even larger spatial interior of hitherto undiscovered parts, and thus new endemic species.

With Vjetrenica in focus, the cave fauna of the Popovo polje has long been on the list of speleobiologists as one of the priorities. The latest list of fauna of Vjetrenica cave includes 231 species of living organisms, of which two types of bacteria, 14 fungi, 35 protista and 180 animals, authentic cave animals. With as many as 90 species of true cave animals, Vjetrenica stands out as one ofthe most biologically diverse caves in the world.

Vjetrenica is a type of locality for 38 species, of which 14 species were found only in Vjetrenica and subsequently nowhere else, and as many as three genera are monotypic: *Zavalia vjetrenicae* Radoman, 1973 (Gastropoda), *Troglomysis vjetrenicensis* Stammer, 1936 (Crustacea) and Nauticiella stygivaga Moravec and Mlejnek 2002 (Coleoptera). Further monotypic genera extending to other speleological objects are: *Spelaeoconcha paganettii* (Gastropoda), *Marifugia cavatica* (Polychaeta), *Velkovrhia enigmatica* (Hydrozoa), *Stalitella noseki* (Araneae), *Dinaria vjetrenicae* (Opiliones), *Typhlogammarus mrazeki* (Crustacea), *Spelaeocaris pretneri* (Crustacea) and *Proteus anguinus* (Vertebrata, Amphibia).

Biospeleological research of Vjetrenica for the first time in the world determined the habitat of hygroperia or cave habitats of rocks with thin water layers and described the first organism specialised in this habitat and the beetle *Hadesia vasiceki*. With each new research, numerous taxa new to science are discovered, and are yet to be described.

Special natural relationships and processes have created optimal ecological conditions for this area. This primarily refers to the presence of specific ecological factors that have enabled a great diversity of habitats and species that are its integral part. For a natural balance in linking of all components of nature or its biotic and physical factors.

Vjetrenica, as a unique natural phenomenon, has an extremely rich biodiversity, with numerous historical nd natural sites. The similarities are great with the caves already inscribed on the UNESCO World Heritage List. Each is characterised by special and specific characteristics that make them unique in the end. Thus, Vjetrenica as one of the leaders in its biodiversity in the world stands out for this characteristic, as a habitat and home of many rare and endangered species, but also rare cave animals (e.g. olm), comparing it with a number of caves from the UNESCO List. Due to the unusual geomorphological and microclimatic conditions in the caves, a unique ecosystem has been developed, and an extremely large number in the underground fauna of Vjetrenica. The cave fauna of Vjetrenica is an extremely valuable segment of European and world cave fauna. There is a distinct biological diversity with an extremely large number of endemic and relict taxa, but also an increasing threat to cave fauna.

Vjetrenica, in a significant way, offers exceptional space and entry into a rare site of the listed numerous species, including the interior itself and the beauty of the cave; in this respect it is unparalleled to any site on or outside the World Heritage List.

Apart from the rich universal underground fauna, Vjetrenica is also adorned with a special interior, as a hydrologically active flowing spaleological object with four autonomous watercourses, a dozen smaller ones, numerous underground lakes, spacious passages and halls, but also valuable archeological sites. Vjetrenica is not a typical cave ambience due to an explicitly unusual, quite constant wind blowing from the cave. As already noted, an extremely attractive and interesting morphological phenomenon of the Dinaric Alps.

The Dinaric underground fauna has a special historical significance, because there are localities where cave animals were first known and researched. The richness of the Dinaric underground fauna has been proven in the recording of the richest cave systems in the world. Until the mid-20th century, these were remote areas, so most of the credit is attributed to particularlyadventurous foreign scientists. Interstitial fauna was discovered for the first time in the Dinarides.

Thus, there are many reasons that the underground fauna of the Dinaric area and its surroundings can be considered not only natural, but also historical and cultural heritage. All this is proven by the unique habitat sites in Vjetrenica. Undoubtedly, a more complete record with more systematic research would greatly expand the list of cave systems of the central Dinarides.

Comparison of Vjetrenica with caves from the UNESCO World Heritage List

The comparison between caves is the subject of discussion among scientists, but it is certain that when it comes to caves and cave systems, the emphasis is on the richness of the species. In 2000, Culver and Sket published a list of caves and karst wells that were reported to have more than 20 species of stygobionts and troglobionts. Based on the numbers available, Vjetrenica cave was ranked on the top as the hotspot of the submenditeranium diversity in terms of overall stygobiotic plus troglobiotic species richness. Culver and Sket's approach is compelling as it only requires species lists of a relatively few high diversity caves. However, it has severe limitations as (a) it does not take into account regional diversity, (b) it is not possible to estimate list completeness, and (c) no confidence intervals can be placed on the numbers.

The "quick and dirty" approach of Culver and Sket does allow comparison among many regions, including ones for which less data are available. Culver and Pipan's (2013) latest tabulation of the most species-rich caves (Table 13.) are separated into stygobionts and troglobionts. With better and more complete data, the cutoff for global hot spots of subterranean biodiversity is now 25 stygobionts or 25 troglobionts. According to this criterion, the terrestrial fauna of Vjetrenica cave is a global subterranean biodiversity hotspot among the world's caves. The stygobiotic fauna is among the richest caves and is generally remarkable in its richness.

Frequently expressed concern that cave species richness patterns largely reflect sampling intensity, rather than actual differences. In an analysis of a very large dataset from the Dinaric karst of southeastern Europe, Zagmejster et al. (2008) show that cave beetle richness in the Dinaric karst is strongly influenced by collection intensity. However, in more thorough analysis, Zagmeister et al. (2010) showed that when sampling bias was removed, the same pattern of species richness persisted. More interestingly, there is a biological explanation that has been put forward for the location of terrestrial cave biodiversity hot spots globally (Culver and Sket 2000; Culver et al. 2006).

Based on an extensive analysis of hundreds of caves in relatively small (* 10,000 km2) regions, Culver et al. (2006) concluded that there was a ridge of high subterranean terrestrial biodiversity in southern Europe that corresponded to a ridge of high actual primary productivity and hence to allochthonous input in caves. Similarly, Culver and Sket (2000) concluded that terrestrial cave biodiversity hotspots were ones with high productivity, either chemoautotrophic or allochthonous.

A detailed comparison with another terrestrial subterranean biodiversity hotspot - Mammoth Cave in Kentucky, U.S. - is possible as there is also a published species list for Vjetrenica (Romero 2009), the only other published hotspot list as far as we can determine. Both caves have more than 32 described troglobionts.

There are more species of Arachnida in Mammoth Cave than any other group, and there are more species of Coleoptera in Vjetrenica than any other group. In both caves, these two groups together make up more than half of the species. Somewhat surprisingly, Hexapoda (e.g., Collembola) are minor components of both fauna. The level of endemism is roughly the same in the two caves - Mammoth Cave has eight species endemic to the cave, and Vjetrenica has as many as 14 endemic

species in the cave.

The most obvious difference between the two caves is that in Vjetrenica, five genera are represented by two species; all other are represented by one. In Mammoth Cave, only two genera have more than one species, but one of these (the beetle Pseudanophthalmus) has five. If adaptive radiation, that is, the diversification of species through natural selection, were important (see Fišer et al. 2012 for a subterranean example), more examples of multiple species in the same genus in the same cave would be expected. Nearly all of the global high diversity sites (Table 12.) are either in the Dinaric Mountains or are relatively water-permeable areas.

Table 13 *Caves with more than 25 stigobionates (A) or 25 troglobionates (B). From Culver and Pipan (2013), with additional data from other sources ((Source: Encyclopedia of Caves and Karst Science, 2004)*

Name	Country	No. of species	Notes
A. Stygobionts			
Vjetrenica	Bosnia and Herzegovina	56	Dinaric karst
Postojna Planina Cav System	Slovenia	48	Dinaric karst
Walsingham Cave	Bermuda	37	Anchialine cave
Triadou Aqujifer well	France	34	Phreatic
Robe River well	Australia	32	Phreatic
Cross/Cold Cave	Slovenia	29	Dinaric karst
Logarček	Slovenia	28	Dinaric karst
Šica-Krka system	Slovenia	27	Dinaric karst
Edwards Aqjuifer well	Texas, USA	27	Dinaric karst
B. Troglobionts			
Postojna Planina Cave System	Slovenia	36	Dinaric karst
Postojna Planina Cave System	Slovenia	36	Dinaric karst
Cueva de Felipe Reventón	Canary Islands, Spain	34	Lava
Mammoth Cave	Kentucky, USA	32	Longest cave

Cueva del Viento Spain	Canary Islands,	32 L	
Vjetrenica	Bosnia and Herzegovina	47	Dinaric karst

Compared to the surrounding caves, with the richest cave system - Postojna Mountain Cave System with 49 stygobionts and 33 troglobionts, Vjetrenica cave leads the list in terms of the richness of stygobionts and troglobionts. This data is indicative of the importance of Vjetrenica cave in its uniqueness given that the number of endemic species is far higher in this cave than anywhere else.

Compared to the Skočjan Caves which are on the UNESCO list, where living conditions are such the underground fauna is much poorer than the surface ones. With the exception of troglophilic species, such as bats that feed outside and rest only in caves, all terrestrial cave animals are tiny, rarely reaching a length of one centimetre. Beetles (Coleoptera) are the most numerous, such as Carabidae, *Anophthalmus spp., Leptodirus hochenwartii* and others, even tinier relatives. Many species in the underground belong to the orders Araneae (spiders) and Pseudoscorpionids (pseudoscorpions), while the snow-white *Titanethes albus* (Koch, 1841) is one of the most commonly seen troglobionts.

The situation in groundwater is similar, the only exception being that the troglobionts here are represented by a "giant" cave salamander (*Proteus anguinus* (Laurenti, 1768)) that can be longer than 20 centimeters. Also, various species of crustaceans predominate in the waters, both in terms of the number of species and the density of distribution. Crabs (*Astacus astacus*) are only occasional migrants, the most numerous of which are small crustaceans (Copepoda), with body size of about millimetre, followed by isopods (Isopoda) nd amphipods (Amphipoda). Blind amphicodes are the most diverse group; the smallest species are only two millimetres long, while those of two millimetres or longer are relatively large.

Therefore, compared to Vjetrenica, Škocjan Caves have far poorer underground fauna. Vjetrenica Cave has far more numerous species that specialise in cave life without contact with the aboveground part. As the Vjetrenica cave, in addition to the extremely rich underground world, also has a significant paleontological and/or archaeological value, this is another characteristic that can be referred to as a higher value in relation to the Škocjan Caves or any other cave in the world.

The importance of Vjetrenica cave, in addition to the rich fauna, is reflected in the richness of the sites of extinct species that have an important place in the evolution and understanding of life. In the cave itself, paleontological remains of the entire skeleton of a leopard (*Panthera pardus* Linnaeus, 1758), the bear Ursus sp. and *Ursus arctos priscus* (Goldfuss, 1818), rodents (Microtinae) and bats (*Rhinolophus ferrumequinum* (Schreber, 1774)).

Sket et al. (2004) suggest that part of the explanation for high subterranean species diversity in the Balkans, and the Dinaric Mountains, in particular, is its long and complex geological and evolutionary history, especially the proximity to the Adriatic Sea, which was a source of subterranean colonists during the Messinian salinity crisis when the Adriatic and Mediterranean Seas dried-up. What is certain is that cave Vjetrenica is globally important as a centrepiece of subterranean biodiversity for its richness and unique.

3.3 Draft Statement of Outstanding Universal Value Brief synthesis

State party:	Bosnia and Herzegovina
State, province or region:	Herzegovina-Neretva Canton, Ravno
Name of nominated property:	Vjetrenica Cave, Ravno
Geographical coordinates to the nearest second:	N 42° 50' 45" E 17° 59' 1"

Textual description of the boundary of the nominated property

Vjetrenica is a complex cave system with passage length of 7.323,9 m; as such, it is the second longest cave in Bosnia and Herzegovina. The cave consists of the main passage of Upper Vjetrenica, about 2,500 m in length, and numerous side passages, the most important being: Lower Vjetrenica, Absolon's upper and lower passage, Radovanović's passage, Leopard's passage, Wales passage and Ravno passage named after the nearby settlement of Ravno.

It is located within the protected landscape "Vjetrenica-Popovo polje". Cave Vjetrenica sits in the area of the south Dinaric karst, in a karst hill stretching from the outhern edge of the western part of the Popovo polje plains (Eastern Herzegovina) to the Adriatic Sea. Its entrance is located on the very edge of the Popovo polje plains, 300 meters east of the central part of the village of Zavala, at 260 meters above sea level, 12 km by air to the Adriatic Sea (Republic of Croatia). The main direction of the cave passages is south – southeast, or in the direction of the coast. Noteworthy, the cave is located in the immediate hinterland of the city of Dubrovnik, a leading tourist hub. In addition to Vjetrenica, the cave system includes the Lukavac spring, located below the entrance to Vjetrenica, and the smaller Bjelušica cave, above the entrance to Vjetrenica.

The cave has several permanent and disappearing streams and lakes, the largest some 180 m in length. It abounds in countless stalactites, flowstone, draperies, cascades and other cave formations. Also, it is it is one of the richest caves in the world in terms of its biological diversity, officially ranked as second, with 85 troglobionates. So far, over 231 cava taxa have been identified, of whitch over 65 stenoendemic. The remains of eight fossilised animals have been recovered in the cave, the largest being the cave bear (Carnivoria, *Ursus spelaeus* Rosenmüller, 1794) and one full skeleton of a leopard (Carnivoria, *Panthera pardus* (Linnaeus, 1758)). The rocks at the entrance to the cave have two carved stones, with drawings typical of medieval tombstones in the region. In scientific terms, Vjetrenica has been the site of numerous different forms of research, dating as far as back to the 16th century. In his work Historia Naturalis published in 77, Pliny the Elder makes a first reference to Vjetrenica in the mid-1st century a.d., with many references to follow by other authors, such as Getaldić. Systemic scientific research, however, will start only in late 19th century with Groller (1889), Vavrović (1893), Katzer (1903) and others. Vjetrenica Cave was adjusted for tourist purposes even before 1940, with extensive works and lighting introduced

in 1964, including a passageway of as many as 1800 meters long, and lighting in the length of 1050 meters, including a nearby motel built to accommodate tourists. The cave suffered major devastation in the period from 1991 to 1996, during the war.

Criteria under which property is nominated (itemize criteria)

Criterion vii - to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

The cave system of Vjetrenica and its surroundings are exceptional and well-conserved manifestations of Karst topography. It reveals a broad range of karst features with its exceptional scale and aesthetic quality. Almost all passages in Vjetrenica are wide and high in their entire length. The cave consists of several passages that could be grouped into four levels: Main Level, Upper Level, Lower Level and Vertical Level. The Main Level is semi-horizontal and the longest in the cave. It runs from the cave entrance almost to the furthermost point of the cave. This is also the level with the longest and widest passages in the cave: Main Passage (Glavni kanal) and Main Hidden Passage (Skriveni glavni kanal). Even with the debris on the cave floor, untypical horizontality of that level caused differences in views over the direction of the slope (and the direction of the former water flow) of the main part of the cave. The Lower Level is approximately 10 to 30 meters lower than the Main Level, comprising the Lower Lake (Donje jezero), Karaman's Lake (Karamanovo jezero), Absolon's Lower Passage (Donji Apsolonov kanal), Absolon's Upper Passage (Gornji Absolonov kanal) and Radovanović's Passage (Radovanovićev kanal). These passages are grouped in the first part of the cave, up to approximately 600 meters from the entrance.

The Upper Level consists of five passages – the Leopard Passage (Leopardov kanal), High Flowstone Passage (Visoki zasigani kanal), Platy Passage (Pločasti kanal), Wales Passage (Velški kanal) and Ravno Passage (Ravanjski kanal). These passages are some dozens and up to 120 meters higher than the Main Level, and sit at 1700 to more than 2500 metres from the entrance. An assumed, but undetected, fourth level – the Vertical Level of the cave is believed to consist of deep pits that lead from the surface of the terrain to the cave. Despite speleologists' efforts, none of these pits were found. The main proof of the pits' existence is the air movement at the entrance and inside the cave. Milosavljević (1979), from an unknown source, references 13 m/s as the highest speed of the wind at the entrance, while the highest recorded speed during the recent mapping of Vjetrenica was 8.5 m/s (Lučić & Sket 2003). Such a strong 'wind cave' is possible only in caves with multiple entrances situated at different heights. The movement of air is caused by differences in air pressures and temperatures between the open atmosphere and underground cavities and air velocity is fastest in narrow passages (Bögli 1980). During high waters, when the sump in the Main Passage is completely flooded, there is no wind at the entrance (I. Lučić, 2009, pers. comm.). In other words, pits are connected with a cave beyond the approximate 1000 metres from the entrance, where the sump is. Due to the topography of the hill above the cave, those pits should be at least 160 m deep to be connected with the known parts of the cave.

Several smaller streams, both permanent and intermittent, exist in the cave. Directions of the flows are on course towards or opposite of the entrance. There are also several water pools, the largest

of which is the Great Lake (Veliko jezero) with some 180 m in length, and a few sumps that occasionally close some of the passages (Lučić & Sket 2003). The walls and ceiling of the cave are only sporadically covered with flowstone, in the form of thinner or thicker flowstone coating. Dripstones (stalactites and stalagmites) are rare in the cave due to the most prominent process present in the cave – breakdown. Breakdown is a mechanical failure of rocks comprising the walls and ceiling of the underground cavities (Ford & Williams 1989).

The floor of almost the entire cave is covered with angular rocks of different size mixed with clayish sediment. Several sizable chambers are almost entirely filled with rock blocks, slabs and chips, in the form of piles tens of meters high. It is almost certain that rock breakdown at some points choked the passages by completely filling these and cutting the way into other unexplored parts of the cave. A good example of a breakdown choking the passages is the entrance into the widest passage – the Main Hidden Passage. The entrance that leads through the boulders is only some 50 x 50 cm. In addition to carbonate clasts, large quantities of clay are also found on the cave floor. According to Radovanović (1929) and Malez (1985) there are two different ages of clay. The older clay lays under the breakdown rocks, covered by the more recent clay. Scallops are spoon-shaped depressions created by a fast-turbulent water flow. Their shape could be used to determine the direction of paleoflow in relict caves (Ford & Williams 1989). In front of the cave entrance is a karst plain named Popovo polje. The Trebišnjica River, the largest European sinking river, passes through the plain. Before hydrotehnical interventions in the middle of the 20th century, Popovo Polje was flooded on an average 253 days a year (Milanović 2006). The hydrological function of Vjetrenica in the past caught attention of many researchers. Some of the authors agree that Vjetrenica had a function of a swallow hole for water from the Popovo Polje (Absolon 1916, Radovanović 1929, Cvijić 1950, Malez 1985, and that the cave spread all the way to the Adriatic coast. Milojević (1928 1938 and Zubčević & Gašparović (1958, however, argue the opposite – that water from Vjetrenica flows into the Popovo polje. The main argument in both points was the topography of the cave bottom from the entrance to the Great Lake. The problem was that the map drawn by Radovanović (1929) shows a slope in the direction inside the cave while maps drawn by Milojević (1938) and Zubčević & Gašparović (1958) show a slope in the direction of the cave entrance. The last map of the cave is the one published by Lučić & Sket (2003). According to that map, the entrance of the cave lies at some 8 metres above the Great Lake which is further at a distance of 1200 metres. In the Four-state Model (Ford & Williams 1989) of differentiation of phreatic and water table types of caves, Vjetrenica belongs to caves with a mixture of phreatic and water table levelled components, close to the ideal water table cave.

Criterion x - to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation

Vjetrenica is a remarkable and the most unique cave, located in the Popovo polje, a karstic plain in the south of Bosnia and Herzegovina. It is quite a sizable cave – more than 6000 meters have been explored, with several subterranean lakes (one is 180 meters long); and it has been known since Antiquity (Pliny the Elder makes a reference to the cave in his Historia Naturalis). It earned its name (vjetar = wind) thanks to a strong cold wind at almost all times. Yet, biodiversity is what

gives it its uniqueness: while most caves on the planet harbour only a handful of animal species, Vjetrenica has the unique feature of sheltering more than a hundred, and is likely the richest in the world in terms of biodiversity. Among these cave species, more than half are endemic in the Popovo polje, while others are only know to inhabit Vjetrenica.

Vjetrenica is one of the most faunistically rich caves in the world (Culver & Sket, 2000), due to its biogeographical position in the Dinaric karst, its size, and ecological heterogeneity. It is also one of the world's most prominent biodiversity hotspots for cave-dwelling fauna. In fact, 231 taxa were detected in Vjetrenica: two types of bacteria, 14 fungi, 35 protista and 180 animals, with 96 cave-dwelling taxa *Nitrospira (1), Gammaproteobacteria (1), Trematoda (1), Enopla (1), Gastropoda (11), Bivalvia (1), Hydrozoa (2), Amphibia (1), Myriapoda (8), Insecta (11), Entognatha (4), Crustacea (36), Arachnida (9), Polychaeta (1), Oligochaeta (7), Hirudinea (1),* and together with Lukavac spring and Bjelušica Cave, as parts of its system, Vjetrenica is a type locality for 38 taxa, of which 14 are strictly endemic, and tree are monotypic: *Zavalia vjetrenicae* ((Radoman,1973))(*Gastropoda*), *Troglomysis vjetrenicensis* ((Stammer, 1933)) (*Crustacea*) and *Nauticiella stygivaga* ((Moravec & Mlejnek 2002))(*Coleoptera*). Vjetrenica is inhabited by more than 49 troglobites and 56 stygobites.

Further monotypic genera, found in other speleological objects of the Popovo polje include: *Spelaeoconcha paganetti* (Sturany, 1901) (*Gastropoda*), *Marifugia cavatica* (Absolon & Hrabe, 1930) (*Polychaeta*), *Velkovrhia enigmatica* (Matjasic & Sket, 1971) *(Hydrozoa*), *Stalitella noseki* (Absolon & Kratochvíl, 1933) (*Araneae*), *Dinaria vjetrenicae* (Hadži, 1932) (*Opiliones*), *Typhlogammarus mrazeki* (Schaferna, 1907) (*Crustacea*), *Spelaeocaris pretneri* (Matjasic, 1956) (Crustacea) and *Proteus anguinus* (Laurenti, 1768), (*Vertebrata, Amphibia*).

Among the veterinary fauna, some taxa stand out, in particular: *Velkovrhia enigmatica (*Matjasic & Sket, 1971), the only one species of the genus, the only freshwater species of the family Bougainvilliidae and the only troglobiont species of Hydrozoa (Sket 2003). Congeria kusceri (Bole, 1962) is a living fossil, the only one of the hundred or so extinct species of congeria that peaked in the Upper Miocene, and which inhabited the freshwater remnants of the Dinaric and Pannonian seas in the Pliocene, and the only stigobiont shellfish (Bivalvia). *Marifugia cavatica* (Absolon & Hrabe, 1930) is the only freshwater serpulide (Serpulidae) and the only stigobiont tubeworm (Polychaeta) (Sket 2003).

Pholeoteras euthrix (Sturany, 1904) is the only known snail from the Cyclophoridae family in Europe, a relic of old tropical fauna (Sket, 2003).

Dina absoloni (Johansson, 1913) is the first discovered stigobiont species of leech (Hirudinea) in the world; *Proteus anguinus (*Laurenti, 1768) the well-known olm, is the only European troglobiont vertebrate. With as many as ten species of the genus *Niphargus* (Amphipoda), biological diversity of Vjetrenica is explained as a phenomenon of local radiation, not yet recorded in the world underground (Sket 2006). *Hadzia fragilis* (Karaman, 1932) (Amphipoda) is a typical species of crustacean for the genus *Hadziidae*. Vjetrenica is home to three troglobiont species of ten-legged crustaceans (Decapoda), of which two species of the genus *Troglocaris* (*T. anophthalmus* (Kollar 1848), *T. hercegovinensis* (Babić, 1922) and the only species of the genus *Spelaeocaris, Spelaeocaris pretneri* (Matjasic, 1956).

Vjetrenica Cave is a typical site of many invertebrates that exclusively inhabit the Vjetrenica system (according to Ozimec and Lučić, 2010). According to the data, as many as 14 of the 38 species for which the Vjetrenica system is a typical site are endemic to the Balkan Peninsula or are an endangered or vulnerable species.

Statement of integrity

The area of the Vjetrenica cave and its surroundings adequately represents both natural and cultural, terrestrial and aquatic features, as well as processes of importance for the long-term conservation of the rich biodiversity and exceptional natural beauty. Vjetrenica Cave is the most important and unique element of biodiversity of this part of the region. The area around the Vjetrenica cave also protects all major terrestrial vegetation species and important species habitats. The nomination of the Vjetrenica cave will include all the features that make up the outstanding universal value of the property. In addition to an internationally renowned site of Vjetrenica Cave, the nominated area includes lesser-known and as yet unexplored sites. We are thus in a position to permanently maintain the integrity of the designated property with the help of existing protective measures and safeguard provisions.

Vjetrenica Cave is a complex underground system that has not yet been fully explored, offering exceptional opportunities for further exploration of the karst underground of the Dinarides, primarily along the lines of physical speleology, geology, hydrology, ecology, biospeleology, paleontology, archeology; but also underground climatology, tectonics and more. Research brings us new insights about caves themselves, hydrogeological and ecological relations, the present living world extremely rich endemic species and many other aspects important for this area, but also for the community as a whole.

The main threats to the integrity of the property include a wide range of anthropogenic influences (physical devastation, changes in the habitat and ecology of the cave, waste accumulation, collection and disturbance of cave fauna, uncoordinated urban development, population growth in the area above and around caves, old infrastructure, illegal interventions at springs and tourist pressure). Total property compliance, and in particular the relationship between urban projects and landscapes, is sensitive to lack of proper control of new development.

Protection and management requirements

Vjetrenica Cave belongs to the system of karst area that is the most environmentally endangered in Bosnia and Herzegovina. The natural beauty of this cave has been recognised since ancient times. However, systematic forms of protection of Vjetrenica appeared only in 1952 when, in accordance with the then law, it was declared a natural monument (Decision of the Institute for the Protection of Cultural Monuments and Natural Rarities of the People's Republic of Bosnia and Herzegovina, No. 979/52 of 25 December 1952).

The 1981-2000 Spatial Plan of BiH for the period, which remains in force until the adoption of the Spatial Plan for the Federation of BiH, due to its cultural and natural heritage significance, protects the wider area of the Zavala-Slano wave as a special natural landscape (Article 115, Official Gazette of the Federation BiH, No. 2/06).

The Ravno Municipality has adopted the Spatial Plan, as a basis for the protection of Vjetrenica. It protects a wider area surrounding the cave and defines it as a “special natural area”, and its irregularly shaped entrance as a “landmark world heritage”.

Despite the lack of documentation required for all World Heritage sites, the Vjetrenica Cave was inscribed on the UNESCO Provisional Natural Heritage List on 22 November 2004 as a natural monument, and on 11 December 2007 the same was done for the Vjetrenica cave with the architectural ensemble of the village of Zavala.

According to the current 2003 Law on Nature Protection, which is in line with the EU Directives, the Vjetrenica cave is entrusted to the competence of the regional administration or cantons. Classification process in this category would require determining the status of the Vjetrenica cave as a protected area.

According to the Law on Nature Protection of the Herzegovina-Neretva Canton (Official Gazette of the Herzegovina-Neretva Canton No. 12/17) Vjetrenica cave with its surroundings in the wider area of the Popovo polje is declared a Protected Landscape. Such a change in the mode of protection of this area is a consequence of new findings and the coherence and connectivity of the area which is of importance for the Vjetrenica cave itself.

In 2021, with the decision to declare this area as a protected landscape "Vjetrenica - Popovo Polje", this area receives formal legal protection, respecting all legally formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina.

Zoning of a protected area is a key instrument and a basic step in planning the use and management of the space, which should ensure the preservation of the value of the protected area. The zoning process divides the areas into zones with different conditions of use according to the objectives of protection, existing use and needs for the development of the area. Zoning is performed from the degree of protection of the area in the range from the zone where almost no human influence is allowed, to the zones of more intensive use where the natural space within the zone can be significantly altered. Zones are determined in accordance with the degree of protection determined by natural habitats and animal communities and permitted human activities in a particular area. All zones provided for in the zoning system do not have to be represented in every protected area.

The Vjetrenica Cave is located in the very nucleus and its protection is guaranteed by implementation of the Law on Protected Landscape Vjetrenica-Popovo polje.

Since the state of flora and fauna in caves depends on the quality of groundwater that flows into them, this segment of space was taken as an important criterion in defining boundaries and zones. In addition, based on the analysis of natural and cultural values of the area, the priority components have been defined due to which the area is gaining in value and thus it is possible

to include it in the wider local and international level.

The protected area of the Vjetrenica cave has features of international, federal or cantonal significance with emphasized landscape, educational, cultural-historical and tourist-recreational values. Economic and other activities and actions that do not endanger its essential properties and role are allowed in the protected area.

Vjetrenica remains rather protected and preserved, despite being a sizable speleological facility consisting of numerous habitats, especially aquatic ones, all under the hydrological influence of precipitation and groundwater from the surrounding topographic surface or impact area. In this regard, the area above Vjetrenica should be managed with due care, and so far no allogeneic watercourses have been observed. There are several smaller villages in the area of the impact zone, suffering from extreme depopulation and with very few older households remaining, dealing exclusively with the traditional agriculture. There is no significant use of pesticides or fertilisers with increased nitrate content. There is no developing industry or exploitation of natural raw materials in the impact area.

Vjetrenica Cave

Name and contact information of the official local institution / agency:

Public company "Vjetrenica" d.o.o. Straight

Address: Trg Ruđera Boškovića bb
Tel: +387 36 891 034
Fax: +387 36 891 034
E-mail: info@vjetrenica.ba
Web address: www.vjetrenica.ba

Properties for inscription on the World Heritage List

Identification of the Property Vjetrenica cave

Country (and State Party if different) Bosnia and Herzegovina

State, Province or Region Federation Bosnia and Herzegovina

Name of Property Vjetrenica Cave

Geographical coordinates to the nearest second

The protected area of Vjetrenica cave is located in the extreme south-southeastern part of Bosnia and Herzegovina, ie it extends within the following astronomical and geographical determinants: - the northernmost point: ϕ = 42 ° 51 ’13” N; λ = 17 ° 57 ’08” E (locality: Tower); - southernmost point: ϕ = 42 ° 47 ’50” N; λ = 18 ° 00 ’12” E (elevation: Knež Do - 546 m); - westernmost point: ϕ = 42 ° 49 ’12” N; λ = 17 ° 54 ’08” E (locality: Ružni dolac); - easternmost point: ϕ = 42 ° 47 ’02” N; λ = 18 ° 01 ’40” E (elevation: Kujino Osoje - 742 m)

4 State of conservation and factors affecting the nominated property

The state of conservation of the nominated property is described along with a buffer zone. The state of the nominated property is excellent. It is the given conservation of the habitat that has conditioned the development of a rich and unique living world, which is why the Vjetrenica cave has been marked worldwide as the Dinarides Cave Biodiversity Center.

4.a Present state of conservation

The Popovo Polje plain is the buffer zone of Vjetrenica cave and belongs to the forest area of Europe by its hytogeographic location. Centuries of human interventions in the buffer zone of

the Popovo polje have led to degradation of the primary ecosystem and differentiation of different types of habitats. Thus, habitat such as forests, wetlands, all shrubs, karst meadows, meadows and pastures, gardens, fields, arable land are now clearly differentiated in this area.

In the area of buffer zone Popovo field has numerous of secondary ecosystems (meadows and pastures). Tertiary ecosystems in the context of settlements are also present, in addition to the fact that the buffer zone Popovo field is a rural, with few settlements and a very limited demographic structure. Detailed monitoring is listed and elaborated in the Protected Landscape Management Plan "Vjetrenica-Popovo polje".

The area iof nominated site and the buffer zone is protected in accordance to the Law on Nature Protection of the Herzegovina-Neretva Canton (Official Gazette of the Herzegovina-Neretva Canton No. 12/17). Vjetrenica cave with its surroundings in the wider area of the Popovo polje is declared a Protected Landscape. Such a change in the mode of protection of this area is a consequence of new findings and the coherence and connectivity of the area which is of importance for the Vjetrenica cave itself. In 2021, with the decision to declare this area as a protected landscape "Vjetrenica - Popovo Polje", this area receives formal legal protection, respecting all legally formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina. The current condition of the state is remain unchanged for the last decade ect, since the Jugoslavia war were minor change in enetery hall has occured.

4.b Factors affecting the property

Each environmental unit, including the area of the Protected Landscape / LandscapeVjetrenica - Popovo polje, is built of landscapes, which consist of four basic elements: relief, vegetation, water and anthropogenic elements (civilization tradition). Anthropogenic influence is crucial and present not only in the elements of the civilization tradition, but in all elements of the landscape.

Although traditional management is not exclusively positive for the preservation of landscape values and there have been major or minor devastations within these systems in the past, especially between the 17th and 20th centuries, we can say that positive elements of landscape conservation dominate. That this spatial management is not an automatic mechanism has become especially evident since the second half of the 20th century, when the pronounced depopulation of rural space and the neglect of existing landscapes began. There are many reasons why the management of the existing landscapes in the area of Vjetrenica - Popovo polje and their preservation is in the interest of the entire local community, but also the whole of Bosnia and Herzegovina. We can define eight basic ones:

1. Primary quality of space

2. Aesthetic value of space

3. Economic value of space

4. Preservation of ecological systems

5. Habitat (biotipe) conservation

6. Conservation of the living world (biodiversity)

7. Ethical commitment to future generations

8. Ethical obligation to the international community.

Table 14 *Identified pressures and threats in the Popovo polje protection zone with prominent trends*

Pressure factors	**Type of endangered ecosystem**	**Mode of pressure**	**Justification**
Agriculture - use of fertilizers and pesticides	Arable cosystems and meadow ecos ystems	Intake of nutrient components in ecosystems (artificial feeding) The use of pesticides Creating eutrophication	Relatively low population due to negative demographic trends and relatively small agricultural area in coverage causes the pressure to decrease
Sewage system	Aquatic and terrestrial ecosystems, ecosystems of water protection zones and phreatic zones	The organic overload of this ecosystem, which due to undeveloped sewage infrastructure remains in the vicinity of a point discharges of waste water, if it is discharged into the natural recipient of the soil, or diffused if the waste water is discharged into a nearby watercourse Groundwater pollution by faecal bacteria The ppearance of unpleasant odours	Sewerage system in the entire coverage area is not adequately addressed (except in the area of Zavala)

Illegal landfills	Forest ecosystems, aquatic ecosystem	Pollution of these ecosystems due to inadequate waste disposal contamination and further dispensing of surface and ground water Permanent contamination of soil due to waste disposal as strain to water - the degradation of the habitat Disturbance to visual and aesthetic value of the area	A large number of illegal landfills on the area which covers the service of collection and disposal of municipal waste, and the emergence of new illegal landfills in he cleaned areas due to lack of awareness of people about the need to protect the environment are indicative of an increasing trend
Tourist activities	Vjetrenica cave ecosystem and surr ounding surface part	Converting land for the expansion of tourist facilities and tourist attractions in scope, construction of new tourist facilities Una uthorised tourist activities (off-road driving, removing valuabl e plant species) Illegal activities of the local population (removing valuable species)	The trend of increase in pressure is a result of higher intensity of tourist activities and active work to increase the tourist offer
Existing transport infrastructure	Meadow and forest ecosystem	Disturbance to timid species (deer, rabbit, squirrel, various species of birds)	The trend is constant since the intensity of traffic in this area is constant too
Development of transport infrastructure	Underground water	Possible changes in the flow of underground water, the level and quality	The trend of constant pressure due to maintenance and works on existing roads, but considering that the plan is to develop transport infrastructure, the pressure trend will certainly be on a rise
Illegal hunting and fishing	Forest ecosystem and meadow ecosystems	Illegal hunting	The trend of falling pressure as a result of the adoption of laws and

		Threat of ichthyofauna due to fishing in the forbidden period (spawning) Intense illegal hunting and fishing can result in unbalanced relationships in the food chain of the fauna Introduction of nonnative species for hunting and fishing	regulations that prescribe the manner in which the natural resources are used, managed and kept

However, the presence of a wealth of species and habitats in the area of the Protected Landscape / Landscape Vjetrenica - Popovo polje indicates the high specialization of the area. The presence of species from the Habitats Directive and the European Union Birds Directive confirms that this area is also of national, regional and global importance for the protection of species and habitats from the aspect of aboveground fauna.

Any changes in ecosystems and habitats ultimately also affect changes or a degenerative change in the cave ecosystem. The pressure on ecosystems would be any kind of impact that could endanger the ecosystems or cause lasting changes in the ecosystem, as follows:

- Morphological changes of habitats (due to degradation of natural values);
- Changes in habitat quality (pollution);
- Functional changes of habitats and the wider environment (fragmentation of habitats and increase of marginal effect);
- Changes in the structure of communities (due to introduction of invasive species).
- Ecosystem pressures can generally be broken down by origin or type of event into:
- Natural pressures
- Anthropogenic pressures.

➢ Natural pressures can occur in the form of rare catastrophic natural phenomena such as: floods, fires, earthquakes, landslides, etc. Also as natural low-intensity natural processes such as natural erosion processes, washing down of nutrients into the soil due to steep terrain, natural selection, natural extinction of species, etc.

Anthropogenic pressures are those that arise as a result of various human activities in an area, such as:

- Agriculture (causes the introduction of nutrients into ecosystems and the use of pesticides);
- Urbanisation (leads to the creation of municipal wastewater, industrial wastewater and technological processes, washing down from unsanitary and illegal landfills of municipal waste);
- Inadequate disposal of hazardous and non-hazardous waste, occurrence of illegal landfills for municipal waste, as well as illegal construction and usurpation of

space);

- Tourism (construction activities on tourism capacity building, direct use of natural resources in equipping tourism facilities, irresponsible tourist behaviour and unregulated tourism activities such as off-road driving, illegal plant harvesting or plant theft by uprooting, means of transport for tourists may increase the risk of introduction of allochthonous (foreign) and invasive species, and the behaviour and frequency of human presence can cause behavioural disorders in animals, etc.) Existing infrastructure and use (transport, water and energy infrastructure);
- Planned construction of new infrastructure;
- Economic activities in the protected area (forestry activities, deforestation and inadequate timber removal) as well as excessive/illegal hunting and fishing;
- Other activities of the local population (such as emissions from combustion or forest fires caused by the negligence of the population/picnickers);

Natural pressures have a lower rate of invasiveness to protected areas than anthropogenic ones for the following reasons: (i) these are either very rare (ii) or occur with very low intensity over a long period for which species can adapt to newly created conditions.

In addition to the listed possible threats to ecosystems, in the protected area, due to the high intensity of pressure of anthropogenic origin, these can lead to the loss of basic values of the area, which led to the placement of a certain area under protection. Conservation areas are the most common centrepieces of the following: genetic and specific diversity, biocenosis diversity, morphological diversity, biotopes and/or habitats of endemic species, and often represent national reserves of these values, so pressure on protected area ecosystems should be reduced to at least ecosystem tolerance levels. Detailed monitoring is listed and elaborated in the Protected Landscape Management Plan "Vjetrenica-Popovo polje".

4b.i. Development Pressures and managment response

Pressures from agriculture are at a minimum level and it is necessary to encourage the development of agricultural activities in the wider area. With the disappearance of agricultural activities, grasslands and all their biodiversity are disappearing, as well as the cultural landscape marked by them. All the biodiversity of old varieties and breeds is disappearing.

HNC has rich mineral ore resources, but the existence, knowledge and research of ore-rich localities is not enough for the long-term development of industries that require the use of ores. Of the mineral resources of the Municipality of Ravno, deposits of building and decorative stone have been registered at a total of two locations, with a total area of about 75 ha. In the vicinity of the Zaplanik settlement, the Repinac exploitation field, the exploitation of limestone mineral raw material as a technical-construction material has been approved. Rare occurrences of bauxite have not been seriously investigated. No data were found in the literature or in the field on the existence of surface mine mines or the exploitation of underground minerals on the Vjetrenica - Popovo field. The position of areas on which, according to the spatial planning documentation, it is possible to use mineral raw materials is far away, and it is clear that such

areas do not exist in the area covered by the Protected Landscape. There are no mineral mines in the protected area.

Sewage system

There is no organised wastewater treatment and treatment system in the Ravno Municipality. Due to small settlements and short mutual distance characteristic of the Ravno Municipality, the plan is to build three separate sewerage systems, as follows:

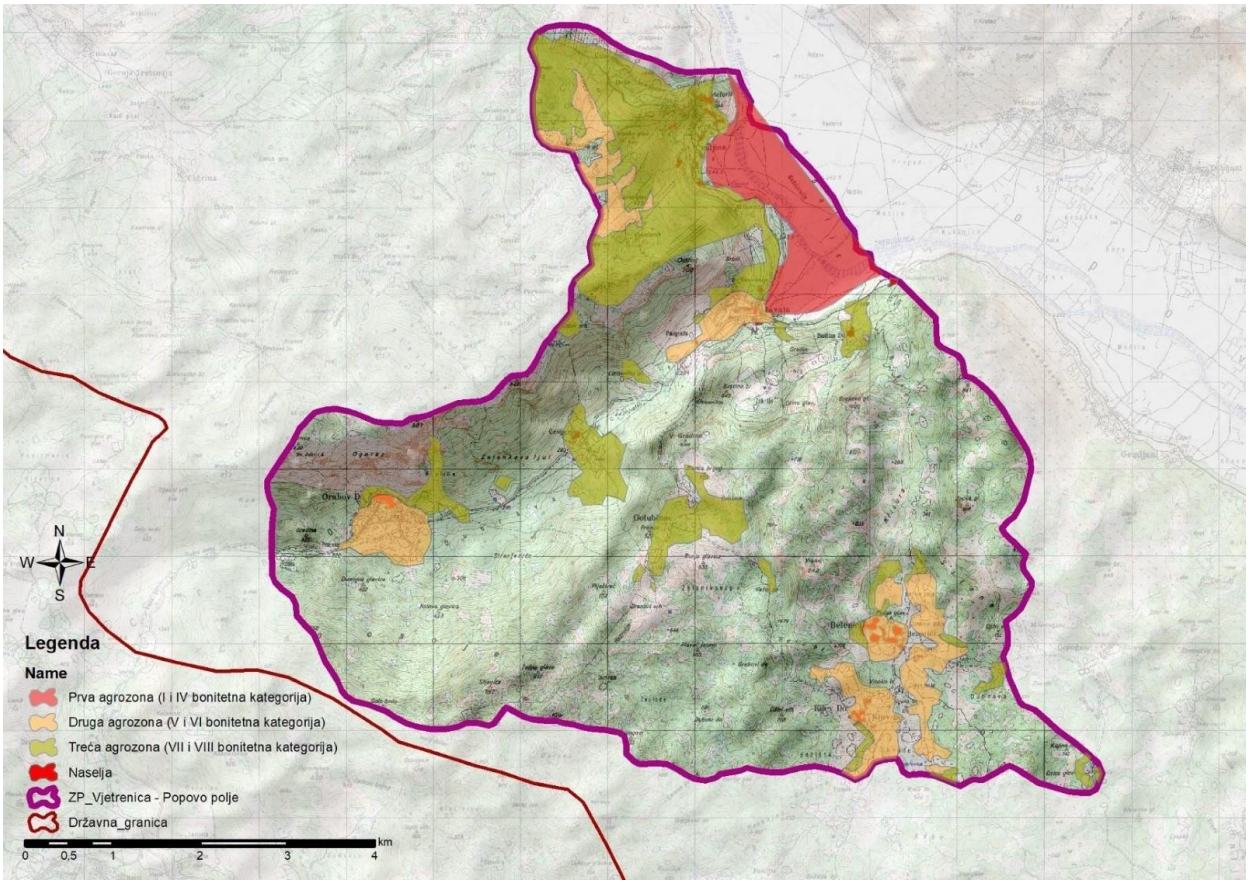
- Ravno system
- Ivanica system and
- Ledenica tourist zone system.

In 2010, a filtering facility was built in Zavala as part of the public toilet for visitors to Vjetrenica. During the construction of the tourist facility Ledenice, water purifiers were installed, which will be replaced with the completion of the construction of a separate drainage and water purification system for the settlement of Ivanica.

Agriculture

According to the Herzegovina-Neretva Canton Spatial Plan, agriculture is a key element of the economy of the Herzegovina-Neretva Canton, which must be fully modernised, specialised and developed on the market. It should be noted that in the entire territory of the Herzegovina-Neretva Canton, category II land is registered only in the municipalities of Ravno and Čapljina, or, in percentages, 0.52% of the total land (2,285.86 ha). The Ravno Municipality is entitled to 27.58% (650.56 ha) of the highest quality agricultural land. The pedological map shows the credit rating categories of agricultural land and their distribution in the proposed protected area Vjetrenica-Popovo polje, where it can be clearly seen that lands and agrozones (I-IV rating category) registered in the area around the villages Zavala and Čvaljina are defined as land intended exclusively for intensive agricultural production. The second agrozone (V and VI rating categories) includes land defined as land intended for semi-intensive agricultural production. Such lands are located in the settlements of Orahov Do, Kijev Do and Belenići. Most of the land of the proposed protected area Vjetrenica-Popovo Polje belongs to the III agrozone (VII and VIII rating category), or defined as land for intensive agricultural production (Map 16.).

In Ravno, agriculture is almost completely neglected due to small size of arable land and fragmentation of agricultural land and unorganised production. Natural and created potentials are not used, which leaves an open opportunity for development of production, especially in the production of healthy food.



Map 14 *Land capability classes of agricultural areas within the scope of protected area Vjetrenica - Popovo polje*

Illegal landfills

In the Herzegovina-Neretva Canton, the strategy for municipal waste management has not yet been determined, nor have macro-locations with facilities for the control of municipal waste been identified. As there is no waste control system, it is impossible to conduct an indicative assessment of generation, movement and disposal of municipal waste. Municipal waste includes household waste and production and/or service waste with a similar composition as household waste. Specific quantities of waste per head range from 0.5 kg / day / inhabitants, which means that if it is assumed that there are about 600 to 800 permanent inhabitants, the amount of waste per year does not exceed 10 tonnes. In the Ravno Municipality, a significant number of illegal landfills has been registered that need to be tackled. The municipal landfill is outside the proposed scope of the future protected area. Field research has identified the problem of unintended waste disposal along the road within the area of Vjetrenica, mostly by participants in transport.

Tourist activities

Due to a prominent tourist-recreational function of the buffer area of the Popovo polje, the growing number of contents, development of programmes and services for visitors, it is possible to see negative consequences of tourism emerging. The negative consequences are related to excessive arrivals of visitors in a relatively small area (locality) in a relatively short period, which burdens the environment, especially natural and cultural values.

The main goal of the visit to the Popovo Polje protection zone is to educate visitors to minimise the impact on the environment within and outside the protected area. Visitors must be given the opportunity to have an experience as basis to understand and appreciate the natural and cultural-historical values of the area. These goals are achieved by the so-called organised system of visits. For an acceptable number of groups (so-called Acceptable Load Capacity), this includes a systematic order of ownership with sites/spots (info points, lookouts, caves), trails (instructional, cycling, walking), directions and transport means, duration of the visit, security measures, etc.

According to information obtained from representatives of Vjetrenica-Popovo polje Public Company, as the current managing authority of Vjetrenica cave, in 2009, an estimates were carried out in terms of the capacity of Vjetrenica cave, with a certain maximum number of visitors to the cave in a working day of 240 days. In the current conditions, the number of visitors to Vjetrenica cave rarely exceeds 100, mostly in cases of educational, school or research visits. As the process of planning the construction of tourist facilities and actively promoting Vjetrenica cave is underway, an increase in the number of visitors is expected. On the other hand, it is necessary to act in accordance with the data obtained on the basis of the assessment of the cave's capacity, and in no case is it advisable to exceed the permitted number of visitors or 240 during one working day.

4b.ii Environmental Pressures, natural disasters and risk preparedness

Based on the broad reference number used in compiling the Nomination Dossier, specific data are available on the impacts of climate change on various environmental parameters in Vjetrenica cave and the protected area. Various observations by experts have included several approaches to the risk and tendency of such impacts on a specific ecosystem such as Vjetrenica cave.

Climate change is expected to increase the frequency and magnitude of extreme events and related damage caused by floods, droughts, forest fires, heat waves and other climate hazards. It is also expected to reduce water availability.

Climate change is likely to have a strong impact on biotic components of the cave. Temperature deviations, precipitation anomalies, and an increased frequency of extreme events can lead to depletion of water resources and can cause serious consequences for ecosystems.

Changes in average rainfall can potentially affect ecosystems, biodiversity food production, water resource availability, and river flows, which are particularly important for cave habitat. Climate change impacts on the components of biodiversity are based on modified

environmental factors such as temperature and water availability and other, equally important factors, such as CO2, Radon, humidity, etc. Particularly sensitive species must adapt to changing conditions so that the structure of the ecosystem can change.

Natural disasters represent a problem over the long-term. Although disaster cannot be completely avoided, no preventive measures can be taken. Neither the protection zone nor the cave is experiencing extreme environmental conditions that could adversely affect the property or the planned protected zones. Special protective measures against earthquakes, floods, fires or other extreme climatic conditions are not necessary from today's point of view. The caves, however, are subject to natural processes of decay and erosion, which occur especially in karst areas. Therefore, preventive measures need to tackle the possible risk of collapse.

In the last few years, several small earthquakes have occurred in this area. According to the Hydrometeorological Institute of the Federation of Bosnia and Herzegovina, the area where the components are located is marked "earthquake zone 0". In other words, an intensity of 6.0 to <6.5 on the Richter scale can be achieved according to the level of risk used as a basis. However, the highest strength of seismic shocks ever recorded in the area was around 5 on the Richter scale.

S. Milojević (1928) argues that the Vjetrenica cave is the riverbed of the former tributaries of the Popovo polje and the river Trebišnjica. The low permeability of the lower karst horizons reflects water retention during floods in cave passages defined by the cave system, as evidenced by the formation of cave lakes and disappearing streams. At the time of increased inflow of cave waters, karst cracks raise water due to limited capacity, and at the time of reduced flow, they lower the level of karst. In this way, the level of karst waters in the cave passages pulsates vertically. This is caused by the disproportionate inflow and outflow of drained water through the inlet and outlet system connected by cave cracks.

Extreme pulsations of karst waters lead to a markedly increased amount of bad weather, which occurred in early October 2015, when a huge amount of precipitation came out of the cave basin of the Vjetrenica system; in just three days 270 mm/m2 of rain. As the lower passage of the cave system is less rocky compared to the middle and upper system, its capacity is limited and an upward pulsation of water is triggered, which caused the immersion of the central cave system (main passage) and even its entrance.

Excess water from the lower cave passages was markedly poured into the main cave passage, causing a flood that lasted from 12 to 16 October 2015. Flood waters swell through a vertical passage, leading to the lower Vjetrenica. The vertical passage took on the role of an abyss through which a huge amount of water swelled, squeezing out stone blocks weighing several hundred kilograms. These torrential waters passed through underground cracks towards the Lukavac spring, occasional tributaries of the Trebišnjica river. A huge amount of water came out as a torrent through the main spring Lukavac, estimated at about 8 m^3/s. The discharge of torrential waters lasted throughout the flooding of the main cave passage.

The consequences of the cave sinking are evident. In addition to the temporary disabling of infrastructure and facilities, on the middle tourist floor, the cave passages were affected by the cave shell in the form of boulders that slowed down the flow of water. The floods of the

Vjetrenica cave confirm the basic assumption that this is a separate karst system and that the system collects karst waters in the direction of the Adriatic Sea, where they end in the form of springs and towards the Popovo polje through a number of springs. Allegedly, the occurrence of floods is related to climate change and it is absolutely necessary to provide upstream regulation for higher water levels that can collapse parts of the cave.

As all caves are located in the forest or in the immediate vicinity of the forest, cultivation is required. Vegetation of protection zones does not constitute an integral outstanding universal value of the property. They are defined by the shape of the cave and the layers contained in them and the findings which, apparently, would not be affected by the forest fire.

Landscape conservation status

Since the cave landscape and its biodiversity are an important part of the Universal Value, its appearance and permanent shape are important aspects. To date, the nominated components remain largely intact. Only one part of the cave is open to the public and the rest has remained closed to the public and as such still represents a virgin natural phenomenon in its original state. The construction of additional buildings in the protection zone of the nominated cave, as well as the change from agricultural or breeding to commercial use requires explicit approval. Further development and settlement is not planned in the future. Statistics show that the size of the population and the form of land use in the area are stable.

Natural disasters / natural deterioration of the caves

Natural disasters represent a problem over the long-term. Although disaster cannot be completely avoided, no preventive measures can be taken. Neither the protection zone nor the cave is experiencing extreme environmental conditions that could adversely affect the property or the planned protected zones. Special protective measures against earthquakes, floods, fires or other extreme climatic conditions are not necessary from today's point of view (Figure 21.). The caves, however, are subject to natural processes of decay and erosion, which occur especially in karst areas. Therefore, preventive measures need to tackle the possible risk of collapse.

Earthquakes

In the last few years, several small earthquakes have occurred in this area. According to the Hydrometeorological Institute of the Federation of Bosnia and Herzegovina, the area where the components are located is marked "earthquake zone 0". In other words, an intensity of 6.0 to <6.5 on the Richter scale can be achieved according to the level of risk used as a basis. However, the highest strength of seismic shocks ever recorded in the area was around 5 on the Richter scale.

Figure 20 *Current tourist trail (Photo: M. Mazija)*

Climate change

Based on the broad reference number used in compiling the Nomination Dossier, specific data are available on the impacts of climate change on various environmental parameters in Vjetrenica cave and the protected area. Various observations by experts have included several approaches to the risk and tendency of such impacts on a specific ecosystem such as Vjetrenica cave.

Climate change is expected to increase the frequency and magnitude of extreme events and related damage caused by floods, droughts, forest fires, heat waves and other climate hazards. It is also expected to reduce water availability.

Climate change is likely to have a strong impact on biotic components of the cave. Temperature deviations, precipitation anomalies, and an increased frequency of extreme events can lead to depletion of water resources and can cause serious consequences for ecosystems.

Changes in average rainfall can potentially affect ecosystems, biodiversity food production, water resource availability, and river flows, which are particularly important for cave habitat. Climate change impacts on the components of biodiversity are based on modified environmental factors such as temperature and water availability and other, equally important factors, such as CO2, Radon, humidity, etc. Particularly sensitive species must adapt to changing conditions so that the structure of the ecosystem can change.

Flood

S. Milojević (1928) argues that the Vjetrenica cave is the riverbed of the former tributaries of the Popovo polje and the river Trebišnjica. The low permeability of the lower karst horizons reflects water retention during floods in cave passages defined by the cave system, as evidenced by the formation of cave lakes and disappearing streams. At the time of increased inflow of cave waters, karst cracks raise water due to limited capacity, and at the time of reduced flow, they lower the level of karst. In this way, the level of karst waters in the cave passages pulsates vertically. This is caused by the disproportionate inflow and outflow of drained water through the inlet and outlet system connected by cave cracks.

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Fires

As all caves are located in the forest or in the immediate vicinity of the forest, cultivation is required. Vegetation of protection zones does not constitute an integral outstanding universal value of the property. They are defined by the shape of the cave and the layers contained in them and the findings which, apparently, would not be affected by the forest fire.

Toursim is a branch of economy that in the modern development of this activity extends to almost all areas (in therms of space) and to all other activities, i.e. branches of economy and represents one of the backbones of development. Toursim is one of the most promising industries, which in the future, in addition to agriculture, will be the backbone of the development of this area. What especially characterizes the municipalitsy of Ravno is the Vjetrenica cave, the beauty of the landspace almost untouched by the modern civilization (the phenonomen of Popovo polje and river Trebisnjica). Vjetrenica Vace, located km form the centre of the municipality, with a total lenght of 1300 m of well-tended trails for visitors, is a protective fence and illumenated in the length of 600 m.

Right next to the entrance to the cave there is the Biospeleological Museum Vjetrenica, a specially created unit that shows the natural, biospeleological and historical units of this part of the Herzegovinian karst as a natural phenomenon. In the lower part of the Museum building, there is an exhibition and sales area, where souvenirs and products of the local community. A **tour of the museum is included in the price of entering the Vjetrenica cave. On the path towards** the entrance to Vjetrenica there is an Info Center which is designed as an educational and informative digital center that should present the richness and beauty of the cave in an innovative way before entering it. These facilities are managed by public company Vjetrenica llc Ravno. In the first year of operation and operation of JP "Vjetrenica", ie in 2010, only 500 visitors were recorded.In 2016, the cave Vjetrenica was visited by 8,753 visitors.In 2017, 9,836 visitors were recorded, while in 2019 the number of visitors According to the data on the number of visits, there is a constant increase in the number of visitors. Table 14 contains an analysis of visitors who visited the municipality of Ravno during 2018 and 2019 with the structure of guests and the number of overnight stays.

Table 15 *Overview of the number of registrated ivernight stays based on official dana for 2018 and 2019*

Municipaty of Ravno	**2018**		**2019**	
	Arrivals	**Overnight stays**	**Arrivals**	**Overnight stays**
GERMANY	45	50	46	52
SLOVENIA	/	/	50	50
SAD	20	20	49	49
UNITED KINGDOM	41	43	44	44
FRANCE	38	42	/	/
CROATIA	30	34	/	/
BELGIUM	/	/	34	38
NETHERLANDS	24	24	25	25
BOSNIA AND HERZEGOVINA	22	40	24	31

5. Protection and management of the nominated property

5.a Stakeholders

The municiplity of Ravno consist of a large, rural, preserved area of 323 km^2. According to the Spatial Plan, the Municipallity of Ravno has 55 settlements with a total of 1,391 inhabitatnts. The settlements with the largest number of inhabitants (Invanica 250, Ravno 244 and Trebinje 185) are also the central settlements that cover other settlements with their services. Map 9. shows the settlements within the booundaries of the protected area.

The group of key stakeholders certainly includes the Bosnia and Herzegovina Ministry of Foreign Trade and Economic Relations, Federal ministry of environment and tourism, Ministry of Trade, Tourism and Environmental Protection of the Herzegovina-Neretva Canton, the Ministry of Construction and Spatial Planning of the Herzegovina-Neretva Canton and the official area manager, Vjetrenica Public Company Ltd. Ravno. Other relevant stakeholders are:
- Private landowners
- Representatives of the local community and local residents
- Agricultural sector (Irrigation Association Popovo polje Ravno)
- Public Utility Company Popovo Ltd. Ravno
- NGOs (Citizens' Association Stijena Ravno, Association Zavičaj Zavala Ravno, Citizens' Association
Pelin Popovo polje-Ravno, Association of Beekeepers Vrijesak Ravno)
- Mountaineering, cycling and hunting associations such as the Hunting Association Lisac whose hunting ground is located in a protected area
- Educational institutions and faculties
- Zavala monastery
- The remains of the church of St. Peter in Zavala
- Catering facility Zavala
- Biospeleological Museum Zavala
- Tourists
- Private sector
- Investors (e.g. construction of an ethno-hotel is planned in Orahov Dol)
- Citizens' Association Dilutum
- Ministry of Trade, Tourism and Environment of Herzegovina-Neretva Canton
- Dubrovnik School of Tourism and Hospitality.

5.a (i) Ownership

In Bosnia and Herzegovina – Federation Bosnia and Herzegovina, the municipalities are responsible for the documentation of the ownership circumstances of the areas under their authority. The obtaining of updated information is possible at any time by making enquiries at the municipal Registry offices concerned.

The ownership circumstances of the areas in the component part Vjetrenica – Popovo Polje are:

- 20% of the area in the ownership of the Municipality Ravno where Cave Vjetrenica is 100% included and,
- 80% of the area in private ownership Vjetrenica Cave is state-owned.

The Ravno Municipality assigned the Public Company Vjetrenica Ltd. Ravno management and care of the cave. The company runs daily management activities in the area, including maintenance of Vjetrenica cave.

Estimated population located within:

Nominated Property Cave Vjetrenica 423 ha is 0 Year 2021

Buffer Zone of Cave Vjetrenica 4290 ha is 255 inhabitants Year 2021.

5.a (ii) Indigenous People

With in area of naminated proprerty and buffer zone there is no indigenous people and their respecive communites.

5.a (iii) Participation

During the preparation of this document, the local community and indigenous peoples were consulted so that all interested parties would be included in the nomination process. As a method for analyzing the influence of identified and available local communities and indigenous peoples in the process of preparing the nomination of Pecine Vjetrenica to the UNESCO list of natural and cultural heritage protection, and for the purposes of this document, a matrix for the analysis of interest groups was used. Matrix interest - power. Given that the area in question is located in the municipality of Ravno, key groups have been identified that play a role in these communities. In order to improve intersectoral dialogue and cooperation with all interested parties, the following concept of involving interested parties was represented during the preparation and creation of the document:

- for interest groups with expressed power and interest, the "direct involvement" strategy was applied, which implies full cooperation and full satisfaction of their interests.
- for interest groups that have a relatively large power and a less pronounced interest, the "keep them satisfied" strategy is applied
- for interest groups that have a great interest but relatively little power (local communities, various non-governmental organizations, private entrepreneurs, etc.) the "keep informed" strategy is applied, although depending on different circumstances this strategy is sometimes not sufficient to satisfy all their interests and expectations for interest groups with low power and less pronounced interest, in the process of communication and strengthening of intersectoral dialogue, the strategy of "minimum engagement" was applied, with constant monitoring of changes in both parameters in the interest-power matrix.

The stakeholders from interest/power matrix made a great contribution to the creation of the document through the delivery of various types of data and the preparation of bases (data sets),

area boundaries, etc. In addition, through three consultative meetings, a constructive conclusion was reached and the solution was appreciated proposals for this area, which reconciled different interests in the space.

5.b Protective designation

Vjetrenica Cave belongs to the system of karst areas, and it is the most endangered habitat type in BiH. Vjetrenica is a complex cave system and the longest cave in BiH, and it is also a hydrologically active cave system with active groundwater and underground lakes. The first form of protection of Vjetrenica took place already in 1952, and the relevant spatial planning documentation so far suggested that this area of Vjetrenica cave with the surroundings of the karst plateau and part of the Popovo polje should be under protection. However, the Vjetrenica cave area today does not enjoy formal legal protection; in order to achieve this, it is necessary to inspect the area as well as all other protected areas before 2003 in accordance with the 2013 Law on Nature Protection.

According to the Law on Nature Protection from 2013 (Official Gazette of FBiH, No. 66/13), which is partly harmonised with EU legislation, Vjetrenica Cave is a former natural monument, classified in Category III of protected parts of nature and is in the process of re-proclamation, entrusted to the competence of the regional administration or canton. For the procedure of classification into this category, it is necessary to determine the status of the Vjetrenica cave as a protected area.

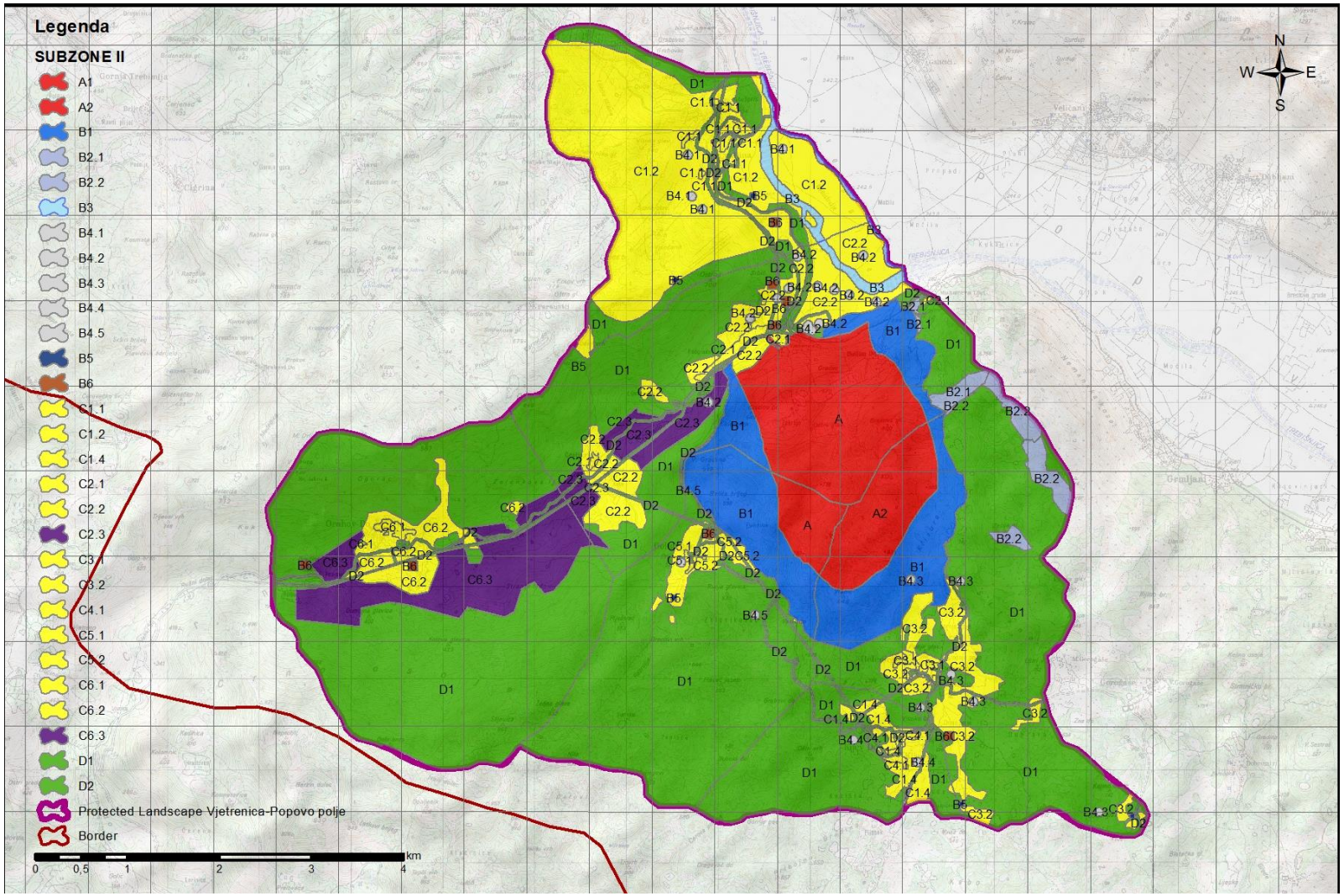
During the period 2016-2020, a new document "Expert explanation for declaring the Vjetrenica-Popovo field a protected area" was prepared. It was completed at the end of December 2020 and is part of the UNEP / GEF project and represented the first concrete step in the process of establishing formal legal protection in this area, in accordance with the activities envisaged in the specialized plan for establishing formal legal protection in Vjetrenica-Popovo. The project in the previous phase. This document should bring the protection procedure closer to all stakeholders, given that no protection review has been performed to date on any basis. In the process of drafting this document and analyzing the spatial planning documentation, it was decided that the protection area should be larger than the 1952 protection scope.

In 2021, with the decision to declare this area as a protected landscape "Vjetrenica - Popovo Polje", this area receives formal legal protection, respecting all legally formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina. The process of promulgating a separate law "protected landscape Popovo Polje - Vjetrenica" is underway, which will regulate the management, monitoring and detailed protection of space. In 2021, the Municipality of Ravno held a session on 31.08.2021. (OV-III.60 / 21) adopted the Management Plan for the protected landscape "Vjetrenica-Popovo polje" for a period of 10 years.

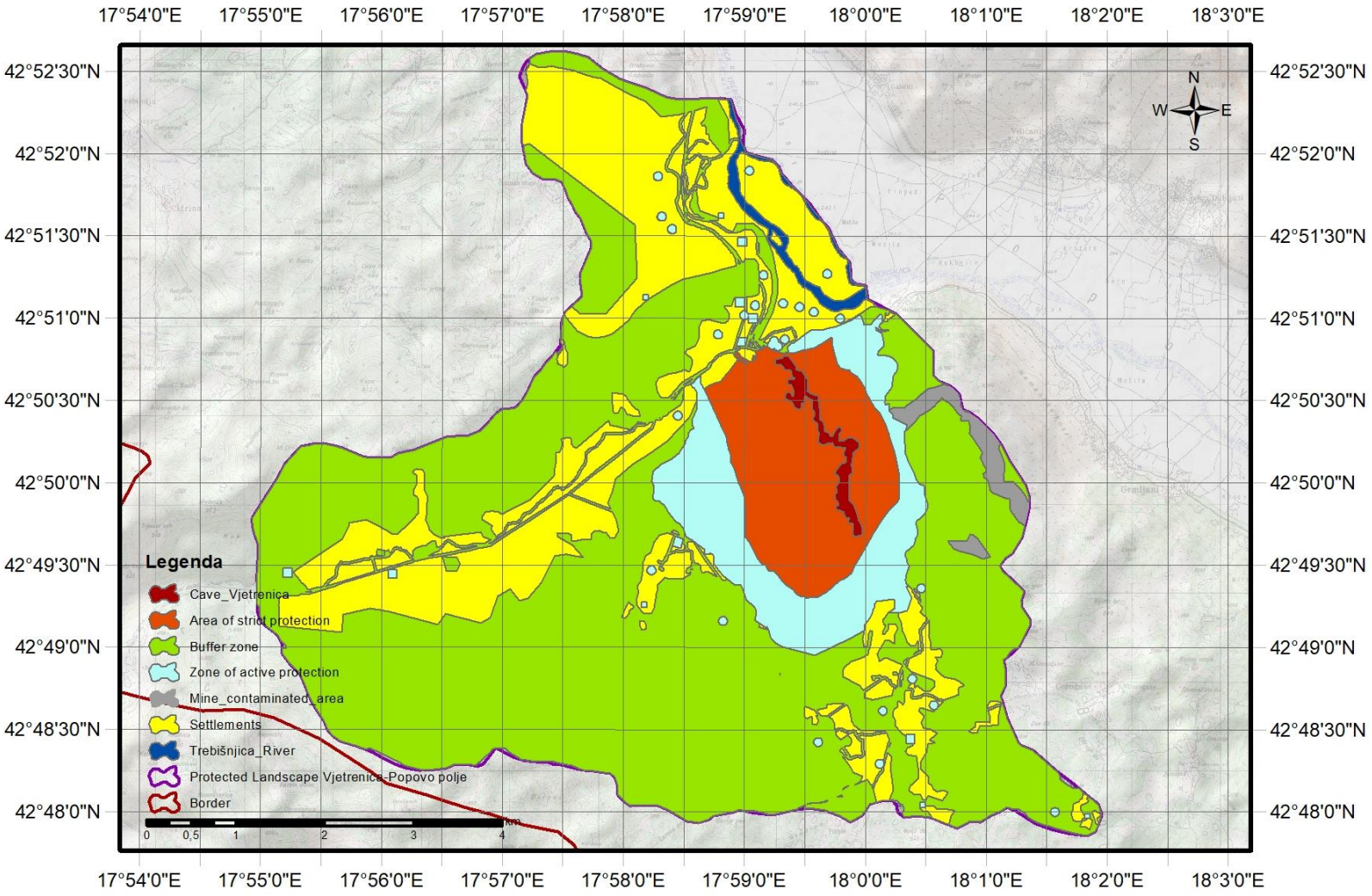
The Spatial Plan of BiH for the period 1981 to 2000, which is in force until the adoption of the Spatial Plan for the Federation of BiH, due to its importance from the aspect of cultural and

natural heritage protects the wider area Zavala-Slano as a special natural area (Article 115, "Official Gazette of the Federation of BiH ", No. 2/06).

2008-2028 FBiH Draft Spatial Plan In its text on the area of Vjetrenica - Popovo polje, this area is mentioned as one of the eighteen planned naturally protected areas in the FBiH, with an area size of 3572.5 ha, or 35.72 km^2, but in the graphic part the Plan foresees the protection of Vjetrenica cave. Currently, the Ravno Municipality entrusted the management and care of the cave to Vjetrenica Public Company Ltd. Ravno, which performs daily management activities in the area, including maintenance of Vjetrenica cave. According to the current Development Plan, the Protected Landscape / Landscape “Vjetrenica - Popovo polje” covers an area of 4,710.17 ha.



Map 15 *Protected zones and subzones within the Protected Landscape "Vjetrenica – Popovo polje"*



Map 16 *Protected zones and subzones within the Protected Landscape Vjetrenica – Popovo polje*

Council of Europe Convention on the Conservation of European Wildlife and Natural Habitats, better known as the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats, Bern Convention) https://www.coe.int/en/web/bern-convention is a binding international legal instrument in the field of nature conservation. It encompasses the entire natural heritage of the European continent, and extends to some African countries, such as Burkina Faso, Morocco, Tunisia and Senegal. In addition to the conservation of wild species of plants and animals and their natural habitats, the Berne Convention aims to promote European cooperation in this area. The Convention was adopted in Bern (Switzerland) in 1979 and entered into force in 1982.

An integral part of the Berne Convention are the lists of strictly protected species of flora (Annex I) and fauna (Annex II) and the list of protected species of fauna (Annex III), for which legislative and administrative measures need to be taken to ensure the conservation of their habitats. In addition, the use of certain means and methods of killing, capturing and other forms of exploitation for mammals, birds and freshwater fish is prohibited (Annex IV).

The area of Popovo polje - Vjetrenice is on the list of habitats of this network under number BA0000012 Popovo polje – Vjetrenica.

Natura 2000

Natura 2000 is an ecological network made up of areas important for the conservation of endangered species and habitats of the European Union. It is based on two directives that support the European Union's nature protection policy. These are the Habitats Directive and the Birds Directive.

Bosnia and Herzegovina has not legally formally adopted Natura 2000, but during the process of identifying areas of importance, the Popovo Polje-Vjetrenica area has been recognized as a Natura 2000 area with its habitats and species.

5.c Means of implementing protective measures

According to the Law on Nature Protection from 2013 (Official Gazette of FBiH, No. 66/13), which is partly harmonised with EU legislation, Vjetrenica Cave is a former natural monument, classified in Category III of protected parts of nature and is in the process of re-proclamation, entrusted to the competence of the regional administration or canton. In 2021, with the decision to declare this area as a protected landscape "Vjetrenica - Popovo Polje", this area receives formal legal protection, respecting all legally formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina. Assembly of the Herzegovina-Neretva Canton, at the session held on March 22, 2021. passed the Act on

the Proclamation of the Vjetrenica Cave Area with a Part of Popovo Polje as a Protected Landscape (Vjetrenica - Popovo Polje) (Official Gazette of the HNC No. 2/2021). Protected landscape "Vjetrenica - Popovo polje" covers an area of 4,710.17 ha.

In 2011, the Ravno Municipality adopted Amendments to its Spatial Plan, as a basis for the protection of Vjetrenica. Accordingly, a wide area around the cave was proposed for protection and defined as “Special Natural Area” and the entrance to the cave as “World Heritage”.

From the administrative point of view, a wider area of Vjetrenica belongs to the Ravno Municipality, or the Herzegovina-Neretva Canton.

The analysis of all spatial planning documents is crucial for determining the spatial area of protection because the boundaries of the PA are determined in accordance with the relevant spatial planning documents, according to the Law on Physical Planning and Land Use at the FBiH level.

The following spatial planning documents were taken into account in this analysis:

- 1981-2000 Spatial plan of Bosnia and Herzegovina
- 2008-2028 Draft Spatial Plan of the FBiH
- 2012-2022 Draft spatial plan of the Herzegovina-Neretva Canton
- 2007-2017 Spatial plan of the Ravno Municipality
- Spatial planning documents of lower levels, urbanistic and regulatory plans for this area have not been adopted.

1981-2000 Spatial Plan of BiH The proposed protected area Vjetrenica-Popovo polje is intended for protection as a special natural area (reserves, landscapes and natural monuments). Within this document, the place of Vjetrenica cave bears the designation of the Special Natural Landscape - Reserves, Landscapes and Monuments of Nature on the map of natural and historical values, together with the historical natural units in the area.

Specific natural areas, defined in the project area, according to the Spatial Plan of BiH, are used under regime III (regimes I, II, III are defined), which includes the preservation of natural resources from possible pollution or degradation of their normal natural reproduction. These areas are allowed to be used, but with a ban on the development of the polluting industry, deposition of sediments in mining, landfills in traffic and deforestation in forestry.

2008-2028 FBiH Draft Spatial Plan In its text on the area of Vjetrenica - Popovo polje, this area is mentioned as one of the eighteen planned naturally protected areas in the FBiH, with an area size of 3572.5 ha, or 35.72 km^2. Assembly of the Herzegovina-Neretva Canton, at the session held on March 22, 2021. passed the Act on the Proclamation of the Vjetrenica Cave Area with a Part of Popovo Polje as a Protected Landscape (Vjetrenica - Popovo Polje) (Official Gazette of the HNC No. 2/2021). Protected landscape "Vjetrenica - Popovo polje" covers an area of 4,710.17 ha.

The process of drafting the Spatial Plan of the Herzegovina-Neretva Canton was initiated in 2008, but to date the document has not been formally adopted by the Cantonal Assembly. 2012-2022 Spatial Plan of the Herzegovina-Neretva Canton It is currently in draft form.

The boundaries of the natural area Vjetrenica - Popovo polje, whose protection is planned by the municipal spatial plan, were adopted as reference boundaries for planning the protection of this natural area during the development of the Herzegovina-Neretva Canton Spatial Plan for the period 2012-2022.

The mentioned Spatial Plan identifies the Vjetrenica cave system as a geologically valuable site, and the surroundings of the Popovo polje as a valuable area from the aspect of natural values and proposes protection in accordance with the category "protected landscape" or "nature monument / nature park".

5.d Existing plans related to the municipality and region in which the nominated cave is located Vjetrenica Cave is state-owned.

1) Vjetrenica Cave belongs to the karst system, which is the most ecologically endangered habitat type in Bosnia and Herzegovina. There were no systematic forms of protection of Vjetrenica until 1952, when it was declared a natural monument in accordance with the-then Law (Decision of the Institute for the Protection of Cultural Monuments and Natural Rarities of the People's Republic of Bosnia and Herzegovina, No. 979/52 of 25 December 1952).

2) Spatial Plan of BiH for the period 1981 to 2000 - The Spatial Plan of BiH for the period 1981 to 2000, which is in force until the adoption of the Spatial Plan for the Federation of BiH, due to its importance from the aspect of cultural and natural heritage protects the wider area Zavala-Slano as a special natural area (Article 115, Official Gazette of the Federation of BiH, No. 2/06).

3) Draft Spatial Plan of FBiH for 2008-2028 - In his text on the area of Vjetrenica - Popovo polje, he mentions this area as one of the eighteen planned naturally protected areas in FBiH, with an area of 3572.5 ha, or 35.72 km^2, but in the graphic part he envisages the protection of the Vjetrenica cave.

Despite the lack of documentation required for all goods that want to be included in the World Heritage List, Vjetrenica Cave was included in the UNESCO List of Natural Heritage on 22 November 2004 as a natural monument, and on 11 December 2007 the same was done for Vjetrenica cave, including an architectural ansamble of the village of Zavala. According to the current FBiH Law on Nature Protection of 2003, the Vjetrenica Cave is a natural monument classified as Category III of protected nature areas and is entrusted to the competences of the regional administration or cantons. In 2021, this wider area around the cave Vjetrenica was declared a protected landscape "Vjetrenica - Popovo Polje", and received formal legal protection, respecting all legal formal regulations and protection guaranteed by the Federal Law on Nature Protection of the Federation of Bosnia and Herzegovina.

In 2021, the Municipality of Ravno adopted a Management Plan for a period of 10 years. It protects and defines the wide area around the cave as a "special natural area" and the immediate entrance to the cave as a World Heritage Site.

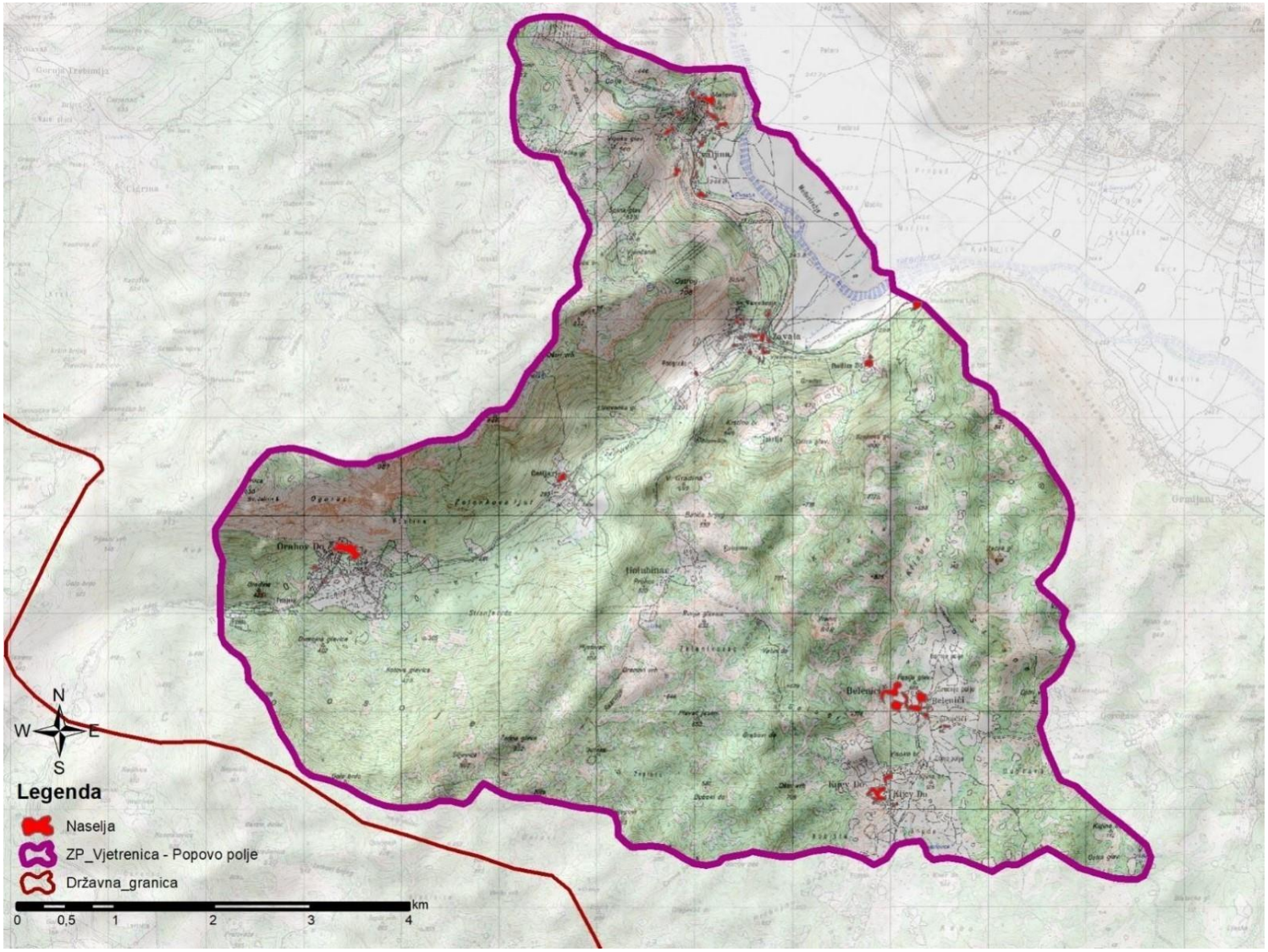
4) 2012-2022 Draft Spatial Plan of the Herzegovina-Neretva Canton - The process of drafting the Spatial Plan of the Herzegovina-Neretva Canton was initiated in 2008, but to date the

document has not been formally adopted by the Cantonal Assembly. 2012-2022 Spatial Plan of the Herzegovina-Neretva Canton According to the information received from the Department of Construction, Physical Planning, Geodetic and Property-Legal Affairs of the Ravno Municipality, the local community participated in the development of the cantonal Spatial Plan. The boundaries of the protected landscape Vjetrenica - Popovo polje, whose protection is planned by the municipal spatial plan, were adopted as reference boundaries for planning the protection of this natural area during the development of the Herzegovina-Neretva Canton Spatial Plan for the period 2012-2022. The mentioned Spatial Plan identifies the Vjetrenica cave system as a geologically valuable site, and the surroundings of the Popovo polje as a valuable area from the aspect of natural values and proposes protection in accordance with the category "protected landscape" or "nature monument /nature park".

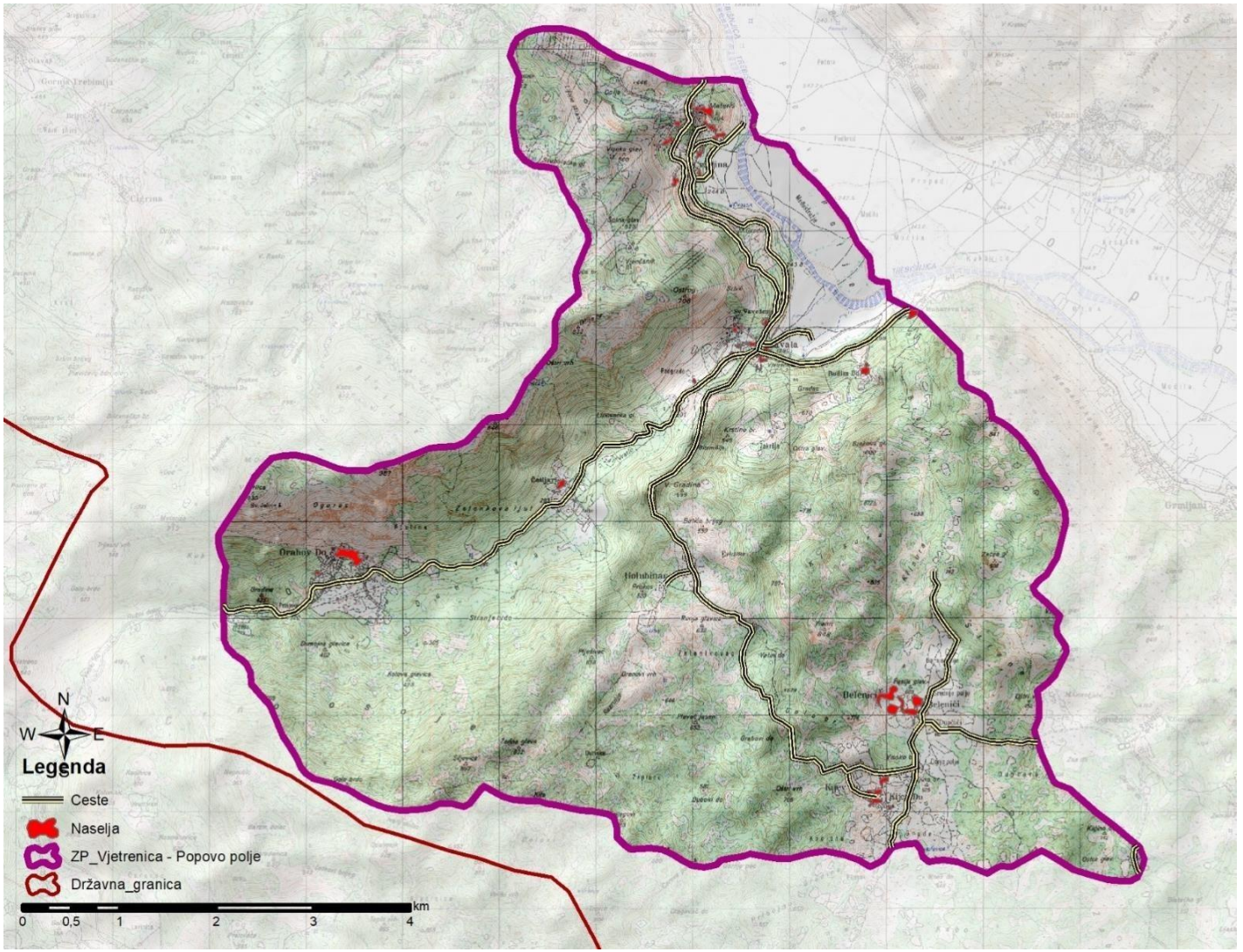
5) Spatial plan of the Ravno Municipality - Amendments to the 2007-2017 Ravno Municipality Spatial Plan - The Ravno Municipality has adopted the Spatial Plan as a basis for the protection of Vjetrenica. Spatial Plan of the Ravno Municipality - Amendments to the 2007-2017 Spatial Plan of the Ravno Municipality (Ravno Municipality, 2011) supports the continuation of activities for the protection of Vjetrenica cave, as well as the continuation of research into other natural values of this Municipality. In accordance with the provisions of the Amendments to the Spatial Plan of the Ravno Municipality, the protected area of the Vjetrenica cave with its surroundings is located in the far southeast of Bosnia and Herzegovina, and extends within the following geographical markings:

- northernmost point: 42 ° 51'13 "N; 17 ° 57 '08 "E (location: Kula)
- southernmost point: 42 ° 47'50 "N; 18 ° 00 '12 "E (altitude: Knež Do - 546 m)
- westernmost point: 42 ° 49'12 "N; l = 17 ° 54 '08 " (location: Ružni Dolac)
- easternmost point: 42 ° 47'02 "N; l = 18 ° 01 '40 " (altitude: Kujino Osoje - 742 m).

From the point of view of the general physical-geographical position, or Zone belt, the area belongs to the southern part of the low-mountainous coastal-Herzegovinian area, the outer Dinaric landscape area of Bosnia and Herzegovina, the northern temperate zone. The area is characterised by the following geographical features and toponyms: Trebišnjica river around Čvaljina, Gradina hill (612 m), Larića hill, Ošlje hill, Oštri vrh, Orlovica (846 m), Ilijino hill (987 m), Velika Orlica (930) in the west settlements Rizišta, brdo Golo (821 m) in the southwest, Brijegovi (653 m), Žarbina (680 m) and Gornja Peć (650 m) in the south, then settlements Pijesak and Kijev Do the south-southeast of the area, hill Gradina (672 m)), Kujino Osoje (742 m), then north to an altitude of 634 m, Oštri vrh (752 m), Visoka glavica (890 m), Sovar (824 m)), Oštri vrh (841 m), and to the north- to the northwest the village of Muhareva Ljut (262 m) and the valley of the river Trebišnjica).



Map 17 *Settlements within the protected area Vjetrenica - Popovo polje*



Map 18 *Transport network within the protected area Vjetrenica - Popovo polje*

5.e Property management plan or other management system

Protected landscape "Vjetrenica - Popovo polje" covers an area of 4,710.17 ha.

An indicative list of stakeholders involved in the overall protection planning process is given below. This indicative list, originally created for the needs of the Roadmap for the establishment of formal legal protection in the area of Vjetrenica - Popovo, was amended during the development of the protection procedure for that area.

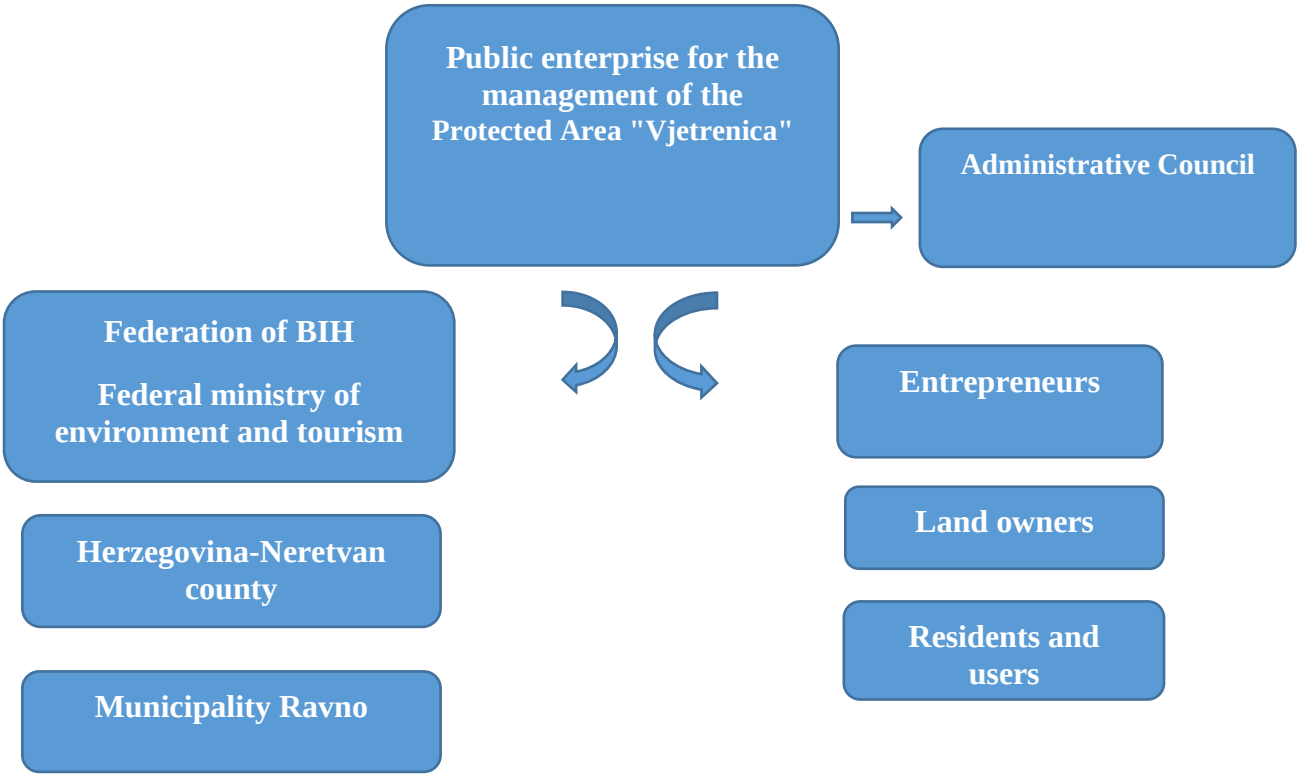


Chart 2 *Different entities involved in the management of the proposed property and their relationship*

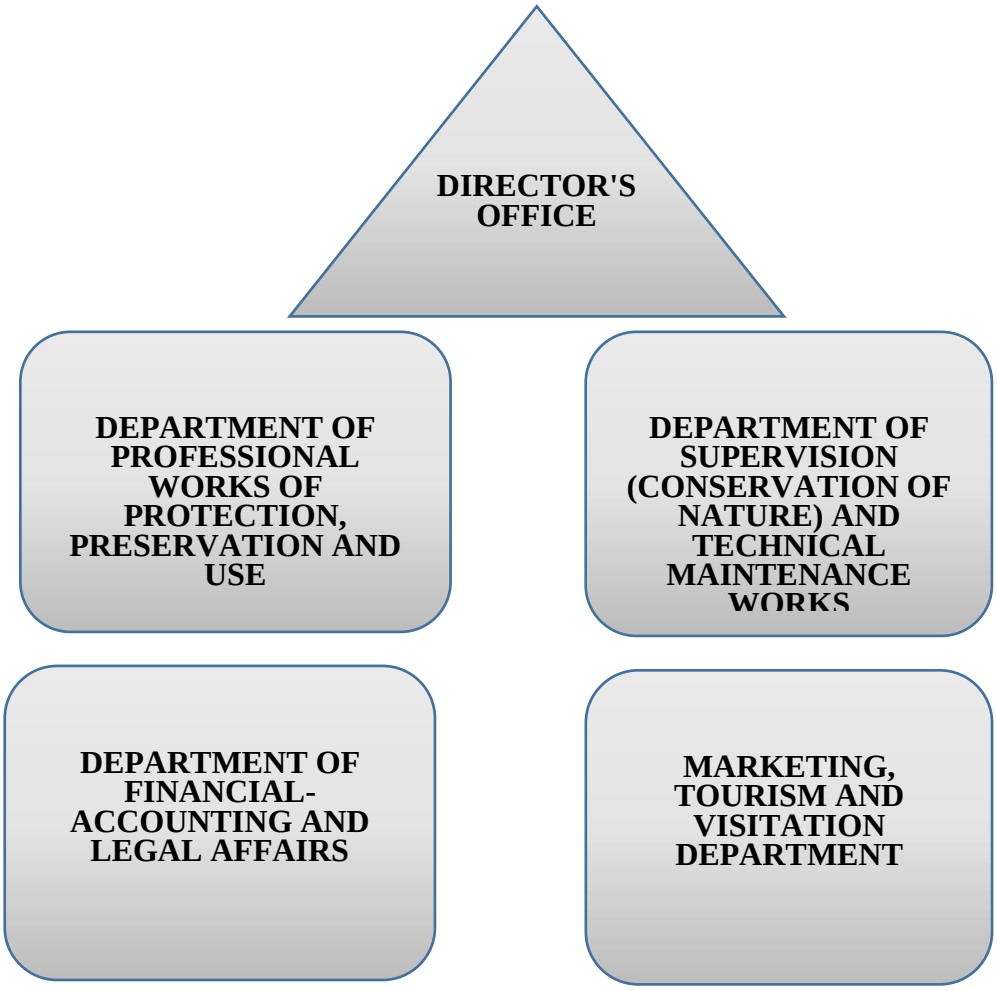


Chart 3 *Management of the proposed site*

General stakeholders in the process (Review) of protection of natural areas are shown in Table 15.

Decision-makers in the process of protection of natural areas

Table 16 General stakeholders in the process of protection of natural areas

Groups	***Activities***
Authorities (FBiH / cantonal authorities and their spatial planning services)	FBiH Ministry of Environment and Tourism Ministry of Trade, Tourism and Environmental Protection of Herzegovina-Neretva Canton Ministry of Construction and Spatial Planning of Herzegovina-Neretva Canton Ravno Municipality

Interest groups	Forestry, hunting, livestock, fishing, agriculture, beekeeping, water management, utilities, transport, mining
Beneficiaries – target groups	Sciences, tourism, private sector (crafts, services, small business)
Beneficiaries – end users	Area manager, local population, protected area residents, nongovernmental organisations (sports, recreation), education
Project partners	Cantonal administration, institutions and non-governmental organisations (nature protection, religious and cultural-historical heritage, education)

The group of key stakeholders certainly includes the Ministry of Trade, Tourism and Environmental Protection of the Herzegovina-Neretva Canton, the Ministry of Construction and Spatial Planning of the Herzegovina-Neretva Canton and the official area manager, Vjetrenica Public Company Ltd. Ravno. Other relevant stakeholders are:

- Private landowners
- Representatives of the local community and local residents
- Agricultural sector (Irrigation Association Popovo polje Ravno)
- Public Utility Company Popovo Ltd. Ravno
- NGOs (Citizens' Association Stijena Ravno, Association Zavičaj Zavala Ravno, Citizens' Association Pelin Popovo polje-Ravno, Association of Beekeepers Vrijesak Ravno)
- Mountaineering, cycling and hunting associations such as the Hunting Association Lisac whose hunting ground is located in a protected area
- Educational institutions and faculties
- Zavala monastery
- The remains of the church of St. Peter in Zavala
- Catering facility Zavala
- Biospeleological Museum Zavala
- Tourists
- Private sector
- Investors (e.g. construction of an ethno-hotel is planned in Orahov Dol)
- Citizens' Association Dilutum
- Ministry of Trade, Tourism and Environment of Herzegovina-Neretva Canton
- Dubrovnik School of Tourism and Hospitality

Protected natural values

Vjetrenica cave is designated as a special geological reserve. Priority and endangered habitats from the Habitats Directive have been identified in field surveys of the surface area and outlined in the relevant chapter.

Other protected natural values from the area of Vjetrenica - Popovo polje refer to certain species that have been identified as endangered and vulnerable species. There is still no state-level Red List in Bosnia and Herzegovina; therfore, the identification of endangered species at the national level was done using the FBiH Red List of Wild Species and Subspecies of Plants, Animals and Fungi (Official Gazette of FBiH, No. 7/14). Species of international importance

for conservation are the species listed in the IUCN Global Red List and the European Red List, as well as the species listed in Annexes II and IV of the EU Habitats Directive.

Depending on the category of protected area management, anthropogenic pressures will be present to a greater or lesser extent. Human impact is inversely proportional to the level of management in the protected area and is expected to be higher in the lower categories of protected area. In addition to these types of threats to ecosystems due to the high intensity of anthropogenic pressures in the protected area, such pressures could lead to the loss of basic values of such an area, which was the reason to have the area placed under protection in the first place. Protected areas are the most common hubs of genetic and biological diversity, biocenosis diversity, morphological diversity, biotopes and/or habitats of endemic species, and often represent national reserves for these values; hence the importance to reduce pressure on protected area ecosystems to at least ecosystem tolerance levels.

Field research and survey conducted during the preparation of this Expert Explanation confirmed that the high level of flora, fauna and habitat diversity of the Vjetrenica-Popovo polje area, and the presence of a large number of endangered and protected species justifies the inclusion of a larger area of Vjetrenica caves within the future protected area. The presence of species from the Habitats Directive of the European Union confirms that this area is of national, regional and global importance for the protection of species and habitats in terms of terrestrial fauna and deserves to be included in the ecological network Natura 2000 in the category Protection.

According to the Law on Nature Protection (Official Gazette of FBiH, No. 66/13), the definition of a protected area is as follows:

A protected area is a geographical area, recognised and intended for long-term nature conservation, generally useful functions of nature and cultural values, which is regulated by legal and other effective mechanisms.

The International Union for Conservation of Nature (IUCN) defines a protected area as:

A clearly defined area that is identified by its purpose and managed with the aim of permanently preserving the entire nature, the ecosystem services it provides and the associated cultural values in a legal or other effective way.

It is obvious that such a definition of a protected area has been transferred as an abbreviated version into the new FBiH Law on Nature Protection (Official Gazette of FBiH, No. 66/13).

The boundaries of the protected area are regulated in accordance with the relevant spatial planning documents, the Law on Spatial Planning and Land Use at the FBiH level (Official Gazette of FBiH, No. 2/06, 72/07, 32/08, 4/10, 13/10 and 45/10). In order to prevent the endangerment of protected natural values, a protected zone outside the protected natural value may be determined and appropriate protection measures may be prescribed therein.

The goals of nature protection are the preservation and restoration of the existing biological and landscape diversity in a state of natural balance and harmonized relations with human activity: determine the state and ensure the monitoring of the state of natural values; provide a system of protection of natural values for the permanent preservation of their properties based on which

they have been declared protected; ensure the sustainable use and development of natural resources and the biodiversity of the landscape for the benefit of present and future generations without significant damage to parts of nature and minimizing the imbalance of its parts; prevent harmful interventions and disturbances in nature as a consequence of technological development and activities and ensure the most favourable conditions for the conservation and free development of nature in its use in the economy; ensure the right of citizens to a healthy environment, rest and relaxation in nature.

Protected area Vjetrenica-Popovo polje is recognised as an environmentally significant area, and data on the value and importance of habitats and biodiversity of the proposed area are given above, and can be directly linked to Article 68 of the Law on Nature Protection, explaining how under what conditions it is possible to protect an environmentally important area:

Law on Nature Protection (Official Gazette of FBiH, No. 66/13), Article 68 defines as follows:

The protection of environmentally important areas is ensured by applying the prescribed measures and conditions for nature protection in order to preserve biological and landscape diversity and achieve the protection of natural values in accordance with the provisions of this Law.

Interventions or actions that may cause destruction or other significant or permanent damage to an environmentally significant area are prohibited.

The International Union for Conservation of Nature (IUCN) defines a protected area as (Table 16.):

"A clearly defined area that is identified by its purpose and managed with the aim of permanently preserving the entire nature, the ecosystem services it provides and the associated cultural values in a legal or other effective way."

Table 17 *Explanation of parts of the IUCN definition of a protected area*

TERM USED IN DEFINITION	INTERPRETATION (IUCN, 2008)
CLEARLY DEFINED AREA	Includes land, inland water, sea and coastal areas or combinations thereof. It implies all three dimensions of space, defined within clear and agreed boundaries. Boundaries can in some cases be determined by time-varying elements, such as river banks, and certain existing management measures, such as restricted use zones.
RECOGNISED	The area may be designated by a state or different organisations or groups of people, but as such it must be recognised in some way, for example in the World Protected Areas Database (WCPA) or in the case of protected areas in Bosnia and Herzegovina, a decision must be made at the cantonal or the FBiH level (depending on the level of protection) to declare an area as protected.

WITH A PURPOSE OF	It points to a long-term commitment to conservation, which can be based on a legal decision, international convention, agreement, treaty, etc.
MANAGEMENT	This includes the implementation of special procedures aimed at preserving the natural (and other) values of the protected area, including the absence of any action if this is the best strategy to achieve this goal (it also depends on the level of protection).
WITH A GOAL OF	Setting a specific goal is needed to allow for an assessment of the effectiveness of protected area management.
PERMANENTLY	It is highlighted that the management of the protected area is not a short-term, temporary strategy, but a continuous process.
PRESERVING	In the context of this definition, this term means in situ a place of conserving ecosystems, natural and semi-natural habitats and preserving stable populations of wild species in their natural environment, or indigenous or cultivated species in the environment in which they are located and have developed their specific characteristics.
THE WHOLE NATURE	It encompasses all biological diversity, at the genetic, species and ecosystem levels, as well as geological and landscape diversity.
ECOSYSTEM SERVICES	It refers to services provided by nature to man, the use of which is not contrary to the objectives of protection. Ecosystem services cover supply issues, such as water, timber and genetic resources; regulation services, such as mitigation of extreme natural phenomena, diversion of droughts, floods, soil erosion and disease; support services for natural processes such as substance circulation and soil formation; and cultural services such as recreational, spiritual, religious and other intangible benefits.
CULTURAL VALUES	All cultural values that do not conflict with conservation objectives, including in particular those that contribute to them and those that are endangered.
BY LEGAL OR OTHER EFFECTIVE MEANS	The management of the protected area may be carried out in accordance with legal decisions, international conventions or agreements, or according to traditional customs or principles of non-governmental organisations.

You can see more information in the Protected Landscape Management Plan Vjetrenica-Popovo polje which is added as a separate document.

5. f Sources and levels of finance

Financing of protected areas is often a challenge because there is a small number of cases of protected areas that are financially independent, that is, they are dependent on the budget of institutions of higher order.

Management of Protected Landscape Vjetrenica - Popovo polje and the day-to-day work of the manager of the public company Vjetrenica should rely on clear financial mechanisms and specific financial resources necessary for the functioning of the company and the achievement of the objectives of the Management Plan.

Funds for the work of the public company Vjetrenica llc Ravno are ensured from:

- Budget of the Municipality of Ravno
- Cantonal budget
- Own revenues
- Donations and
- projects at the Federal, cantonal and international level.

Following the example of the world's practice, other forms of financial support necessary for management should be based on the activities of funds and foundations of various agencies, NGOs, etc. Other sources include subsidies, donations, funds of local, federal, state and international institutions and organizations. It is envisaged that public enterprises may also receive funds from municipal budgets in accordance with their programs if they are an integral part of protected area management plans. Direct costs at the level of the protected area refer to the operating costs of the protected area as well as to the costs of organizing the seat, equipment, vehicles, etc. of the Manager. Based on the proposed protected area management arrangement, which will entrust the management of the extended area to the existing cave manager, the Public Company Vjetrenica doo, followed by an overview of the company's current annual operating costs (Table 17.). At the entrance to the Vjetrenica cave there is an entrance building, and the purchase price of a smaller building was 22,200.00 KM).

Given the annual number of visitors to the Vjetrenica cave of some 10,000 and the ticket price of BAM 15 (EUR 7.5), it can be concluded that the Vjetrenica Public Company Ltd. has already achieved financial sustainability. However, it is worth noting that the annual costs listed in Table 16. relate to the work of the institution, and a significantly smaller area of Vjetrenica cave. It is realistic to expect that the costs of this company will increase because it covers the entire area of the Protected Landscape "Vjetrenica-Popovo polje".

Table 18 *Description of annual expenditures of the Vjetrenica Public Company Ltd.*

No.	***Expenditure description***	***Annual expenditure per item (BAM)***
1.	Salaries for 5 employees	127,620.00
2.	Electricity costs	4,700.00
3.	Phone, landline and mobile	4,500.00
4.	Accounting	2,400.00
5.	Office expenses, depreciation expenses	7,700.00
	Total	**146,920.00**

Indirect costs are related to the ban on hunting activities in the strict protection zone for the total area of the protected zone of 425 ha according to the finally adopted Option E, for which there is currently an approved hunting concession. Considering that the Hunting Association Lisac currently pays an annual concession fee in the amount of BAM 3,700.00 for the total area of the Ravno Municipality of 29,700 ha, the proportional indirect cost for banning this type of activity in the strict protection zone is BAM 51.57 per year. The Hunting Association Lisac is entiteled to a reduction/compensation of the concession fee in the amount of BAM 51.57 per year.

Table 18. below is a summary of direct and indirect costs in the first three years after the field was declared a protected landscape Vjetrenica-Popovo. Direct costs will ultimately depend on the chosen management model, and the option that is more financially viable is certainly the possibility of assigning management of the future protected landscape Vjetrenica-Popovo polje to the existing manager of the Vjetrenica cave, meaning Vjetrenica Public Company Ltd. Ravno.

Table 19 *Summary of expenditures in the first three years after declaring the Vjetrenica-Popovo polje as a protected landscape*

No.	***Type of expenditure***	***Year 1 (BAM)***	***Year 2 (BAM)***	***Year 3 (BAM)***	***Total for a period f three years (BAM)***
1.	Direct costs	146,920.00	146,920.00	146,920.00	440760
2.	Indirect costs of a hunting ban in a strict protection zone	51.57	52.94	52.94	154.71
	Total	146,971.57	146,972.94	146,972.94	440,914.71

Sources of financing required for the implementation of the declaration of protected natural values

Funds for the work and activities of this public company will be provided through:
- Cantonal budget
- Income from the use of natural values in protected areas
- Income from fees
- Identified benefits (tax exemption for all or part of the profit)
- Other sources.

Additional funds for the work of the protected area manager will be provided from the system of fees normally paid to the company/enterprise that manages the protected area for the following:
- Entry to the protected area
- Camping and/or parking
- Sale of souvenirs, tickets, books, etc.
- Daily tickets for recreational and other authorised sports activities
- Fees for the use of the protected area logo
- Obtaining special permits, e.g. for promotions, photography, filming, etc.

Other forms of financial support needed for management should, similar to global practice, be based on the activities of funds and foundations of various agencies, non-governmental organisations, etc. Other sources would include: subsidies, donations, funds from local, national and international funds and foundations, institutions and organisations. There is also the possibility of applying for international funds and agencies whose funds can then be used to fund measures to improve the area and/or research activities of the census and monitoring of species.

The profits made in accordance with the financial and management plans and annual work programs will be available to the public company that manages the protected area. The public company is to make a profit in accordance with its annual work programmes, development of its own business operations and purchase of real estate, subsidies for the implementation of development guidelines listed in the Draft Law, fees for contractual protection and care of natural values, rehabilitation of buildings and degraded environment. protected areas and other activities in accordance with the goals and purpose of protected areas.

5. g Sources of expertise and training in conservation and management techniques

In cooperation with the FBiH Ministry of Environmental Protection and Tourism, the competent authority encourages the construction of a drainage system in accordance with the objectives of groundwater protection.

The adoption of acts on the internal organisation of services will create the operational potential of the Public Enterprise for the effective management of the management body, and in particular for the implementation of the Management Plan.

The creation of an Expert Council as an expert assistance to the management of the protected area was encouraged.

A model of cooperation with the competent cantonal administrative bodies, especially inspection services and intervention organisations, has been developed.

Cooperation has been established with beneficiaries in the area, especially with tourism, hunting, cooperation with educational, professional, scientific institutions and organisations and other institutions at the regional, national and global level of agriculture and water management.

Conditions have been created for the inclusion of volunteers and participants in the work of the administration in protected areas. Training of protected area staff is ongoing.

Coordination was established with all institutional levels for environmental protection - FBiH Ministry of Environment and Tourism, FBiH Environment Fund, Cantonal Environment Fund, etc.

Transport infrastructure

The Ravno Municipality or the wider area of Vjetrenica-Popovo Polje is connected to other parts of BiH by a transport network, but also with the neighbouring Republic of Croatia. Road connections are especially important in order to take advantage of the proximity of a major tourist market of the Dubrovnik coast.

Transport network of the Ravno Municipality consists of:
- part of the main road M20 Dubrovnik-Trebinje-Ljubinje-Stolac-Mostar (8 km in the Ravno Municipality)

- part of the regional road R 426 Čapljina-Hutovo-Ravno-Zavala (24 km in the Ravno Municipality)

- part of the regional road R 428 Zavala-Češljari-Orahov do to inadequate Dolac border crossing Lozica (10 km in the Ravno Municipality) and further to Slano (CRO) as an access point to the Adriatic highway.

There are also local roads within the protected area for the transport needs of the local population of the Ravno Municipality. The densest part of the traffic network is around the settlements of Zavala, Čvaljina and Belenići, while in other parts the roads are connecting the settlements of Kijev Do, Orahov Do and Češljari.

5.h Visitor facilities and infrastructure

The tourist offer of the Protected Landscape / Landscape Vjetrenica - Popovo polje is today based on individual or group visits to the Vjetrenica cave. Vjetrenica Cave, located 5 km from the center of the municipality, with a total length of 1300 m arranged paths for visitors, is a unique location for tourism development in this part of Europe. The total length of the arranged path in the cave is 1300 m and the path is secured with a protective fence and illuminated in the

length of 600 m. The cave has 7.3 km of tested channels and over 22 km of assumed total length. , where), a high degree of biodiversity in the cave itself, then more than 200 animal species adapted to life underground and fantastic paleontological findings that take us back 35,000 years. Vjetrenica has a unique hydrological system of the cave (dominated by the Great Lake) in symbiosis with the hydrology of Popovo polje, with a constant temperature of 11.2 degrees and the appearance of strong winds at the entrance to the cave in summer. The offer includes a tour of the first biospeleological museum in BiH, which opened in 2013.

Most of the cave organisms living in the cave can be seen in the museum, including a replica of the Pardus panther, whose skeleton was found in the cave and is housed in the National Museum in Sarajevo. It is the largest find of its kind in the world, estimated to be more than 35,000 years old. Due to its peculiarities, the Vjetrenica cave is highly ranked in all speleological circles and associations, both in BiH and in the world.

Right next to the entrance to the cave is the Biospeleological Museum Vjetrenica, a specially created unit that shows the natural, biospeleological and historical units of this part of the Herzegovinian karst as a natural phenomenon. In the area of the Museum building in the lower part there is an exhibition and sales area, which sells souvenirs and products of the local community. A tour of the museum is included in the price of entering the Vjetrenica cave.

On the path towards the entrance to Vjetrenica, there is an Info Center designed as an educational and informative digital center that should present the richness and beauty of the cave in an innovative way before entering it.

These facilities are managed by JP Vjetrenica d.o.o. Straight.
In the first year of operation and operation of JP "Vjetrenica", ie in 2010, only 500 visitors were recorded.In 2016, the cave Vjetrenica was visited by 8,753 visitors.In 2017, 9,836 visitors were recorded, while in 2019 the number of visitors According to the data on the number of visits, there is a constant increase in the number of visitors.

On the route of this railway there is a hotel "Hotel Stanica Ravno", which is a renovated railway station. As part of its offer before the accommodation service, the hotel also offers the services of a restaurant with a terrace and a wine cellar. Also, in the immediate vicinity of the Protected Landscape / LandscapeVjetrenica - Popovo polje there are several restaurants and one accommodation unit with a restaurant. Inn Zavala is located within the scope of the Protected Landscape / Landscape, near the cave Vjetrenice in an area with ethno ambience can serve a larger number of guests and there are also accommodation units - apartments. Cafe bar Srednjice is a complex with a shop and a coffee bar. In addition to the inner part, the proctor also has an outer part - a terrace. Tavern Oblat is located towards Zavala on the main road. It is built in the traditional Herzegovinian style and offers rich dishes of traditional cuisine.

The number of tourists who visited the municipality of Ravno is growing from year to year. Visitors who stay more in this area are mostly foreign nationals from the following countries: Germany, USD, United Kingdom, France, etc., while the number of overnight stays of domestic guests is lower. The reasons for this order can be found in the fact that domestic guests mostly come for a day trip, while foreign guests mostly have different tourist habits, which are most often reflected in a multi-day stay.

5.i Policies and programmes related to the presentation and promotion of the nominated property

The promotion of this area is conceived as an instrument for improving the tourist function of the protected area and better compliance with its scientific and educational function on the principles of sustainable development, and as such it has certain specifics. They refer to the approach to the formation of a tourist product that is not a classic tourist product, but an experience. In the coming period, it is planned to enrich the marketing strategy, which should integrate the above elements. It should provide key guidelines for action. You can see more information in a separate document "Protected Landscape Management Plan Vjetrenica-Popovo polje".

5.j Staffing levels and expertise (professional, technical, maintenance)

Indicate the skills and qualifications available needed for the good management of the nominated property, including in relation to visitation and future training needs.

Currently Staff:

1. Davor Baković, B.Sc. in tourism and environmental protection – acting director of public company Vjetrenica
2. Jasna Matijić, marketing manager
3. Helena Brajković, tourist guide
4. Vesna Slobođan, guide in the biospeleological museum
5. Tomo Batina, electrician (Service contract)

Protected landscape requires a new systematization and more employees.

In cooperation with experts we need to organize more training for currently staff for the good management of the nominated property.

For monitoring and evaluation of activities JP Vjetrenica d.o.o. Ravno is in good relationship and colaborate with experts and associations from BiH end Croatia:

Roman Ozimec, Lada Lukić, Damir Basara, Mirna Mazija, Marlena Ćukteraš, etc…

Associations: Adipa, Osmica, Lijepa Naša, Biospeleološko društvo BiH, etc....

6. Monitoring

Natural habitats and primary ecosystems are fairly well preserved. This is confirmed by the diversity of species and habitats, of which a significant number are in the Habitats Directive and the European Union Birds Directive. Also, a large number of species have not only national and regional but also global significance. Because it is here that a large number of stenoendems have found their refuge and peace (species that are present only here and are nowhere else in the world).

Given the importance of natural features, relict flora and fauna that lives in the cave Vjtrenica and its surroundings, it is important to explore and map all speleological objects in the Protected Landscape / Landscape and their underground fauna, and monitor the state of these natural values. Also, it is important to research and monitor the aboveground flora and fauna as a complete monitoring of the state of these natural values of the entire area. For quality monitoring, regular field research is necessary, through which meters will be set for:

- In-situ measurement of microclimatic parameters
- Water sampling
- Collection of phytobenthos and lampenflora samples
- Collection of data on cave fauna

The method of research and monitoring of these parameters will be performed through meters (data loggers) for various parameters, manual collection and collection with auxiliary instruments.

To date, no single pattern has been established for scientists to monitor cave fauna. The reason for this is the uneven distribution of fauna in underground systems, which depends on many factors: the amount of food, the type of object, but also the geological past in which the object was formed. In order to cover all types of microhabitats and collect detailed data on fauna, we used several methods. Therefore, the monitoring of the fauna will be periodic, but with an uneven way of measuring, because it depends on what is found in the cave. The method of research (methodology) of monitoring will be manual sampling, measurement, counting, photography, etc.

Table 20 Key *indicators for measuring state of conservation*

Indicator	Periodicity	Location of Records
air temperature	Automatic measurement 3 times a day	in front of the entrance, in the middle and end of the main channel (in each speleological object)
relative humidity (RH)	Automatic measurement 3 times a day	in front of the entrance, in the middle and end of the main channel (in each speleological object)

concentration of carbon dioxide in the air (CO_2)	Automatic measurement 3 times a day	in front of the entrance, in the middle and end of the main channel (in each speleological object)
External measurement of temperature and humidity (data loggers)	Automatic measurement 3 times a day	4 locations (field, in front of the cave, above the cave)
Water temperature	4 times a year	4 locations (river, spring, 2 ponds in the cave)
PH value of water	4 times a year	4 locations (river, spring, 2 ponds in the cave)
Phytobenthos samples	2 times a year	2 locations
Samples of lampenflora	2 times a year	Locations as needed

Table 21 *Below summarizes key indicators for the monitoring of the state of conservation of the Vjetrenica Cave. While baseline data for a number of indicators are available already, the collection of additional baseline data for other indicators is planned for 2023/2024.*

THEMATIC UNIT A: THE PRESERVED DIVERSITY OF SPECIES, HABITATS AND KARST FORMS AND STABLE PROCESSES ENSURE THE UNIQUE BEAUTY OF THE NATURAL LANDSCAPE AND THEREFORE THE PRESERVATION OF UNIQUE UNIVERSAL VALUE FOR PRESENT AND FUTURE GENERATIONS.		
Goals and actions	Indicators	Periodicity
SPECIFIC OBJECTIVE 1.: Preservation of the value of the Vjetrenica cave and other underground habitats		
GENERAL OBJECTIVE 1.1 Monitoring of the Vjetrenica cave		
A1.1.1. Monitoring of the microclimatic conditions of the Vjetrenica cave	Installed monitoring devices; report	Continiusly
A1.1.2. Continuous monitoring and chemical analysis of water in the Vjetrenica cave	nstalled monitoring devices; report	Continiusly
A1.1.3. Monitoring of cave habitats and underground fauna of invertebrates in	Reports, analyzes continuously	Every 5 years

speleological facilities and sources of Vjetrenica caves		
A1.1.4. Monitor the status of underground species and preserve the ecological features of the habitat of troglobionts and troglophilous fauna in the Vjetrenica cave	Reports, analyzes continuously	Every 4 years
A1.1.5. Start research activities on rhodon, microplastics and heavy metals in the Vjetrenica cave	Report onthe activities carried out	Started in 2022
A1.1.6. Research, analyze and monitor the state of the lampflora of the Vjetrenica cave	Reports, analyzes continuously	Start in 2029
GENERAL OBJECTIVE 1.2. Monitoring of underground habitats		
A1.2.1. Establishment of monitoring of underground habitats	Installed monitoring devices; report	Started in 2022
A1.2. 2. Monitoring of bat colonies	Reports, analyzes continuously	Start in 2023
A1.2. 3. Regular monitoring of underground habitats and underground fauna of invertebrates in speleological facilities	Reports, analyzes continuously	Start in 2028
GENERAL OBJECTIVE 1.3. Active protection measures to ensure the preservation of natural processes in the cave system		
A1.3.1. Create zoning of the Vjetrenica cave with an entry protocol; Develop a visiting plan for visits, systematic research and monitoring the condition of the cave	Zoning map of the cave; Cave interior research protocol aligned with Rulebook on internal oder	2022/2023

A1.3.2. Inventory and research the distribution of bat species in speleological objects, cracks in rocks and anthropogenic objects, determine important areas for their conservation with regard to the way the space is used, and make recommendations for management	Reports, analyzes continuously	Every 5 years
A1.3.3. Active monitoring of access to speleological facilities	Continuous activity; with a research permit	Continiusly
A1.3.4. Continually arrange the cave	Continuous activity, a report on the measures taken was drawn up	Continiusly
A1.3.5. Revise the tourist reception of cave visitors according to the results of monitoring and the condition of the cave	The annual plan for the tourist reception of visitors was created based on the results of the research and the calculation of the tourist capacity	Every 3 years
A1.3.6. Monitor the micoclimatic conditions of the Vjetrenica cave due to the use of the cave and, if necessary, take appropriate measures	Continuous activity, a report on the measures taken was drawn up	Continiusly
A1.3.7. Continuously enter species and habitat research into the information system and cadastre (portal)	Continuous activity, a research report was prepared	Continiusly
A1.3.8. Develop an evacuation and rescue plan (GSS protocols incorporated into the plan)	Prepared evacuation and rescue plan	Start 2023
GENERAL OBJECTIVE 1.4. Adequate measures to establish sustainable ecological characteristics		

A1.4.1. Create a detailed plan for the arrangement of the Vjetrenica cave	A detailed plan for the arrangement of the cave was drawn up	Started in 2022
A1.4.2. Limit and/or if possible stop disturbance of bats (make a plan)	Developed protocols for dealing with the hibernation process Procedure protocol	Start in 2023
A1.4.3. Remove excess construction material, waste, parts of abandoned infrastructure, etc.from the Vjetrenica cave.	Removed material taken from the cave	Continiusly
A1.4.4. Renovate the dilapidated cave infrastructure (fences, lighting fixtures, electricity) (if necessary)	Restored dilapidated cave infrastructure	Continiusly

Administrative arrangements for monitoring property

The researched area is located in the municipality of Ravno, and the administrative control over the given area is held by the Municipality of Ravno and Public company Vjetrenica llc. More information can be found in the Vjetrenica-Popovo Polje Protected Area Management Plan.

Results of previous reporting exercises

The field has an extremely long scientific past. Biospeleology has been especially researched, however, other natural areas have followed the course of research. Biospeleological research of Vjetrenica began in the late 19th century with the visit of the German zoologist Karl Verhoeff and the Austrian beetle expert (Coleoptera), Gustav Paganetti Hummler, who called the cave ‘a cave in Zavala’ (Höhle bei Zavala). Only one hundred years ago, Vjetrenica was considered biologically very poor (Absolon, 1916). However, after the cave spider *Stalagtia hercegovinensis* (Nosek, 1905) and the underground beetles (Coleoptera, Choleviniae, Leptodirini) *Antroherpon apfelbecki* (Müller, 1910) and *Hadesia vasiceki* (Müller, 1911) were described, Vjetrenica drew interest of biologists; in particular, Czech biospeleologist Karel Absolon, who visited Vjetrenica at least 27 times in the period from 1908 to 1922 and discovered a large number of taxa that are already known elsewhere, but also many new species for science. Unfortunately, Absolon never published his list of species, nor his biospeleological cadastre Biospeläologica Balcanica. The number of identified organisms was subsequently published, 47 taxa for Vjetrenica and 51 for smaller Bjelušica (Pretner, 1976), which is considered part of the Vjetrenica cave system. Interest in Vjetrenica did not cease throughout

the 20th century. Most research was conducted in the 1930ies and then in the 1950ies. The author of the first published list is the German biospeleologist Benno Wolf in his catalog Animalium Cavernarum Catalogus, printed in the period from 1934 to 1938, where he listed 35 species from Vjetrenica based on 32 references, with an additional eight from Bjelušica. The second list of habitats was publishedin 1951 by the Bosnian biologist Adem Buturović with 13 taxa from Vjetrenica and 12 from Bjelušica. One professional hydrobiological study from 1956 registers 64 species, including all known members of the Protozoa group (Georgijevski et al., 1956). A much longer list was published by the Slovenian biospeleologist Egon Pretner in 1963 with 54 species, while the Bosnian biologist Sofija Mikšić (1979) published a list of 25 species. In 2003, Slovenian biospeleologist Boris Sket, together with Bosnian speleologist Ivo Lučić, published a comprehensive list of fauna, which includes the Vjetrenica and Bjelušica caves, and the Lukavac spring with 111 taxa, including 75 troglobionts. The list was published as part of the monograph Vjetrenica - a look into the soul of the Earth, describing each higher and lower taxon of Vjetrenica, with analysis of various aspects of habitat and underground fauna of the entire Popovo polje plains, including its vulnerability. Among the authors, Stanko Karaman leads in the number of described taxa with nine taxa, followed by Karel Absolon (independently and together with others) and Karl Verhoeff, followed by Janez Matjašič with seven taxa, F. Kiefer and L. Kulczynski with five taxa each, and numerous others. It should be noted that the biospeleological research of Vjetrenica for the first time in the world determined the habitat of hygroperia or cave habitats of rocks with thin water layers and described the first organism specialised in this habitat and the beetle *Hadesia vasiceki,* J.Müller, 1911.Since 2004, systematic biospeleological research of Vjetrenica has been organised by the Speleological Association Vjetrenica from Ravno and the Croatian Biospeleological Society. In addition to microclimatic measurements, collection of fauna, macro photographs of cave organisms in the cave itself (in situ), a computer database for cave fauna was created and systematically supplemented with literature data and the latest field research data, including new taxa for cave fauna. Research has identified numerous new taxa for the fauna of Vjetrenica, including some new taxa for science. Numerous taxa were macro photographed for the first time. The microclimate of the property was periodically measured and the CO_2 content of the building was measured for the first time. Vjetrenica has both archaeological and paleontological significance. At the entrance to the cave there are two drawings typical of medieval tombstones known as stećak and the latest research has established the first archaeological finds for the cave, a piece of pottery and a bone needle. A summer house of an unknown Roman aristocrat was built at the entrance to Vjetrenica, and the air flow from the cave served as one of the first cooling systems (Grmek & Balabanić 2000). In 1952, Vjetrenica was for the first time placed under protection, under a decision of the Institute for the Protection of Cultural Monuments and Natural Rarities of the People's Republic of BiH, under No. 979/52. Since 1965, in accordance with the Law on Nature Protection (Official Gazette of SR BiH, No. 4/65, dated 5 February 1965), Vjetrenica has been placed in the category of "special geological reserves". In 2004, Vjetrenica was nominated for a preliminary list of UNESCO World Heritage. In Vjetrenica, 231 taxa have been detected (two bacteria, 14 fungi, 35 protist and 180 animals) including 103 taxa (47 troglobitic and 56 stygobitic). Vjetrenica has the world's largest cave biodiversity, including representatives of the following groups: *Nitrospira (1), Gammaproteobacteria (1), Trematoda (1), Enopla (1), Gastropoda (11), Bivalvia (1), Hydrozoa (2), Amphibia (1),*

Myriapoda (8), Insecta (11), Entognatha (4), Crustacea (36), Arachnida (9), Polychaeta (1), Oligochaeta (7), Hirudinea (1). Vjetrenica is also a type of locality for 37 species, including 14 endemics and three monotypic genera: *Zavalia vjetrenicae* Radoman, 1973 (Gastropoda), *Troglomysis vjetrenicensis* Stammer, 1936 (Crustacea) and *Nauticiella stygivaga* Moravec and Mlejnek 2002 (Coleoptera). Vjetrenica is a habitat of two Red List species, olm (*Proteus anguinus*) and minnow (*Delminichthys ghetaldii*). It is the very particular environmental conditions of the cave that provide a habitat for rare and threatened fauna. The cave also bears historic biological importance. More detailed information about this, but also the entire natural research of the area can be found in the Management Plan for the Protected Landscape Vjetrenica-Popovo polje.

7 Documentation

7.a Photographs and audiovisual image inventory and authorization form

Id No.	Format (slide/print/video)	Caption /Page	Date of Photo (mo/yr)	Photographer/Director of video	Copyright owner (if different than photographer/ director of video)	Contatct detalis of copyright owner (Name, adress, tel/fax, and email)	Non exclusive cession of rights
Figure 1	Slide	Entrance to the Vjetrenica cave (Source: Vjetrenica Public Company) Page 38	December 2022	Vjetrenica Public Company		Trg Ruđera Boškovića bb 88370 Ravno, BiH Tel.036/891-034 e-mail: info@vjetrenica.ba	PHOTO CONSENT FORM
Figure 2	Slide	Detail of the ceiling in the Spacious Hall with a network of anastomoses and deposited sigmas along tectonic and interlayer cracks Page 39	September/2013.	Nenad Buzjak		Nenad Buzjak Ivanečka 17 10000 Zagreb, RH Email: nbuzjak@gmail.com Mob: 00385958374022	PHOTO CONSENT FORM

Figure 3	Slide	Cascades in the part of the passage called Page 40	August/2013.	Mirna Mazija		Mirna Mazija Koledinečka 3, 10000 Zagreb, RH Mob: 00385913256320 Email: mirna.mazija@gmail.com	PHOTO CONSENT FORM
Figure 4	Slide	Ruscus aculeatus L. (picture left) and Galanthus nivalis L. (picture right) Page56	September/February 2014.	Aldin Boškailo		Aldin Boškailo, Počitelj polje bb, Čapljina; mob: 0038763205315; email: aldinboskailo@hotmail.com	PHOTO CONSENT FORM
Figure 5	Slide	Vegetation of forests and shrubs within the Protected landscape Vjetrenica - Popovo polje Page 57	May/ 2021	Aldin Boškailo		Aldin Boškailo, Počitelj polje bb, Čapljina,BiH mob: 0038763205315 email: aldinboskailo@hotmail.com	PHOTO CONSENT FORM

Figure 6	Slide	Vegetation of dry habitats in which widely used and well-known medicinal, aromatic and honey species Salvia officinalis L. - sage finds its optimum Page58	May /2021	Aldin Boškailo		Aldin Boškailo, Počitelj polje bb, Čapljina,BiH mob: 0038763205315; email: aldinboskailo@hotmail.com	PHOTO CONSENT FORM
Figure 7	Slide	Vegetation of rock cracks on which a large number of endemic and endangered species found their place to live Page59	June /2021	Aldin Boškailo		Aldin Boškailo, Počitelj polje bb, Čapljina, BiH mob: 0038763205315; email: aldinboskailo@hotmail.com	PHOTO CONSENT FORM
Figure 8	Slide	Vegetation of the Protected landscape Vjetrenica - Popovo polje in which there are wet meadows of the Mediterranean and sub-Mediterranean area Page 61	June/ 2021	Aldin Boškailo		Aldin Boškailo, Počitelj polje bb, Čapljina, BiH mob: 0038763205315; email: aldinboskailo@hotmail.com	PHOTO CONSENT FORM

Figure 9	Slide	Vineyards containing also autochthonous grape Page 62	May /2021	Aldin Boškailo		Aldin Boškailo, Počitelj polje bb, Čapljina, BiH mob: 0038763205315; email: aldinboskailo@hotmail.com	PHOTO CONSENT FORM
Figure 10	Slide	Panthera pardus spelaea Bächler, 1936 - Vjetrenica Cave Page 88	April/2013.	National Museum of Bosnia and Herzegovina		National Museum of Bosnia and Herzegovina Zmaja od Bosne 3, 71000 Sarajevo, BiH Tel:0038733 668-027 Email: kontakt@zemaljskimuzej.ba	PHOTO CONSENT FORM
Figure 11	Slide	Cave spider Stalagtia hercegovinensis Page 89	May/2019.	Roman Ozimec		Roman Ozimec Hvarska 8 Varaždin,RH Mob:00385992132576 Email: roman.ozimec@zg.t-com.hr	PHOTO CONSENT FORM

Figure 12	Slide	Cave beetle Hadesia vasiceki Page 89	May/2019.	Roman Ozimec		Roman Ozimec Hvarska 8 Varaždin,RH Mob:00385992132576 Email: roman.ozimec@zg.t-com.hr	PHOTO CONSENT FORM
Figure 13	Slide	Piece of pottery found in Vjetrenica Page 91	July/2010.	Vjetrenica Public Company		Trg Ruđera Boškovića bb 88370 Ravno, BiH Tel.036/891-034 e-mail: info@vjetrenica.ba	PHOTO CONSENT FORM
Figure 14	Slide	One needle Page 91	July/ 2010.	Vjetrenica Public Company		Trg Ruđera Boškovića bb 88370 Ravno, BiH Tel.036/891-034 e-mail: info@vjetrenica.ba	PHOTO CONSENT FORM

Figure 15	Slide	Medieval tombstone stećak at the exit from Vjetrenica Cave Page92	September/ 2010.	Vjetrenica Public Company		Trg Ruđera Boškovića bb 88370 Ravno, BiH Tel.036/891-034 e-mail: info@vjetrenica.ba	PHOTO CONSENT FORM
Figure 16	Slide	Tube worm *Marifugia cavatica* Page 98	June/2019.	Roman Ozimec		Roman Ozimec Hvarska 8 Varaždin, RH Mob:00385992132576 Email: roman.ozimec@zg.t-com.hr	PHOTO CONSENT FORM
Figure 17	Slide	Harvestman *Dinaria vjetrenicae* Page 98	August72019.	Roman Ozimec		Roman Ozimec Hvarska 8 Varaždin,RH Mob:00385992132576 Email: roman.ozimec@zg.t-com.hr	PHOTO CONSENT FORM

Figure 18	Slide	Cave cricket *Troglophilus sp.* recorded on 27 November 2016 Page 99	November/ 2016.	Roman Ozimec		Roman Ozimec Hvarska 8 Varaždin,RH Mob:00385992132576 Email: roman.ozimec@zg.t-com.hr	PHOTO CONSENT FORM
Figure 19	Slide	Mrazek amphipod *Typhlogammarus mrazeki* Page 100	June/2019.	Roman Ozimec		Roman Ozimec Hvarska 8 Varaždin,RH Mob:00385992132576 Email: roman.ozimec@zg.t-com.hr	PHOTO CONSENT FORM
Figure 20	Slide	Current tourist trail Page 149	August/2013.	Mirna Mazija		Mirna Mazija Koledinečka 3, HR - 10000 Zagreb, RH Mob: 00385 91 3256 320 Email:mirna.mazija@gmail.com	PHOTO CONSENT FORM

7.b Texts relating to protective designation, copies of property management plans or documented management systems and extracts of other plans relevant to the nominated property

The texts are added as a separate document:
Annex 2 - *List of typical populations in the area of Vjetrenica-Popovo polje (according to Ozimec and Lučić, 2010), and Overview of the species of underground fauna of the Vjetrenica cave with the threat category*

The Management Plan of the nominated entity is Annex 3 - *Overview of endangered status of species for which Vjetrenica is a typical place according to IUCN endangered categories (NA - not assessed, VU - sensitive, EN - endangered, LC - not endangered, and*

List of endangered species according to IUCN, Red List of the Federation of Bosnia and Herzegovina and protected species according to the Habitats Directive, Annexes II and IV (Insecta) in the area of Vjetrenica-Popovo polje

7.c Form and date of most recent records or inventory of the nominated property

A complete inventory of the fauna of Vjetrenica-Popovo polje was done in 2021 (Ozimec et al., 2021). Previous partial inventories were undertaken from 1960 to 2018. Detailed records of all surveys are kept, including registers, stratigraphic data, graphs, and related materials. The records are available in digital and paper form.

7.d Address where inventory, records and archives are held

NATIONAL MUSEUM OF BOSNIA AND HERZEGOVINA ADDRESS:

ZMAJA OD BOSNE 3, 71000 SARAJEVO

PHONE: 033 668-027

EMAIL: kontakt@zemaljskimuzej.ba

WEB ADDRESS: http://www.zemaljskimuzej.ba

7.1 Bibliography

(Note: Only a part of the literature that directly corresponds to the topic and the research project is provided, while a much wider range of bibliographic sources was used in the preparation of this project)

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8. Contact Information of responsible authorities

8.1 Preparer

Name: Marlena Ćukteraš

Title: Dr.Sc. in Biology Ecology and Physic professor

Address: Tasovčići 25. 88300 Čapljina, Bosnia and Herzegovina

Tel: 00 387 63 640 369

E-mail: mcukteras@gmail.com

Name: Ana Soldo

Tel: 00 387 63 461 182

Title: professor

Address: Đure Baslera 4a 88220 Široki Brijeg

E-mail: soldo.ana@gmail.com

8.2 Official Local Institution / Agency

Public Company Vjetrenica Ltd. Ravno
Address: Trg Ruđera Boškovića bb
Phone: +387 36 891 034
Fax: +387 36 891 034
E-mail: info@vjetrenica.ba
Web address: www.vjetrenica.ba

8.3 Other Local institutions

Ministry of Trade, Tourism and Environmental Protection – Herzegovina-Neretva Canton
Federal Ministry of Tourism and Environmental Protection – Federation of BiH

8.4 Official web address

http://www.vjetrenica.ba
Contact name: Public Company Vjetrenica d.o.o, Ravno
E-mail: info@vjetrenica.ba

9. Signature on behalf of the State Party