

Review paper

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GEOMORPHOLOGICAL SPECIFIC FEATURES OF TREBINJE AS TOURIST ATTRACTION

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Abstract: The municipality of Trebinje is located in the Trebišnjica river basin in the south of Bosnia and Herzegovina. Among Bileća, Ljubinje, Ravno, Herceg Novi, Dubrovnik and Nikšić a very specific and distinguishable karst countryside has developed which is made of karst polje in a debris, mountainous scope (Leotar, Bijela Gora, Zubačke mountains) and huge number of bare limestone hills and the surfaces with all micro shapes of holokarst. The author emphasizes the tourist attractions of the specific geomorphological shapes that can be valorized by the tourists in his works.

Key words: Trebinje, Popovo polje, Trebinjsko polje, holokarst, Leotar Mountain

Introduction

The municipality of Trebinje extends from 42° 42' north latitude and from 18° 20' east longitude between two areas: mountainous in the north and coastal in the south. These two areas are located at the distance of 100-130 km and they are connected by the roads through the territory of Herzegovina.

A very important feature of the geographical position of Trebinje is reflected in the fact that Trebinje is located in the coastal, eastern Herzegovina at the junction of three borders of Bosnia and Herzegovina, Croatia and Montenegro. The natural physiognomy of Trebinje and its surroundings are made from karst Trebinje polje and distinctive karst mountainous scope (Leotar, Bijela Gora and Zubacke mountains) and a large number of bare limestone hills and surfaces with all microforms of holokarst.

Trebinje is located in the far south of Bosnia and Herzegovina in the northeastern part of Trebinje polje at an altitude of 274 m. The river Trebišnjica flows through the entire territory. The area is located in Humine (low

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Herzegovina²) at the narrow part that separates the area of karst lakes from the Adriatic Sea. The town is located in the hinterland of the Adriatic Sea, specifically in the hinterland of Dubrovnik and Herceg Novi coast. The municipality of Trebinje covers an area of 904 km². Trebinje borders with Bileća in the north, with Ljubinje in the northwest, with municipality of Ravno in the west, with Dubrovnik in the southwest, with Herceg Novi in the south and Nikšić in the east.

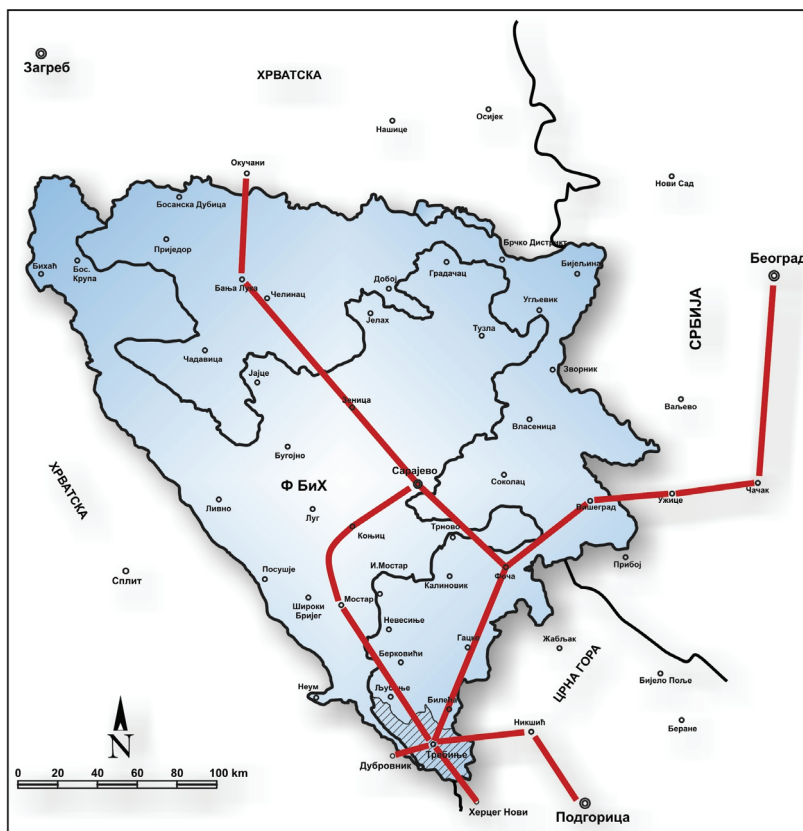


Figure 1. Position of Trebinje in Bosnia and Herzegovina

² By low Herzegovina it is meant the area of 500 m of altitude. This term has more a qualitative meaning, because it denotes the areas with relative strong material influences which are reflected in the structure of cultural landscape (Gnjato, 1991).

Geology structure of the area

Karst polja of Eastern Herzegovina cover geographical area of the municipality of Trebinje. Recent macro-surface karst relief forms are predisposed by the neotectonic processes in this and wider area and they are mainly shaped by the corrosive and fluvial processes (Gnjato, 1991).

That is an integral part of the large geotectonic unit ``Visoki krs`` and it is almost entirely built from the rock of sedimentary origin that is from the karst and dolomite. The limestones prevail so much that we can say they build over 90% of the entire area. In the area of the flow of the Trebisnjica there are Mesozoic old stones developed in the limestone and dolomite facies. The earliest Triassic dolomite fields are located in the area of Grancarevo and they stretch out, covering larger and larger area to the east, and they are from the late Triassic age. The Jurassic formations are represented by the limestones which are nicely layered and occasionally occur in limestone and marl layers which are more common in the lower parts of the series. In Liassic limestones there are basins full of litiotis especially in the way of Arslanagica bridge to Lastva, while in the area of stretching out of Jurassic limestones upstream from the Lastva megalodisi are very common and litiotis are fewer. The Cretaceous formations have also been developed in the limestone facias, but unlike Jurassic they contain much more dolomite. In the immediate part of the flow of Trebisnjica there are Mesozoic formations from upper Triassic to upper Cretaceous. In the series of these sediments certain parts are missing, especially when lower Cretaceous is concerned. All formations are mostly developed in the limestone facies, thereby providing the conditions for karstification that was supported by the intensive tectonics in some specific places (Sikošek, 1954).

The main structural forms in tectonics in the area of Trebinje are anticline and kraljusti-blocks. The part of the terrain around the springs Oko (about 4 km eastern from Trebinje) to Bileca belongs to the first ones while kraljusti or less independent building blocks of the area around the springs of Mokro polje are formed in front of kraljusti. The genesis of those structural forms is conditioned by the very place of these areas in the Dinaric orogen tree, considering that Trebinje is placed in the area of outer Dinarides and it belongs to a typical holokarst (Sikošek, 1954).

Geomorphological specific features of Trebinje as tourist attraction

Morphologically this is an area of typical karst terrains with all the highly developed forms of karst erosion, from corrosion forms and sinkholes to valleys and karst fields. In addition to the karst fields we emphasize the importance of the larger karst valleys and numerous sinkholes.



Figure 2. Physical geographical map of Trebinje area

Trebinje and Popovo polje

Popovo polje covers the area of 4500 ha. The polje is at 227 to 251 m of altitude; where as the surrounding hills and mountains are significantly higher (Zaba 953 m, Bratogosac 868 m, Vranjak 1073 m and Bjelasnica-Siljevac 1298 m). The saddles are also distinctive that surround the polje and through which Popovo polje interacts with the environment. The most significant saddles are the ones on the line Zavala-Orahov Do-Slano, then Ravno-Trebinje-Cepikuci, Hutovo-Gradac-Neum, Donje Hrasno-capljina, Kotezi-Ljubinj and Dracevo-Trebinje (The Devon Karst Research Society, 2009). This polje is polygenetic, tectonically predisposed, straightened by the river accumulation. The brinks of the polje are drilled in places by the corrosive process by the sinkholes (Gnjato, 1991).

Popovo polje is contains many morphological areas karsts morphological and karst hydrology subunits (The Devon Karst Research Society, 2009). Popovo polje and Trebinje polje are connected by the relatively short narrow part of the valley, and they are separated by the kart plateau Luga of relative height of few meters. Plateau Luga continues into the Forest, also typical holokarst area and this one turns into Trebinjsko polje. The main morphological subunit of Popovo polje is Trebinjsko polje in the east which also has its morphological subunit Mokro polje. Morphologically, Trebinjsko and Mokro polje cover the area of about 12 km. All the surface and undreground forms have been developed in polje. Broadly speaking, geologically Popovo polje encompasses straightened area between hills from Trebinje in southeast to Hutovo in the northwest. In the narrow sense Popovo polje is lower northwestern part of the valley cf Trebisnjica covered by the fertile layers of soil. Three natural entireties are clearly distinguished within the Popovo polje. (The Devon Karst Research Society, 2009):

- Mokro polje wedge-shaped southern from Trebinje, 18 km² of surface 268-275 m altitude.
- Trebinje forest, the stony platean from Trebinjeto Poljice 23 km long, 4-8 km average breadth and 115 km² surface. The part from Drazin Do to Hum is called the Forest and more downstream Poljicalug. It is completely without drifts, karst surface which is cut into by the numerous curries and precipices. The Trebisnjica is cut into the stony surface to 7-8 m, 250-270 m altitude.
- In a narrower sense Popovo polje is the area between Poljice and Hutovo. It is covered by the fertile alluvial drifts 37 km of length, 1-3 km of breadth thus 68.4 km² surface, 220-250 m altitude. Gornje polje is called the area from Poljice to Ravno, and from Ravno to precipice of the Trebisnjica donje polje.

Trebinjsko polje is a very distinctive part of Popovo poljska valley which makes genetically and morphologically a very complex formation. It is in fact a vast extension in the valley of Trebisnjica that extends transversely to the river and covers the area of about 18 km². The polje is irregular in shape and it narrows steadily to the south. The longer axis extends to north-south. According to this axis Trebinjsko polje is about 6.5 km long. The shorter axis oriented to east-west is much smaller and it varies within the range from 1 km (in the area of Zgonjevo village) to 3.8 km (in the area of Trebinje-Mostaci). The whole area of the polje is much straightened and the altitude of the bottom is between 268 and 275 m (Zubčević, 1976).

From the alluvial drifts from the village of Pridvorci a big residual limestone hill divided into joints rises typical karst 404 m high. A few isolated hillocks stretch

with which hillocks are attached to peripheral area, the completely low bars, especially around Zasad and Mostici settlements in the northern polje peripheral area. Their relative heights are not over 15 m (Zubčević, 1976).

The Trebisnjica flows through the northern side of the polje, by the river bed that is cut into deposited gravel and sand. However, the river bed of the Trebisnjica goes into the limestone substrate although it is an exceptional one. It is characteristic that altitudes are getting higher towards Gomljani and Drazin Do, in the short distance down the river bed of the Trebisnjica. Furthermore into forest the terrain gradually and slowly falls to the north west. From the peripheral parts on all sides especially from the north east and east towards the plain of polje many dry karst valley and the river beds of recent torrent flows which are often deeply cut into the mass of peripheral mountains. A special feature of this part of valley is that it provides a number of underground karst shapes, which are as springs estavelle and precipices placed along the edge almost in all directions (Zubčević, 1976).

Trebinje polje exceeds into karst plateau of the Forest and Lug in the west. By the Forest we mean the part of plateau that extends from Gomljani and Drazin do settlement to Hum settlement. From here to Poljice settlement the other part of the plateau extends known as Lug. The whole plateau is by the longer axis of direction about 23 km long and 4-8 km wide, the whole area is about 115 km². The Forestuma and Lug are mostly built in top cretaceous limestone and they extend Dinarski (Zubčević, 1976).

Unlike Trebinje and Popovo polje the plateau of Trebinje Forest is completely without drifts. The plateau of Trebinje Forest is often called the whole area of Suma and Lug. Today the surface of the plateau is shortened and cut into by the numerous sinkholes (The Devon Karst Research Society, 2009).

Due to their appearance and the fact the karst shapes are almost deep, Forest and Lug mostly resemble the shallow karst areas where there is determined by the water sustainable stony formations. A large number of hillocks rise up from the bottom of the plain. The plateau pretty sharply goes into the peripheral area. Otherwise the plateau as whole falls slowly to the north east. The altitudes are between 270 and 250 m everywhere. The Trebisnjica flows through the northwest edge of the plateau by the riverbed which is cut into the limestone. (Zubčević, 1976).

In the narrow sense Popovo polje or Blato is the last lowest part of Popovo valley. Popovo polje extends by its largest part to the direction of southeast-

northwest where it gradually decreases. The heights of the bottom slightly vary between 250 and 220 m. The bottom is filled up by the loose drifts which are quite good and pretty fertile soil in the surface area. The whole area of the field is 68.4 km². Its width is not equal everywhere. It is the longest at the beginning (almost 3 km) and the narrowest at the end near Hutovo settlement where the width is less than 1 km. The most of Popovo polje is built from limestone and dolomite. Dolomites are subordinately spread. Popovo polje basically extends Dinarides. However, the direction changes in the far northwestern part. From Ravno by detouring Bratogasić massive Popovo polje makes semicircular bend and from the Velja Medja village to the end changes into parallel direction of the extension. The edge of the polje is dissected. Many slides for logs from the upper parts, especially in the south east to the flat part of the polje come down where the stored alluvial fans are deposited.

Otherwise, the polje is from the all sides except from Trebinje Forest framed by the mountain circuits, so the whole area reminds of the ``blind valley``. The edge of Popovo polje is cut by three typical dry karst valleys, the first one goes to the valley of the Neretva, and it is known as Hutovska hollow. The second Vala stretches from Zavala to Slano, towards the Adriatic Sea, and the third from Strujic to Ljubinje (Zubčević, 1976).

Popovo polje is made from several different entiresities: Mokro and Popovo polje where initially ravines and they were created and expanded by the primary karstification. Then that they were filled by the deposition of the different materials. Forest plateau was formed by erosion of limestone surface. In the Pleistocene, the geological era that lasted about two millions of years, a few ice and between ice eras changed. Harsh climate crushed the rocks which the water rinsed and took to the ravines. Three valleys were observed from where a lot of water has flowed. Pretty karstified surface has been transformed: the ravine was becoming wider and spacious and limestone edge of Trebinje Forest was created. Numerous hillocks on the edge of Popovo polje represent complexes of more resistant stones which water couldn't dissolve. The unique flow of the Trebinjica to Hutovo was provided by the filling and reducing the area of Trebinje Forest and by filling the depression of Popovo polje (Zubčević, 1976).

In the morphology of the relief besides polje we emphasize the importance of the karst (limestone) in the intermountain area. They can reach the surface up to 20 km². In the region of East Herzegovina a specific relief forms are made from corrosive plateaus. These areas are also very limestone without water except rainfall with the feature of degraded vegetation. This area is also featured by the morphoscluptural relief forms in the karst so we emphasize a great number of

karst sinkholes. In the typical holokarst area such as East Herzegovina underground relief forms are developed. We emphasize the value of caves and pits at the area of the municipality of Trebinje.

Vjetrenica cave

Vjetrenica cave is located in the southwestern part of Popovo polje near the village of Zavala. The absolute height of cave opening is 286 m. The opening is 22 m of the relative height above the riverbed of the Trebisnjica. Vjetrenica was named after an interesting meteorological phenomenon that was observed there. In the summer time when the temperatures are much higher above the cave than in it, a cold air circulates from the inside to the exit of the cave. The sound of the air can be heard a few meters from the opening in the winter, when the outer temperature is lower than the interior one, completely different air circulation is created that is the cold air circulates in the cave where it gets warmer. The currents are caused by the differences of the temperature and the air pressure, but they are highly potentiated by the channels in which they occur are related to the topographic surface (Radovanović, 1929).

Vjetrenica cave is divided into Upper and Lower Vjetrenica. Upper Vjetrenica is its oldest part and as we go lower, its channels are younger by its origin. Lower Vjetrenica is a younger cave of polygenetic origin that is excavated after the creation of Upper Vjetrenica. Water of the main channel of upper Vjetrenica and numerous currents leaking and jets of lower channels in the depth influenced on the genesis of the cave. These cave channels are separated from topographic surface by the series of limestone layers which are more than a few meters thick (Radovanović, 1929).

Vjetrenica has been explored in the length of 7500 m. There are several halls in the explored channels. The first hall from the entrance in the cave is 10-15 m wide, 35 m long, and 5-6 m high, the second hall, 115 m from the entrance is about 110m long, 15-25 m wide. Eastern from the big lake there is the highest hall of Vjetrenica, about 80 m wide and it is called Cvijiceva hall. There are more halls which are connected by 1-15 m canals. Travertine channel is large-sized about 120 m length. There is white malt on its right side. The side channel is of 10-12 m wide and over 15 m high, the absolute height of the highest part of the main canal exceeds 330 m more than cave door 62 m of relative height. At 600 m from the cave door, by the main channel a big right channel branches off and ends on 483 m by Siphon Lake. Absolotov channel is examined from the Upper to Lower Lake at the length of 780 m (Mihić, 1976).

Hydrography of Vjetrenica is very complicated. Among the numerous lakes of Vjetrenica, according to their hydrographic features two main types can be distinguished: permanent or real lakes which are always held even at the low hydrographic conditions and periodical or temporary lakes which usually dry up at the end of the summer or at the beginning of autumn, some of them do not dry up for several years, and they make traditional form between the permanent and periodical lakes (Radovanović, 1929).

At 775 meters from the cave opening in Upper Vjetrenica there is a large periodical lake which is 255 m long and 30-35 m wide, up to 4 m deep, which makes it the largest underground lake in former Yugoslavia. The area of the Great Lake is the absolute height of 270 m that is 2 m more than the cave opening, but the bottom of the lake is slightly lower than the cave opening. Siphon lakes of Vjetrenica cave are on the different absolute and relative heights. There is no a general height level where they appear. Upper lake, where the stream flows is on much larger absolute height of 270 m from siphon or Crno Lake (244 m). There is waterfall from 3-4 m of height in Upper Vjetrenica with a fall of water heard at a distance of 300m. Through the main channel of the cave the stream flows that gets two small tributaries at low hydrographic condition. One tributary is from the narrow channel on the right and the other from travertine basin which falls toward Veliko Lake. Since these basins are high above the bottom of the channel, they could be strengthened into hanging travertine basins or lakes (Radovanović, 1929).

Vjetrenica cave is extremely abundant with stalactite and stalagmite, large travertine pillars, huge travertine malt, giant pots and other cave ornaments. The depth of the pit of Lower Vjetrenica from the upper lower opening is about 20 m to the bottom and from lower entrance on the side of the main canal Vjetrenica is only 11 m. There are other pits in the main channel of Lower Vjetrenica from 20 m length and 18 m depth. The part by which this channel goes into this hall was waterfall from 10 m height until karstification of the front part of the channel has been made, and below the waterfall part the Lower lake was formed. (Radovanović, 1929).

Vjetrenica cave is a great attraction for tourists. The underground forms of the cave are curious, its halls, siphons, malt, stalagmite, stalactite, travertine lakes, there are about 130 such lakes in the cave, waterfalls, air circulation and relict flora are also attraction for study of the speleologists, biologists and hydrologists.

There are also two caves which represent tourist attraction near Vjetrenica cave. Near the town there is a famous Pavlova cave above Petro-pavlovski monastery. According to the tradition apostle Pavle was dwelling there and he baptized people of Herzegovina. Vilas cave near Gornje Cicevio also has a tourist value.

The mountains as tourist attraction

At the junction of three borders of Bosnia and Herzegovina, Montenegro and Croatia among Boka Kotorska, Konaval, Trebinje, Grahovo and Crkvice there is Orjen (1895) the highest. Dinarsko-coastal mountain surrounded from the all sides by ridges, crests and peaks which make unique and attractive giant mountain whole. In relief of Orjen there are the most crests on which there are over fifty peaks higher than 1500 m altitude separated into five different sectors. These are: western or Vrbanjski area, eastern or Crkvicki sector, northeastern and west or Bijela gora, northwestern or Dobri do and final north western part or Konjsko-orahovacki sector (Mihic, 1976).

In the relief of Orjen, at the area of 403,9 km² there are 50 peaks with over 1500 m of absolute height or 218 km² of the area over 1000 m altitude. This relief is the world for itself. The ice and karst erosion significantly influenced on mountains relief over 1000 m. There may be separated peaks in the form of ridges arising gradually from south to north. The central part encompasses a number of high peaks properly arranged at the big semi-circle around Vrbanjsko polje. Gigantic crest Prasa joins central and northern part by the part of the mountains of Orjen structure that is: it joins Orjen with unreachable romantic Vuciji zub (1805 m), Jastrebica (1867 m), Pazva (1745 m), Reovacka greda (1609 m) and spacious, timbered, karst plateau Bijela gora which stretches in the south to Korjanic and Grahovo. To Grahovo slopes of Bojanje brdo 1048 m are very topographical and they make watershed to the Grahovska river, in the west from Bojanjeg brda we pay special attention to Paljka prodo or Pasovica prodo due to the transversal position to the tributaries of the Trebisnjica. The mountain is the most prominent in the northwestern part and in the north the only place you can follow Dinaridas tectonics direction northwest-southeast, the largest surface of 1500 m height is in this area (Mihic, 1976).

Bijela gora the area of 92 km of the overall surface of Orjen of 23%. It is significant that is the large areas of Bijela Gora are 88,4 % over 1000 m, between 1200 and 1300 m 27,9% (Ridjanović, 1966). From those heights there are separated peaks jutting out in the relief. Centrally positioned Lisac (1586 m) is significant for bare and steep sides and then height above wooded surroundings. Decidious forests dominate in the northwest of Lisac, in the

southeast grey rocks ground prevail and at the edge less forest reappear. The remaining area of Bijela Gora is characterized by various forms of covered and bare karst, then larger that is to say smaller drifts which are isolated from the environment. Wooded areas of Bijela gora are end steeply and abruptly in deep valleys of the tributaries of the Trebisnjica. (Zaslepnice, Nudolska rivers and kunski stream) and in the relatively open basin of Grahovsko polje (Mihić, 1976).

The karst is the main and basic characteristic of Orjen relief. Periglacial relief was very developed, limestone process was very intensive. Glaciation modified karst of Orjen and altered the relief in places. Orjen is a mosaic of limestone, typical karst mountain with the abundance of well preserved specific traces of Pleistocene glaciations. The Ice Age left numerous traces. Many climbers, skiers, tourists and scientists were inspired by the natural beauties of Orjen for decades. Bijela gora is 55 km away from Dubrovnik and from Herceg Novi 35 km away and from Trebinje 22 km away. This states that the sea-mountain link is very close. By connecting Bijela gora and the Adriatic sea and Trebinje, an extremely attractive and unique tourist site is obtained with lots of varieties and richness of different contrasts and beauties rarely found anywhere in the world.

Leotar Mountain (1224 m) is the highest limestone peak in the area of Trebinje. There is Ljubomirsko polje in the north and Trebinjsko polje in the southwest, the solid structure and cliffs of Leotar haven't prevented the creation of many classical geomorphologic forms like sinkholes. Although there are vertical pits the greatest development happened under the ground. The vertical contours of Leotar are not endowed with vegetation and they are sporadically cut into parallel surface of canals which carry water in the periods of heavy rainfall. The average precipitation permeates mountain range and underground drainage systems. There are springs at the place of junction of the range of Leotar and Trebinje polje. The mountain of Leotar is famous for medical herbs. There are many hills on the foot of Leotar in the south and southeast. Similar to the peak of Leotar some of these lower elevations such as Kablo and Klicanje were used during Austro-Hungarian occupation in order to make many fortifications which surround Trebinje. Some of these fortifications are still used, but not for military purposes. (The Devon Karst Research Society, 2009).

Table 1. SWOT analysis of geomorphologic characteristics

Strengths (S)	Opportunities (O)
<p>Morphogenetic and morphographic diversity as a key factor in the diversity and attractiveness of the landscape;</p> <p>Pronounced morphosculptural elements that allow broad views of the interesting natural scenes, walking, cycling, horse riding, paragliding, mountain climbing;</p> <p>Relatively easy to reach the hill tops that are attractive viewpoints (Leotar, western slopes massif Zupci, Donje Police (Crkvina);</p> <p>Cave Vjetreniva, Pavlova and Vilina cave as a motifs and facilities for tourist visits, with adequate planning and equipment;</p> <p>Mountain Orijen, with steep slopes at altitudes of 1000-1895 meters as the only area in the municipality of winter recreation opportunities.</p>	<p>The development of tourism of special interests;</p> <p>The routing tourist and recreational trails, trails of health, viewpoints;</p> <p>Caving tourism;</p> <p>Educational centers (schools in the countryside, field trips, hiking and excursion centers, etc.);</p> <p>Potential ski runs on Orjen.</p>
Weaknesses (W)	Threats (T)
<p>The difficulty of building and maintaining a network of village roads;</p> <p>The difficulties of maintaining mobility of local and regional roads in winter conditions on the sections that go higher parts of the terrain or crossing over the saddle (roads: Zavala-Orahov Do-Slano, Foca-Cemerno-Trebinje, Dracevo-Trebinje, Ravno-Trebinje- Cepikuci);</p> <p>Inadequate valorization of geomorphological value for tourism purposes.</p>	<p>Ignore the natural conditions;</p> <p>Failure to carrier space capacity;</p> <p>Lack of strategic plans to activate geomorphologic tourism values.</p>

Conclusion

The territory of the municipality of Trebinje is not very touristic area. However, Trebinje and its surroundings have a number of high potential natural and anthropogenic tourist values, its high value far beyond merely local, regional and even national boundaries (Vukojević, 2010).

Taking into account the results achieved in this paper in the concluding remarks we state that the primary tourist offer in the future development of tourism should be based on the emphasising important cultural specificities the town. Trebinje possesses with its surrounding settlements and cultural and historical monuments. But as important, complementary tourist value nad attractiveness of geospace we emphasise geomorphological characteristics of a typical holokarst.

At the relatively small geographical area (904 km²) specific and highly attractive geomorphological karst forms of relief have been developed which, combined with climate characteristics create an authentic landscape of Herzegovina. The landscape presents an important tourist attraction that should be far more valorized in the future tourist development of Trebinje.

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