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RESEARCHING THE TOURIST ATTRACTIONS AND THE ATTRACTIVENESS OF THE VALLEY OF THE RIVER MREZNICA

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Abstract: The River Mreznica (64 km) is a watercourse in the region of Central Croatia. In the valley of the Mreznica, the forms of the relief created by erosion and deposits present an important basis for tourism development.

This paper explores their appeal (attractiveness).

In terms of tourism, about 10 per cent of the direct resources have already been valorised, while the remaining resources represent potential tourist attractions.

The real tourist attractions are located in the lower valley, whereas the potential attractions are found in the middle and upper river valley. Access to potential attractions and their valorisation in tourism is impeded by the spreading of the underbrush, which has advanced considerably over the past twenty years, and by the fact that the upper valley is located in the zone of the "Eugen Kvaternik" Military Polygon.

Travertine barriers, which have created a specific type of waterfalls and cascades, together with mills, bridges and ferries, characterise the tourist attractions in the valley of the River Mreznica.

Key words: tourism, Mreznica, travertine, waterfalls, mill.

INTRODUCTION

The economic and geographic valorisation of the Mreznica valley is linked to the formation of settlements by immigrant cattle-raisers during the time of the Croatian Military Border in the sixteenth century.

With the end of the Turkish threat, the importance of the lower valley became prominent in terms of traffic (transit). The Emperor Joseph Road, connecting the towns of Karlovac and Senj in the late eighteenth century, was built at that time as a part of efforts made to develop a transport system linking the Danube Basin and the north Adriatic.

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The lower valley of the River Mreznica continued to be important for transit traffic even after the construction of the Karlovac-Rijeka railway in 1878 and its branch-line from Ostarija to Split in 1926.

Unlike the longitudinal routes, the transversal routes established in this region failed to be of any permanent significance to, or exert any impact on, the valley's function as a traffic junction. Hence, the elongated layout of settlements is understandable, because they are tied to the geo-strategic importance of longitudinal traffic routes.

A crisis of the traditional economy and the growing level of emigration in the second half of the twentieth century were the cause of spreading social decline, as well as change to the environment that held great potential for (tourism) development.

The importance of the valley as a tourism asset is pronounced in the region stretching from Generalski Stol to Duga Resa. Rural tourism is developed in this area, with holiday homes and cottages overrunning the attractive parts of the valley.

In previous hydro-geographic research, the River Mreznica is described as a river having high, rocky banks and a deeply incised channel. Two long, narrow alluvial deposits characterise the upper and middle part of the valley (Fras, 1835). Underground drainage in the river basin of the Mreznica was surveyed in the mid-nineteenth century (Palfy, a Border general, headed the research). Drainage was measured using staves that were thrown into pits (Pilar, 1876).

The basic hydrographic data on the cross-section and maximum width of the river channel (49 metres), and the river's mean (2.31 metres) and maximum depth (2.94 metres), as measured at Mostanja, were already known in the late nineteenth century (Senoa, 1895). The river's left tributaries were also systematically researched because of their more important social role and their greater number. In particular, research focused on the flows of the Zagorska Mreznica and Dretulja, and on the connection between the Lake Blato and the River Mreznica (Poljak, 1922, 1925).

The Bannat Electricity Company carried out highly complex hydro-geological research of the river basin (1939 – 1941). Later, *Elektroprivreda Hrvatske*, the Croatian electric-power supply company, sorted out and expanded the research initiated, and then went on to make a thorough survey of the River Zagorska Mreznica (1954). The results of these studies were put to use in establishing the Gojak hydroelectric power system, and in making Lake Sabljaci, an artificial lake (1957).

A number of authors (Malez, 1956, 1957; Herak, 1957; Bahun, 1970) have looked into the erosive impact of drainage in the basin of the River Mreznica. These authors agree that drainage over the basin's gentle terrain has endowed the basin with a particular diversity of relief (the V-shaped valley in the river's upper regions, and meanders with stream and river deposits in the lowlands).

The travertine barriers found in the watercourse are a major attraction to tourists. 93 have been counted, many of which are 1 – 2 metres in height (Pepeonik, 2000). Despite the fact that tourism represents a hope for revitalising the region's

economy, its development is not based on any particular spatial concepts, and as such, it poses a serious threat to the highly vulnerable karst eco-system (Maradin, 2007).

NOTES ON METHODOLOGY

In valorising a river valley, a crucial spatial aspect relates to the river channel, the riverbanks, and the valley plain. Composite valleys have played a positive role in the formation of settlements and in the construction of traffic routes. Composite valleys are valleys in which alternating wide valley plains (hollows) and narrow areas (sometimes in the form of gorges) appear. In spatial terms, valleys that are narrow, deep and impassable generally have a negative role, although in a specific period in human social and technological development, these same valleys might take on a particular role and gain special value (most often, in terms of tourism).

The valley of the River Mreznica has a simple morphology, meaning that it becomes lower and wider as it progresses from the river's source to its mouth. In relation to the surrounding relief, the valley is longitudinal (parallel with the global configuration). Because of its openness in the direction of the Sava drainage basin, the Mreznica valley (71.4 km) is considerably longer than the river channel (64 km).

This paper discusses the valley's attractions and appeal, rather than its tourism resources, primarily because the valley is not yet being managed as a destination. Rural tourism, together with several restaurants built near the falls, forms the basis of the tourist trade. Visitor arrivals (2,000 – 5,000 visitors annually) are arranged through tour-operators who possess no concessions for use of the river.

RESULTS AND DISCOURSE

The tourist-attraction base corresponds to the river's flow mechanism. The majority of potential tourist attractions are located in the upper valley where fluvial effects are greater. The travertine barriers, creating waterfalls and cascades, are complex tourist attractions². There are also chutes, places in the riverbed where the river tumbles over travertine barriers.

Travertine barriers are made of travertine rock formed in the river channel during the post-Pleistocene era. Visual contact between tourists and various travertine formations is especially important. Travertine is a crucial factor in creating other tourist attractions as well (water level, temperature, water colour).

The travertine-based attraction is composed of 93 travertine barriers (Table 1).

The total length of all the travertine barriers is 2,790 metres (this being a general estimation that needs to be remeasured), considerably longer than the length of travertine barriers on other watercourses that have become well-known tourist attractions.

² Waterfalls and cascades form over drops in the riverbed. Waterfalls differ from cascades in that they have a steep drop and generally greater height.

Table 1: Waterfalls on the Mreznica According to Heigh (in meters)

	Unknown	Up to 0.5	0.5 to 1	1-2	2-3	3-4	4 and over	TOTAL
No.	5	16	19	31	10	6	6	93
%	5,4	17,2	20,4	33,3	10,8	6,45	6,45	100

Source: Pepeonik, 2000.

The travertine barriers on the River Mreznica have not risen above the travertine threshold behind which the water of the river pools. Because of this, the channel does not have a step-like profile and its longitudinal cross-section is fairly regular. The indentedness of the falls coincides with their height, making the Susnjar Falls, Milkovic Falls, Klaric Falls and Rebic Falls the most indented falls of the river. The only problem is that travertine barriers are not always located close to one another, resulting in a low density of natural features in some sectors.³

In addition to viewing and experiencing the travertine formations, the opportunity to learn more about them is also an element that can enhance tourist appeal. The travertine in the channel of the Mreznica clearly displays its petrographic composition and the conditions for the formation of travertine. In several places, sunken travertine thresholds are also visible.

In addition to the parent rock in the riverbed, the waters of the Mreznica, a karst river, are also vital in the production of travertine. The partial pressure of carbon dioxide in these waters is high (in some sectors of the channel, about 15 times the pressure of atmospheric carbon dioxide). The ability of these waters to dissolve other substances can be expected to grow, given the fact that dissolved carbon dioxide is produced through the respiration of roots in the surrounding forests and that forestation is spreading and air temperatures, increasing.

Calcium hydrogen carbonate is generated as a result of the dissolving of limestone (calcium carbonate) in water. As carbon dioxide pressure decreases in the downstream channel, the chemical conditions for depositing calcium carbonate are boosted. Plants located on the falls or in the area of the water spray are the base on which it is deposited. The quantities of dissolved calcium carbonate diminish in the downstream direction, and at the 61st kilometre of the River Mreznica, travertinisation ceases.⁴

In some towns along the River Mreznica, the terms *vodeni kamen* and *lahnjak* are used as synonyms for travertine (in international transcription, the terms *sedra*, *bigar* and *travertin* are often interchangeable).

Priority attractions also include canyons, essential to experiencing the beauty of the landscape. The river's channel is carved into the karst terrain in which two

³ The density of the travertine barriers is greatest between the seventh and thirty-first kilometre of the river, with an average of one barrier every 436 metres. On the thirteenth kilometre of the riverbed, there are 11 waterfalls/cascades, whereas on the last ten downstream kilometres of the channel, there are only seven travertine barriers.

⁴ Research on carbonate sedimentation was conducted at the Plitvice Lakes. In the first ten kilometres, the water loses 28 grams of calcium carbonate per cubic metre.

different types of substrate meet, each with its own hydro-geological properties and resistance to wear. The lower valley rests on dolomite, and the middle and upper valley, on limestone. Although limestone is more resistant than dolomite, it is porous resulting in less erosion. This has caused the middle and upper course to be shaped as a narrow valley that in places expands from narrow passes (gorges, ravines) into canyons with almost sheer banks. The sides of these canyons are not particularly high, although they do rise above the surrounding terrain. The dominance of the high banks over the surrounding areas has made them into spots with panoramic views.

Many speleologic formations can be found on the limestone banks of the middle and upper valley. However, only in the larger caves have the cave portals been explored. These caves should be rich in cave ornaments (stalactites and stalagmites), because, in the dark of the caves, these ornaments are formed from the same solution that produces travertine in the riverbed. Especially attractive are the portals of caves (hollowed out by the river), which can be entered only by boat. Some tourists, keen of underground rock climbing, might be attracted to untouched caves and deep pits.

Another geological tourist attraction is the islands, known locally as *ade*, which are mainly the result of deposits. These islands are covered in the same underbrush that covers the surrounding land.

The appearance and incidence of geomorphologic attractions makes them the most suitable starting point in exploring the complexity of the Mreznica valley in terms of tourism. They are not associated with any concrete tourist motivations or activities, because they merely serve to facilitate their identification. Over time, deviations are likely to occur in those activities that are connected to such attractions.

This is not the case, however, with hydrographic potentials, as physiological criteria exist that determine their appeal. This pertains, in particular, to water in which tourists may bath or may use as a public utility. Bathing water is required to meet several basic criteria. These are:

- the purity criteria
- a minimum depth of 80 cm of bathing water
- a temperature higher than 18°C during the bathing season
- the physical qualities of the banks and bank beds.

The majority of rivers in Europe are polluted for bathing, especially during low flows, when the proportion of contaminated water is unfavourable. Ecologically, the Mreznica is classified as a first category river in which only occasional pollution has been recorded. The purity of the river's water is foremost the result of socio-economic conditions marked by low population density, the minimum use of chemicals in agriculture, and the structure of the local industry.⁵ It should be noted that the potential threat of contamination is heightened at the location of falls and cascades, because this is where water aeration is increased. When water aeration is high, this

⁵ Occasional pollution was registered during the operation of the kraft-liner paper plant in Plasko from 1965 to 1990. In several occasions, alkalis released from the plant entered the Mreznica through the River Dretulja causing the extermination of fish.

increases the portion of oxygen in the water, which in turn increases the possibility of oxidising harmful substances that might be dissolved in the water.

Travertine barriers are especially important for bathing in the River Mreznica, because of the effect they have in providing:

- a constantly sufficient depth of water
- a favourable water temperature.

Namely, data published by the Belavic Hydrological Station clearly show that the river's flow and water level in the summer are hydrological dimensions that are not fully aligned (Maradin, 2007). During the summer, flow values are lower than water levels (the opposite happens in winter), because the channel is, to some extent, lake-like, with water flowing only at the lowest drops of the travertine barriers.

The sluggish flow of the river enables the water to become warm faster than, say, the water in a very energetic channel. In the summer, the water is too cold for bathing only in the source channel and at those parts of the river channel where marginal springs exist (12°C). From the twelfth kilometre of the river (Cicin Bridge) to its thirty-seventh (the village of Erdelj), the temperature of the water throughout the bathing season ranges 18 – 23°C, while further downstream it ranges 23 - 26°C.

The steep banks of the middle and upper channel make it difficult to enter the water (sandbars are few). Also, the banks of the lower valley (and the middle valley, in places) are marshy in areas with silt deposits.

The asymmetry of the riverbed, a frequent criterion in selecting a river beach (swimmers, non-swimmers, diving into the water, underwater swimming), is correspondent to the flow of a meandering river. The profile of the concave side of the meander is steep, whereas the convex side is a gentle slope. The water oscillates vertically in the channel on the concave side of the meander. Hence, this cross-section profile of the channel is constantly wet, while the convex side of the meander becomes very shallow or dries up in summer.

The bottom of the beaches, which are of the conventional type, are covered in greyish silt, which most likely originates from waters rich in dissolved calcium carbonates. Downstream, the portion of silt declines. The crystals in this type of silt are small and make walking river bottom all the more pleasant. In the lower channel, sediments composed of alluvium created by the wear of dolomite rock provide safety to swimmers.

The fact that the microbiological purity of the waters is increasing (first-class quality according to www.mzopu.hr/doc/Izvjesce_2006/07), together with pleasant water temperatures, leads to the conclusion that River Mreznica possesses the most favourable conditions for the development of bathing tourism in inland Croatia.

In this segment of the offering, receiving capacity can be improved through the construction of heated swimming pools and by prolonging the bathing season. In similar circumstances in other countries, water is heated in a completely environment-friendly way using solar cells. Taken from the riverbed, the water is returned to the

river after use. Because the water supply system is based on the gravitational flow of water, energy consumption is negligible.

Rafting and kayaking have especially developed on the River Mreznica. These recreational activities are suitable for watercourses that have a steep channel with bends and a suitable quantity of fast-flowing water. Rivers with a nival regime have a great advantage, because their maximum water levels occur during the warm time of the year, which is more suitable for rafting and kayaking.

The channel of the River Mreznica is suitable for rafting and kayaking (riverbed drop of 0.0027 per thousand, average speed of flow at 2.86 m/s) providing specific criteria are strictly adhered to. The most suitable section is the upper channel (this section of the channel is part of the "Eugen Kvaternik" Military Polygon under the administration of the Croatian Ministry of Defence).

The fundamental issue in terms of the environment is that users are neglecting the principles of sustainable usage and are destroying the travertine. Their behaviour, in particular, the behaviour of kayakers, is based on personal criteria, because, at present, Croatia law does not regulate the use of inland waters for bathing and recreation. Also, concessions for specific tourism activities on whitewater (which has a strong flow, with rapids and cascades) are given to concessionaires who are not responsible businesspeople.

In such unregulated circumstances, kayaks are used (the most common being the K-2 kayak, the longitudinal line of which is made of hard plastic) that scrape along the barriers when the water level is low, creating travertine detritus.

Kayakers are making the draught of the travertine barriers deeper, which enables them to float from one basin into another, and eliminates the need of carrying the kayaks across low basins.

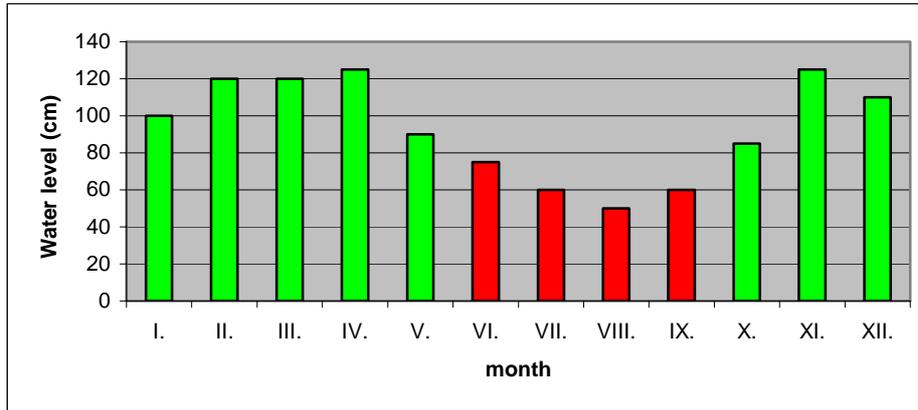
The erosion of travertine is likely to have unconceivable effects on the aquatic environment, making it essential to ban kayaking and rafting during the hydrological period of low water level (Figure 1).

The River Mreznica is also a medium that is suited to other sports and recreational activities, as well as to adventure activities for appropriately equipped and prepared tourists. The spatial and environmental conditions needed for such activities can be found in those locations of the river which are suitable to underwater orientation in fresh waters, sport fishing, rowing sports and sports involving vessels (according to the criteria applied in sports literature, there are 66 sub-types for the type of sport involving water-related recreation, fun and games). Especially important are the locations in which activities can be developed that attract a great number of competitors and spectators.

In a certain way, the vegetation, as an attraction, growing in or around the channel is a limiting factor of tourism valorisation of the River Mreznica. Conditions for growth in the channel are favourable in places where the river makes a bend (slower flow), and during the time of year when the amount of dissolved carbon dioxide

(needed for photosynthesis) is sufficient and the water temperature is higher the 14°C. In order to prevent such spots from taking on the features of a swamp, the marsh vegetation needs to be uprooted (this is mainly carried out by environmental associations registered in Karlovac and Duga Resa).

Figure 1: Mean monthly water level (MW) on the River Mreznica (Mrzlo Polje Station 1976 – 1980)



Source: Meteorological and Hydrological Service

The spreading of shrub-like vegetation on areas that were once used for agriculture makes it impossible to access the Mreznica from land (accessibility criteria). Changes are primarily caused by changes in the structure of settlements located along the Mreznica channel and by advanced depopulation (Table 2)

Over the past twenty years, the share of forests in populated areas has increased from about 50 per cent to 75 per cent, while the existing forests have become even more dense and impenetrable.

At the same time, forests represent a vital element of the landscape and an important factor in tourism planning. In such circumstances, the forest management and cultivation strategy needs to be based on promoting English-style parks (landscaped nature), as this is the only way the underbrush can be transformed into a tourist attraction.

Secular buildings, including commercial facilities (mills, bridges, ferries) and residential buildings, constitute the most important elements of regional identity.

Also important are movable cultural assets, most of which have been collected and are preserved in native museums.

There are 37 mills on the River Mreznica. Provided the appropriate conditions are secured (reconstruction), these mills could attract tourists.

Bridges (11) are attractive parts of the lower valley, as they were constructed across the wide channel and have pronounced supports. The bridge at Zvečaj features creative architecture and it is the longest (208 m) wooden bridge in Croatia.

Table 2: Demographic changes in settlements along the Mreznica channel

River shore	Number of settlements		Population	
	1991.	2001.	1991.	2001.
Left shore	19	19	3798	2708
Right shore	14	14	10920	9344
Total	33	33	14718	12052

Source: Nejasmic, 2000.; Croatian Statistical Institute, 2005.

Ferries are used in places where crossing the river was rational or essential. The best ferries are those made of connected boats and they are attractive for sailing.

Of all anthropogenic resources, houses are the most important. The structure of traditional houses was adapted to specific natural and historical circumstances.

Some of the more isolated villages possess an ethnic quality (Ozanici and the village of Mreznica) and with minimum changes could become tourism assets.

A part of the tourist trade that evades precise statistics takes place in holiday homes. The greatest density of holiday homes can be found along the channel between Belavici and Donji Zvecaj (in particular, in the vicinity of the waterfalls).

It is a general rule that, in the development of unorganised and unplanned tourism, holiday homes irrevocably occupy the most value space. This is true of the Mreznica valley, as well. It is estimated that some 350 holiday-homes have been erected; this figure, however, constantly changes (usually for purposes of tax evasion, holiday homes are transformed into residential homes).

The economic effects of weekend, rural tourism are weak, and some holiday homes, the construction of which does not comply with zoning criteria, have become dotted sources of pollution.

The holiday-home issue, together with other negative traits in tourism, became obvious at an early stage, and it has persisted up to date. Foremost, this issue relates to the physiognomic and functional transformation of space, and to socio-cultural consequences, and environmental and spatial effects. Hence, the 1985 Spatial Plan for Croatia provided for the protection of the River Mreznica as a nature park. This plan was included in the subsequent Urban Development Strategy of Croatia (1997), and in the Urban Development Program of Croatia (1998).

Although the planned protection of the region has the support of businesses and the tourism trade, there is little chance that the protection plan will be implemented any time soon because of the serious issues in this region that need to be previously resolved (landmines, military administration, municipal infrastructure).

CONCLUSION

In the era of traditional traffic links, the River Mreznica played a divisional role; it failed to attract a large population and it was rather poorly exploited in commercial purposes. This spatial role was shaped by the river's canyon-like channel, the scarcity of fertile alluvial deposits, and the irregular regime of the river's flow.

The watercourse's characteristic morphology, which was previously a limitation to conventional development, began to attract tourists in the early 1970s. In the period that followed, the tourism industry continued to develop as an increasingly important spatial reality, until finally becoming a strategic branch of regional (county) development.

In this respect, natural attractions show great potential, together with small number of anthropogenic attractions. The basic tourist attractions are the river's water, which is clean and warm enough for the development of riverside tourism, and its travertine barriers, as major visitations sites.

Tourism in this region develops by tourists discovering and using the attractions, which means that development is unorganised, with the state playing a role that is merely declarative.

Because of uncoordinated development and the devastation of tourism potential, protection is to be provided to the valley of the River Mreznica by making it a nature park.

By proclaiming the Mreznica valley a nature park, it will be possible to provide for better protection of the area's assets and more efficient river management. It is well known that the development of tourism in such destinations has an impact on economic sustainability and on the weak demographic situation.

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