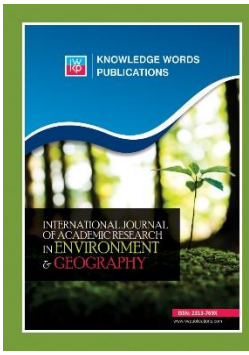

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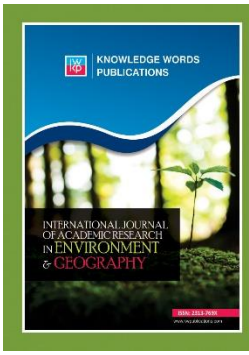

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The Main Karstic Geomorphosites with High Touristic Value in Mehedinti Plateau

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Abstract

This study presents especially the types of geomorphosites generated by water in Mehedinti Plateau area, like caves, the touristic offer in this area and the analysis of indicators representing the Global Touristical Value (GTV) of one of the main geomorphosites. This global value increased particularly due to their scientific, cultural and aesthetic values which make them suitable to ecotourism. The economic value is also an important indicator for the touristic activities in Mehedinti Plateau. The GTV of geomorphosites is determinated according romanian and international methods of evaluation. In Romania, Method (2009, 2012) of evaluation is the most method used for the geomorphosites.

In the Mehedinti Plateau, Mehedinti County, Romania, there is a great number of karsts complexes, also named geomorphosites, created by the action of water in the massive calcareous rocks. Some of these, such as Izverna and Topolnita-Epuran karsts complexes, are suitable to speleological tourism, cave diving, tourist and scientific explorations, underground and underwater photography and filming. Tourists come here from around the world and this is a place where special camps for lovers of cave diving, speotourism or hiking&climbing are organized annually.

Keywords: Mehedinti Plateau, Caves, Topolnita-Epuran Complex, Karst, Geomorphosites, Speotourism, Cave Diving, Scientific Value, Cultural Value, Aesthetic Value, Economic Value, GTV.

Introduction

Mehedinti Plateau is one of the smallest geographical area in Romania – it has only 78.5 square kilometeres surface (Balteanu, 2006), and is situated in Mehedinti County, South-West of Romania, near Serbia, between the Danube and the Motru rivers.

This is one of the representative areas for the beauty and uniqueness of the karstic relief in Romania even if limestone in its petrographic composition is less than 40%.

In a percentage of 50-55%, Mehedinti Plateau is composed of metamorphic rocks (crystalline), the rest is made of sedimentary rocks and in a very small percentage – granite.

More than half of the surface of the Mehedinti Plateau represents natural protected areas for the patrimony constituted by hills, caves, underground and surface animals and plants (see Fig 1).

Water from precipitation and rivers has created, during millions and thousands of years, amazing surface and underground geomorphologic forms in Mehedinti Plateau area - hydrological breakdown in calcareous strata where the processes of dissolution and precipitation are continuous. It is about erosion processus that generated numerous karstic forms and landscapes: caves, caverns, cavities, avens, whirlpools, sinkholes, uvalas, created by permanent or temporary water streams. There are also stalactite and stalagmite forests, cave minerals, huge rooms, water depths, waterfalls, karstic lakes (Pisota, Zaharia, Diaconu, 2010), karstic intermitent spring and water stream with mineral properties. In Mehedinti Plateau, some small karstic hills, named "cornete" (Ielenicz, Sandulache, 2008) and "cornatele" (Stroe, Peptenatu, 2011) are specific calcareous forms only for this area. The main geomorphosites like caves are created in this type of small calcareous hills.

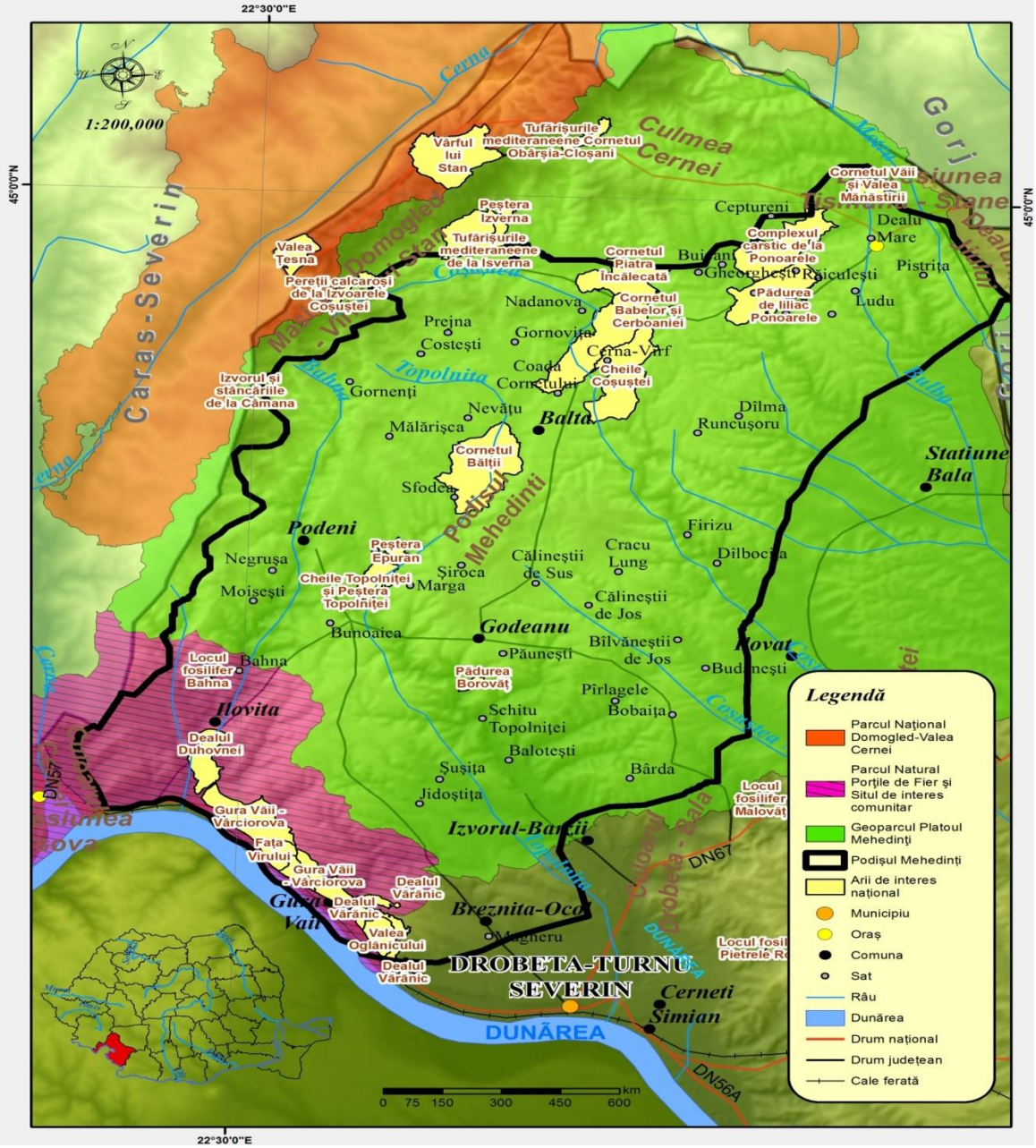

Figure 1. The map of Natural Protected Areas from Mehedinti Plateau
Source: Dragomir M., Iamandei M.

A geomorphosite represents a relief form and any process of relief with some characteristics that make it a touristic destination – value and importance for tourism, relief morphology, physiognomy, originality in a great area, link with any forms of tourism, link with other types of geosites, accessibility (infrastructure, accommodations). The general rule is that the total touristic value is given by all the main characteristics- Attractivity, Uniqueness and Visibility (Ielenicz, Comanescu, 2013).

The geomorphosite term and the methods for analysis are imposed by International Association for Geomorphology. In Romania, this term, *the geomorphosite*, was introduced in

geographical literature by Josan, Ilies, Comanescu in 2009. Later, the term was adopted and developed by Comanescu *et al*, (2010, 2012) who also developed her own theory and method for making the inventory and evaluation of the geomorphosites. The conception adopted by the most countries of Europe is that the geological patrimony is made up of the total number of the geosites included in an areal, while the geomorphologic patrimony represents the total number of geomorphosites from the discussed area. Generally, the geomorphologic patrimony is related to cultural patrimony, when between the human society and relief conections are established in time (Pereira *et al*., 2005 *apud* Comanescu and Nedelea, 2017).

In the Romanian legislation, there are not such terms as *geological patrimony, geomorphological patrimony,* or *geosite patrimony* and *geomorphosite patrimony*; the only one in use is the *natural patrimony*. In the same time, in Romania a national inventory of geosites and/or geomorphosites does not exist yet[1] and it was not started, but there are only local initiatives for different administrative-territorial unities which were not accomplished[2]. Anyway, the Closani-Baia de Arama geomorphologic site is one of the 16 geologic/geomorphologic sites proposed by Romania to be included in the UNESCO patrimony. A part of this geomophosite (Baia de Arama area) is one of the object of study of this work.

All these geomorphosites studied here are analysed according to romanian method devised in 2009 by Comanescu L. and updated by the same author in 2010 and 2012. The above mentioned author tries to impose these terms in the geographical specialty literature and updates personal methodology (Comanescu, 2009, 2010, 2012) (Ielenicz, Comanescu, 2013).

So, based on the research, studies and methods of Laura Comanescu, we started to make the inventory of the geomorphosites in the Mehedinti Plateau, with the aim of determining their global turistical value.

In Mehedinti Plateau there are more than 200 caves which are individual geomorphosites or included in the karstic complexes. In this small geographical unit there are 3 major karstic complexes situated in central calcareous structural bars:

1. *Epuran-Topolnita complex* - one of the internationally notorious karstic complex for its underground beauties and grandour;

2. *Isverna complex* which is well-known for cave diving opportunities and

3. *Ponoarele complex* - with its interesting calcareous landscapes - karenfields, caves and karstic lakes.

All three of them are included in a large natural protected area named GeoParc Mehedinti Plateau.

[1] The countries in which there is an inventory at a national level of the geologic/geomorphologic patrimony, are: Canada, Brazil, New Zealand, Australia, South Africa, Spain, Great Britain, Ireland, Holland, Switzerland, Italy, Denmark, Finland, Estonia, Lithuania, Poland, Czech Republic and Slovakia - according to the site http://geoheritage-iugs.mnhn.fr/index.php?catid=19&blogid=1, *apud* Comănescu L., Nedelea Al., *The geomorphological heritage - definition, assesment and management, comunication to the Geographical Sciences and the Future of Earth Conference, Faculty of Geography, University of Bucharest , 2017, 18 th-19th November*

[2] They are partially inventoried according to the Law no 5/2000 in the largest category of the protected national areas and monuments of nature, Idem.

Figures 2 and 3. Zaton lake in different seasons (rainy season – Fig. 2 -left, and dry season – Fig. 3 - right)
Source: http://www.ponoare.ro/atractii/lacul-zaton

In these three complexes are included over 100 geomorphosites which are about to be classified in a local inventory for the time being. Table no. 1 presents the main geomorphosites (area/punctual geomorphosites) of the three complexes. In this case, all the geomorphosites are classified as KAR geomorphosites (KARSTICAL geomorphosites).

Table no. 1 The main geomorphosites in Mehedinti Plateau

No	Name	Code	Type
1.	Topolnita-Epuran Complex	MHKAR1	area
2.	Topolnita Complex	MHKAR2	area
3.	Epuran Complex	MHKAR3	area
4.	Topolnița Cave	MHKAR4	punctual
5.	Epuran Cave	MHKAR5	punctual
6.	Isverna Complex	MHKAR6	area
7.	Isverna Cave	MHKAR7	punctual
8.	Ponoarele Complex	MHKAR8	area
9.	Ponoarele Cave	MHKAR9	punctual
10.	Karren fields from Ponoare	MHKAR10	area
11.	The Great Zaton Lake	MHKAR11	punctual
12.	The Little Zaton Lake	MHKAR12	punctual
13.	God's Bridge	MHKAR13	punctual
14.	Băluței Gorge	MHKAR14	punctual
15.	Gramei Cave	MHKAR15	punctual
16.	Bulba Cave	MHKAR16	punctual
17.	Cerboanii Pinacle	MHKAR17	punctual
18.	Babelor Pinacle	MHKAR18	punctual
19.	Bălții Pinacle	MHKAR19	punctual
20	Turcului Lake	MHKAR20	punctual
21	Gornovița Lake	MHKAR21	punctual
22.	Balta Lake	MHKAR22	punctual
23.	The Aven from Prosacu Hill	MHKAR23	punctual

Geomorphosites Evaluation

We determined the global value of these objectives using the romanian method (Comanescu, 2009; 2010, 2012, Comanescu et al., 2013) concerning the assesment of the geomorphosites. So, based on four characteristics – scientific, aesthetic, cultural and economic-,

subsumed under several criteria, we assigned each a score between 0 and 1 (see Table 2). Data related to those features are included in the inventory sheet that describes these geomorphosites based on field data and a large bibliography. The total average of the results obtained for each feature gave the total value of a geomorphosite such as the Izverna Cave case. (See also Table 2)

Table no. 2 TGV for Isverna Cave geomorphosite

Value Type	Score 1	Score 2	Score 3	Score 4	Score 5	Score 6	Total (average-sum)
Scientific	1	0.50	0.50	0.75	0.75	1	1
Aesthetic	0.75	1	1	0.25	0.75	-	0.75
Historical-Cultural	1	1	1	0.25	1	-	0.85
Economic	0.50	0.50	0	0.50	1	-	0.5
TGV							0.775

Source: Iamandei M., 2017

For example, for scientifc criteria – some score between 0 and 1 is given for some subcriteria such as - paleogeographic interest, representativity, surface (in an area), uniqueness, rarity, integrity, ecological interest; the result is given by the average of the scores obtained. For aesthetic – landscape contrast of colours, altitude, surface in an area, visibility in and over an area (0/0.25/0.50/0.75/1 score)

TGV (Touristical Global Value) represents the final average of the given scores for the four main characteristics – scientific, aesthetic, cultural and economic.

If the characteristics are analysed for the main geomorphosites from a certain area, the final TGV score is representative for the entire studied area. In this case, based on this methods, the TGV for Mehedinti Plateau is above the average (See table 3).

Table no. 3.TGV for the most important geomorphosites from Mehedinti Plateau

Cave	Scientific	Aesthetic	Historical-Cultural	Economic	Total (Average sum)
Isverna	1	0.75	0.85	0.5	0.77
Ponoare	0.87	0.55	0.4	0.45	0.56
Gramei	0.70	0.45	0.4	0.55	0.52
Epuran	0.95	0.8	0.6	0.3	0.66
Topolnita	0.95	0.85	0.95	0.3	0.76
TGV	0.89	0.68	0.64	0.42	0.65

Anyhow, this area is a very active touristically. The scientific tourism and eco-tourism are the most present, followed by speotourism, cavediving, historical and cultural tourism (see table 4)[3].

[3] See also for more details Bogan E., Iamandei M., 2016, *Romanian trout farms and wineries – successful touristic attractions IN International Journal of Academic Research in Environment and Geography*, vol. 3, issue 1, pp. 38-50, available at http://econpapers.repec.org/article/hurijareg/v_3a3_3ay_3a2016_3ai_3a1_3ap_3a38-50.htm

Table no. 4. Types of tourism in Mehedinti Plateau and their neighbourhoods

No	Type of Tourism/ Tourism forms	Centers/Places/Sights
1.	Scientific tourism	in the whole area
2.	Eco-tourism	Iron Gates Natural Park, Mehedinti Geopark Plateau, The Center and The North of Mehedinti Plateau
3.	Speotourism	Topolnița Karst Complex; Izverna Cave; Ponoarele Cave; Epuran Cave
4.	Cave Diving	Isverna Cave
5.	Historic tourism	Variuos historical sites regarding Romanian people; Ceausescu Protocol House; Ada-Kaleh viaduct (near former island)
6.	Religious tourism	Vodița, Topolnița, St. Ana churches
7.	Cultural tourism	Drobeta Turnu Severin, Orșova, Baia de Aramă, Ponoare
8.	Balneary tourism	Bala baths; Herculane baths
9.	Cycling	Along the Danube border
10.	Hiking&climbing	South, North and in the Center of Mehedinti Plateau
11.	Culinary tourism	Drobeta Turnu Severin, Porțile de Fier I, Orșova, Baia de Aramă
12.	Fishing&hunting	On hunting funds, under the laws regarding protected areas.
13.	Birdwatching, Photo hunting	Along Danube River. From the Hills, in the caves, from the natural bridges (Ponoare), from different heights and different angles, near and in unique forests (Lilac Forest from Ponoare) Black Pine Forest (Borovăț forest)
14.	Nautical tourism	Drobeta, Orșova
15.	Cruises on the Danube river	Orșova

Figure 4. View from under the God's Bridge
Source: Iamandei M., Personal Archive

Touristic Flows in Mehedinti Plateau

Regarding the presence of the tourists in this area, an analysis for 2010-2015 period, based on INS data (National Institute for Statistical Data), show rich touristical flows, every year, in the summer and winter, especially in July, August, respectively December and January (Fig. 5, Fig. 6) (Iamandei, 2016). Also, the average of data prove that Drobeta Turnu Severin, Orsova, Baia de Arama and Bala were the most preferred locations for overnight stays. It is about four cities situated in the South (Drobeta Turnu Severin – SE, Orsova – SW), respectively in the North (Baia de Arama and Bala – NE) of the Mehedinti Plateau. In the center of the Mehedinti Plateau, there are not many accomodations. We talk about rural tourism and ecotourism and the accomodation

can be made only in the houses of the inhabitants and in tents (The Management Project of the GeoParc Mehedinti Plateau, 2017). In 2016 and 2017, these tendencies have been mantained (National Institute for Statistical Data, 2017).

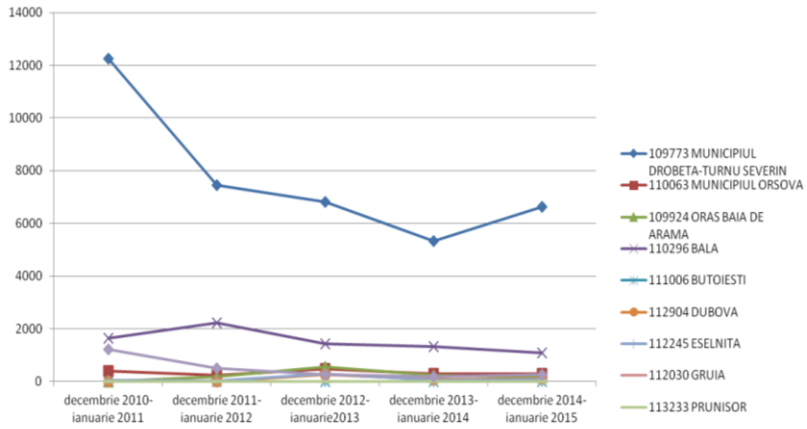

Figure 5. Overnight stays in the winter (average, December and January) in the establishments of touristic reception with functions of touristic accomodation (Mehedinti County, 2010-2015)
Source: Personal processing based on INS data

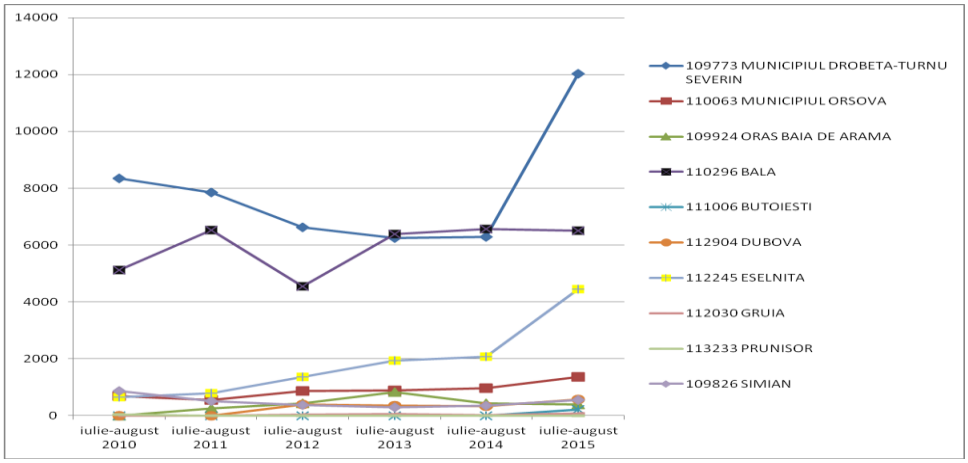

Figure 6. Overnight stays in the summer (average, July+August) in the establishments of touristic reception with functions of touristic accomodation (Mehedinti County, 2010-2015)
Source: Personal processing based on INS data (National Institute for Statistical Data)

Caves Type in the Mehedinti Plateau

From all types of geomophosites from Mehedinti Plateau we have chosen the main caves that constitute geomorphosites complexes.

In the Mehedinti Plateau there are 2 main types of caves:

I. Patrimony caves;

II. Touristic interest caves.

According to ISER/Emil Racovita Speological Institute of the Romanian Academy, there are 3 subtypes:

a. Touristical caves – Tourism (Show Caves);

b. Speological touristical caves – Speotourism;

c. Archaeological caves – Scientific Tourism.

Specialists of the Romanian Academy underlines the fact that in the caves even the speologists can destroy the patrimony of the caves during the exploiration for research.

"The caves destinated to specialised speological tourism represent particular touristic exploitation that may have a significant impact on underground environment" (ISER/ERSI, Romanian Academy – research, 2017). In many cases this impact can be more important and harmful. Everytime a person enters a cave it means aggression over it and disbalances for the underground environment. Generally, there is no control over the impact of the caves exploitation and is a great need of permanent monitoring of the caves. But in the especially in the center of the Mehedinti Plateau touristic traffic is reduced because the touristic objectives are included in natural protected areas for national and international interest. For e.g., EPURAN-TOPOLNITA COMPLEX is one of the biggest and important karst complex system from Romania due to its speological contents, scientific and landscapes high value of natural resources. This KAR complex has a natural protected area status (according the Law no 5/2000). There are 2 natural protected area with scientific extraordinary value, with numerous unique natural resources. The Epuran and Topolnita geomorphosites, situated deep in the heart of the Mehedinti Plateau (See fig. 7) are representatives for national and international speological patrimony.

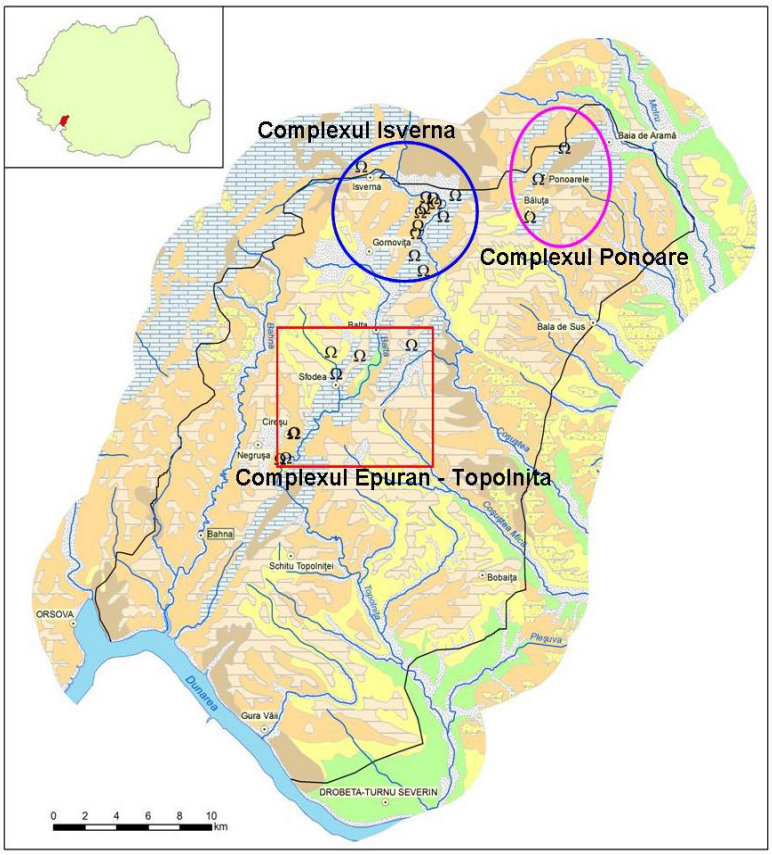

Figure 7. The main geomorphological complexes from Mehedinti Plateau
Source: Dimitrica C., The Institut of Geography, Romanian Academy

EPURAN-TOPOLNITA COMPLEX are 2 genetically connected caves.

1. EPURAN is a Scientific reservation, A class, with 3 levels, 3.560 m lenght. First level have unique concretions and the underground environment has a specific fragility due to speleothemes. This cave cannot be modified or planned. Scientific researches or documentary activities are allowed only based on an authorisation from The Comission of Speological Patrimony.

2. TOPOLNITA is a Scientific reservation, A + B classes (Prosacului Gallery), 6 levels – 2 active+ 4 fosils, 20.500 m lenght. This cave is included in European speological patrimony. In Prosacului Gallery are allowed ecotouristic activities. Top Cave is the meeting point of 4 streams; the cave is a labirinth of over 20 km2, dug in only 5 km of calcareous bar.

Water has worked here, creating holes in a small rock volume. In spite of those over 20 km of holes, not the expantion is the most important thing of this cave, but the way in wich this whole was created. So waters have created here spectacular forms and each level has a specific and original architecture of the galleries. The cave is a natural museum, with thousands of exhibites that cannot be described but those that enter it. The cave is not only beautiful but also vast, very varried and full of surprises. It is one of the most complex and interesting caves in Romania.

Figure 8. To the Clestar Lake in Topolnita Cave
Source: Iamandei M., Personal Archive

Touristic Flows in the Center of the Mehedinti Plateau

One small passage of Topolnita Cave is opened only one day per year, for 6 hours. In 2017, on Top Cave Day, tourists were allowed to visit the cave in the restricted area (one small pasage from the cave), but only 200 managed to visit in this 6 hours while other 200 visitors could not visit it. 200 visitors is a big number taking into account the fact that normally, only around 50 persons, mostly researchers, are permitted to enter the cave annually (See Table 5).

Table no. 5. Visits in the caves from the Mehedinti Plateau

No	Cave	Type-with/without restrictions	Visits/2017		Pers/ entrance	Visitors from	Time/ visit
1.	Topolnița	With restr.	apr-oct	The Day of Topolnita	5-8	Romania, Spain, Germany, Poland, Turkey, France, Sweden	5-6 h
			30	200pers/ 6 hours			
		Prosăcului	100				
2.	Epuran	With restr	8		3-5	Romania	2 h
3.	Isverna	With restr	unknown		3-5	Romania, Hungary	6 h
4.	Gramei	-	50		5-10-15	Romania, other	1h
5.	Ponoare	-	100		5-10-15	Romania, other	1/2 h

Source: Geopark Mehedinti Plateau

On the other hand, in the active zone of The Topolnita Cave - Prosacului entrance, the number of visitors excedes 100/year, namely people who love speology and cave diving, mostly researchers (See also Table 5).

To Preserve Caves

Preserving underground environment is a MUST, also preserving the external environment. The discussion is about preserving versus opening the caves for tourism. That why MONITORING CAVES in more stages is necessary. CARRYING CAPACITY is to be calculated for a longer period is necessary to determine the SOUSTAINABILITY of the caves.

MONITORING CAVES

There are 3 phases of monitoring (ISER/ERSI, Romanian Academy, 2017)

1. Preliminary monitoring;
2. Monitoring during planning project implementation;
3. Before and all the time after the opening a cave for tourism.

Researchers make measurements with Dataloggers (see Fig 9) , they have been monitoring biotic and abiotic environment (Ibidem). The mesured parameters are temperature, Radon levels, absolute humidity, CO2 concentration, air circulation, bats colonies, water properties, water percolation rate, guano deposits, fossil deposits etc. The researchers analyse for at least 2 years cave roof, walls, cave floor, the environment over the hills where the caves are situated.

Figure 9. Researchers make measurements with dataloggers in the caves
Source: Petculescu A., Personal Archive

In the Topolnita cave, there are 8 bat species, grouped in maternal or hibernating colonies: *Rhinolophus blasii, Rhinolophus euryale, Rhinolophus ferrumequinum*, *Rhinolophus hipposideros, Myotis myotis/ M. blythii*, *Myotis capaccinii, Myotis daubentonii*, *Miniopterus schreibersii.*

In 2016, there were approximately 9000 bats in maternal colonies and over 3000 bats in hibernating colonies. Taking into account the fact that these bats are very rare and protected by law, there are discussions about opening or not the cave for tourism.

Figure 10. Bats colony on limestone

Figure 11. Bat sleeping on the cave wall (detail)
Source: http://surprising-romania.blogspot.ro/2011/01/isverna-cave.html

Show Caves Vs Non-Touristic Caves

The topics of discussions are focused on isbalances vs preservation, aggression over cave natural conditions in caves.

In EPURAN-TOPOLNITA COMPLEX the monitoring started one year ago.

Researchers have already decided that EPURAN cave is forbidden to be ever opened, still being visited in the entrance area and that TOPOLNITA cave is forbidden to open. The possibility of opening for small sectors of the Topolnita cave is still under study. The researchers are still going on and this might last for the next 2 years.

Under these conditions, there is a solution of compromise for visitors:

The THREESOME – 3 caves/parts of caves that can be visited: 1. Epuran - can be visited only in the entrance area, 2. Topolnita - active part can be visited and 3. Grama Caves -totally opened to tourism. The last one compensates through its beauty and richness for the partial accesibility for the other two caves which are part of the same complex and are very close to one another.

Even if Topolnita and Epuran caves will not be totally opened, the tourists are intersted in visiting parts of these caves and their neighbourhoods.

Figure 12. View of the Gramei Cave entrance
Source: Iamandei M., Personal Archive

Figure 13. Climbing calcareous wall above the Epuran Cave entrance
Source: Iamandei M., Personal Archive

Figure 14. One of the Topolnita Cave entrances
Source: Iamandei M., Personal Archive

Conclusions

In the Mehedinti Plateau, there are numerous geomorphosites with high touristic potential, based on GTV. All of these are exploited partly and localy in tourism but all of these need money, investments, especially in infrastructure and touristic facilities – hotels, boarding houses, souvenirs selling, products made by the local people. Even if this area will be opened more and more for tourism, that will be only for controlled tourism, ecotourism. Mehedinti Plateau is a small geographical unit, but it represents Romania through unique karstic landscapes and karstical patrimony for international interest.

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