

Оригинални научни рад
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THE LOST RIVER “PULJIĆA POTOK” IN THE RIVER BASIN OF MALA UKRINA

Abstract: The karst morphology of the river basin of Mala Ukrina is characterised, apart from superficial and ground karst forms, by karst hydrography, which gives to this area a specific hydrological mark. In this part of the basin, as a hydrological peculiarity of limestone plain, we can single out the lost river “Puljića potok”, which is the water most lost river in the south rim of the Panonion basin of the Republic of Srpska that has been discovered so far.

Key words: basin, the lost river, ground circulation, blind valley, karst depression

Introduction

Lost rivers make a karst relief in a very specific way, that being the reason why the study of them has not only scientific, but also social significance. An example of importance for common interests of a lost river is expressed through its valorization in geographic areas which, due to their specific features in terms of physical geography, pay more respect to a lost river than people who can use water in unlimited quantities. Although the lost river “Puljića potok” cannot be compared to the lost rivers in the karst of Dinaric Alps in terms of dimensions, it is no different from them when it comes to its features and significance. A complex geological and tectonic form of the river basin of Mala Ukrina, and especially the ratio of distribution of carbonate and non-carbonate rocks, are of essential significance for understanding certain morphological and hydrographic phenomena. Very small areas of limestone rocks in the river basin of Mala

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Ukrina, which represent the relic of the original limestone plain and which were decomposed with fluvio-denudative processes throughout geological history, are characterized by flows going deep into ground, as well as by those superficial ones. In certain valleys of the basin there has been, through morphologic and genetic evolution, a succession of processes, by which the fluvial process was completely replaced by the karst one, and, as a result of partial or complete loss of influence of fluvial process, there are various morphologic and evolutionary types of relief. The succession of genetic processes in river valleys is a result of partial or complete termination of fluvial processes under the influence of karstification, which means the loss of water, change of climate or some other factors of physical geography. The valleys of the rivers that drain the fragments of limestone plain were also exposed to this process, so one can notice in the morphology of the basin the fossil forms of the valley system that was under influence of succession of genetic processes, which means that the fluvial process was replaced by a karst one in a certain phase of the morphologic evolution of the area.

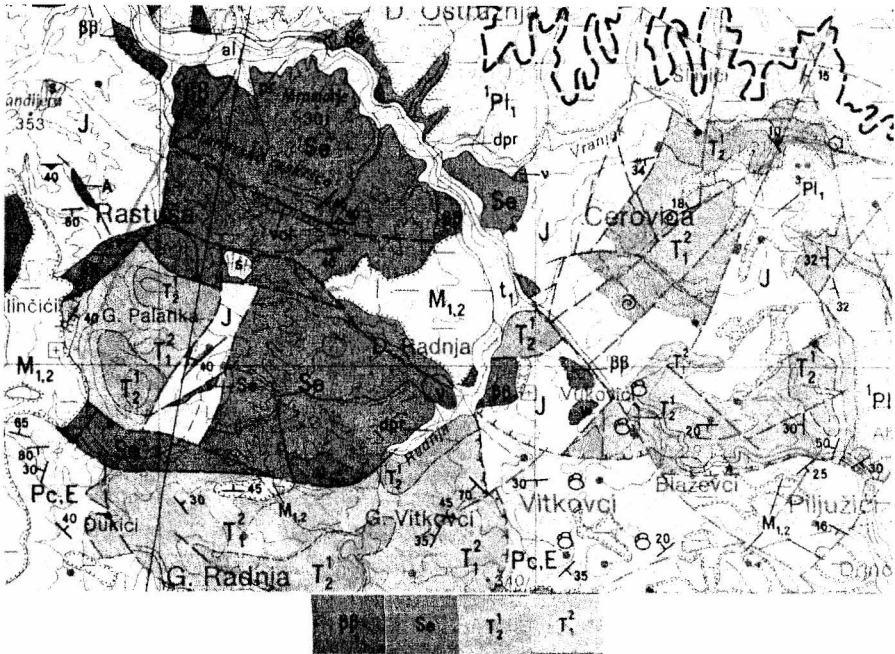
In the morphology of the basin, in the area of "Puljića potok", there are preserved morphologic traces of succession of genetic processes, which enables us to have an insight into the phases of morphologic evolution of this part of the basin. However, the water going deep into ground had and still has an important role for the development of specific morphological forms and hydrological phenomena on this locality, the markers of which are periodically dry valleys and recorded chasm. The river basin of Mala Ukrina is a part of hydrographic system of the River Ukrina, it spreads in the east of the western part of the Republic of Srpska, in the area of 391 km². The river basin comprises the south – eastern part of the river basin of the River Ukrina, which means the area surrounded by morpho-structural units of Javorovo, Čavka, Rastuša and Krnjini. A morphologic basis of the basin of Mala Ukrina is made of fluvio-denudative and karst relief, as well as forms created by rock decay. The karst process influenced only certain superficial cases of triassic limestone or neogenic sediments. An example of a limestone basis is the locality of Puljići, where the superficial karst forms-depressions are dominant in the modern relief of this part of the river basin of Mala Ukrina, and there is also a phenomenon of lost rivers as an immediate consequence of a complex geological and tectonic form and morphologic evolution of the area. So, in the predominantly fluvial morphology of the river basin of Mala Ukrina there are embedded forms of a karst process which, together with hydrologic phenomena represent the specifics of this geographic area and, at the same time, a hydrographic peculiarity of the south rim of the Panonian basin of the Republic of Srpska.

THE CONDITIONS OF KARST DEVELOPMENT IN TERMS OF PHYSICAL GEOGRAPHY AND PHENOMENA OF GROUND WATER HYDROGRAPHY

The hydrologic and morphological development and distribution of limestone areas in the basin of Mala Ukrina is a result of geological structure, tectonic conditions, dominant geomorphological processes, climatic features, pedological base and flora and fauna. However, the greatest part goes to geological and stratigraphic structure, tectonic processes positive and negative morphostructures as well as to the superficial development of hydrographic network.

Mezozoic limestones represent the base of karst process in the basin of Mala Ukrina. Triassic sediments developed in several facies in the areas of Brezičani, Ljubić, Čavka, Rastuša, Puljići, Gornja Radnja, are the most distributed ones. The oldest triassic sediments belong to the Kompil subterrace, they are predominantly elastic masses of isolated thin-layer, dark grey morly limestone. Apart from these sediments, we can also find in great amounts, Middle Triassic sediments of Anizija terrace in the areas of Rastuša, Vitkovci, Gornja Radnja, Križ and Piljužići. The mesozoic limestones are the relies of paleorelief, i.e. the original limestone plain that shaped down towards the bottom of Panonion basin and that was, through geological history, decomposed by fluvio denudative processes. The tectonic relations in the complex geological structure of the studied limestone oasis are distinguished by contacts of the Triassic limestones and the rocks of dialuose formation. Therefore, morpho-tectonic evolution of this part of the basin is directly connected to the genesis and morphological evolution of the relief, because it, for the most part, conditioned the acting of certain processes that marked this area in terms of its morphosculpture. The tectonic structure of the isolated limestone oasis is shown through a great number of aplit lines that occur on the spots of contact of Triassic with diabase rocks, which means on the spots of contact of limestone with the rocks of spilith-keratophir-diabase-dolorit-gabbro-granite association.

The tectonic activity is expressed through disorder of limestone layers where apart from declines from 30 to 70° on the spots of contact of the aforementioned rock formations, one can notice a great number of fractures of various directions, which are the consequence of the tectonic activities in this area on the whole (Panic, I. et al, 1984). The fractures created during this process, as well as those fractures in the rocks that stretch parallel to the layers setting them apart mutually, represent a dense network of fractures that enables ground circulation of karst waters, which is one of the most important conditions for acting of karst process on surface and in ground parts of this limestone oasis. The aforementioned geological and tectonic features represent good conditions for creating karst morphology and existence of karst hydrological phenomena in the area of the lost river "Puljića potok".



(Diabase $\beta\beta$ - Serpentin Se – Triassic T_2^1 (anision level)
 Triassic T_1^2 (Kampil sub-level)

Picture 1. – Geological map of the area of lost river “ Puljića potok “
 OGK 1 : 100 000 section Derventa

In the relief of the Mala Ukrina river basin fluvial relief is predominant, i.i. the morphostructure of the basin is a reflection of the fluvio-denudative activity on vast limestone plain. The River Mala Ukrina built its valley system in neogenic plain, whose morphological traces, i.e. terrace levels, one can notice on both left and right side of the valley, in the localities of Gornja Radnja, Rastuša, Hrnjino brdo and Sokolina.

The terrace levels on these localities are preserved in the Triassic limestones, because they are a lot more resistant than erodible dibase rocks, i.e. limestone layers of Sokolin, Hrnjino brdo and limestone oasis in the locality of Puljići are compact units of structural plain, which through fluvio-denudative activity took the form of hilly relief. However, in the area of the lost river the fluvial process left its traces in the form of the preserved valley system by the original river, flowing towards the River Radnja, its however erosive base. The spring area of this system was formed by the contributory rivers, thus forming a vast spring area of the valley system and valley profile that spread south-east. The fluvial process, which took place over a relatively short period of time, was replaced by the karst one, by which, apart from different morphology of the area, the conditions were created to form morphological and hydrological karst forms and phenomena. The karst morphology of this area is ditinguished by a series od

depressions covered with vegetation which, in terms of their qualitative features and space relations, belong to the lowlands depressions. The recorded depressions, by morphologic division, belong to plate-like and funnel-like depressions, whereas by genetic division these depressions can be classified as corrosive ones.

These plate-like depressions, their diameters ranging 150-300m and no more than 10m deep, several funnel-like depressions (diameters 1-50m, 10m deep) were singled out by morphometric analysis. Other depressions can be classified into those with 1-100m in diameter and up to 10m in depth. Taken on the whole, depressions covered with vegetation, both regular and irregular in terms of their space relations, are basic forms of karst morphology embedded into the original fluvio-denudative morphology of a defined geographic area.

HYDROLOGICAL PHENOMENA AND FEATURES

The end of marine-limnological phase in this area also represented the first phase in forming hydrographic network on the existing plain. The process of forming the valley system of the Mala Ukrina River was followed, at the time, by the process of forming the tributary rivers' valleys, for which the Mala Ukrina River was a lower erosive base. In the localities of Jezero, Golomići and Puljići, the hydrographic network was represented by minor river flows leading towards south-east, which is the direction of the shape of the plain. In the first, fluvial phase, which did not last long (the period when the river were rich in water), there was a process of superficial draining out on the fragment of limestone plain. This draining out formed a relatively shallow valley of the original flow, whose valley system is preserved even today. The limestone areas of the present, which in the past divided this valley system into several parts, are relics of the old valley bottom which was, in that phase, positioned much higher than the present bottom of lowlands depressions and, at the same time, much lower than the watershed that follows this valley system.

The fluvial phase in this area was replaced by karst process, by which three shallow plate-like depressions were formed at the bottom of the valley. The original depressions were initial forms for forming a lot bigger depressions, which were covered with material with allogeneous flows, and that material caused, in a certain phase of evolution, the capture of the fracture system, thus enabling pooling.



Picture 2. – The fossil valley and lower depressions

In this phase, the limestone area at the bottom of the valley separated the spring area of the original flow from the part of the valley, forming a pool whose dimensions were 400m in the direction north-south and 320m west-east. The process of karstification of the limestone base was reduced in relative terms, because the fracture system, was filled with alluvial material which prevented water from circulating and draining out of the pooled water. However, the valley profile downstream the bar that represented the rim of the pooled water of the time continued to fulfill its hydrographic function with the water that came through the chasm, which existed before the present-day spring, which made superficial draining out in the middle and lower parts of the flow possible at the time when the co-ordinated river network existed, i.e. when the river network was connected to its lower erosive base, the River Radnja. During that period, the water that was pooled in depressions drained out through the chasm (into the ground), only to reappear and continue its superficial flow towards the River Radnja. But, this phase did not last long, because the circulation through the fracture system and chasm was re-established which were at the lowest points of the existing depressions of the spring area which, with more intense allocation of the rock layers and, with lowering and moving chasms and canals into deep ground, conditioned tearing down, thus re-establishing the ground circulation through which the pooled water drained out. The water drained out through the chasms that were placed at the bottoms depressions, the very same chasms that were filled with alluvial material that presented significant draining out. Therefore, draining out through the ground was the only way for the water to leave the plate-like depressions in the spring area of the fossil valley system and, at the same time, one of the reasons that conditioned the occurrence of the spring in the locality of Puljici. The spring was very abundant, because it originated from the ground waters which drained out of the spring area of the valley system,

but also from allogenuous flows too. The spring supplied the superficial flow which emptied into the River Radnja. But, as the spring become not so abundant in time, the water of the superficial flow began a regressive withdrawal and started to go deep into ground in the depressions that were for more distant than the present-day chasm of "Puljića potok". This hydrologic phenomenon is normal for the karst areas where, due to the lack of water in a certain flow, water drains out into the ground along the chasms that are in its way. After the pooled water drained out of the depressions that were separated from the spring by a high bar, the process of accumulation of alluvial material began. Thus the bottom of depressions were filled, which enabled the forming of pedological layer and vegetational cover. The only hydrological connection of this part of the fossil valley with its previous valley profile, was through the ground, i.e. through the ground draining out.

The present-day lost river "Puljića potok" is spread over 3 km² of limestone plain in independent and closed river basin. It is supplied with water by allogenuous flows from both the right and left valley side, but also by spring that brings the water from the spring area of the fossil valley system. It has been determined, by analyzing morphometric characteristics, that the lost river "Puljića potok" developed its basin in the valley system 1250 metres long, 500 metres wide, with the bottom at 280 metres absolute sea level, the spring at 300 metres absolute sea level and the spot of chasm at 255 metres absolute sea level. The "Puljića potok" lost river belongs to the group of occasional lost rivers, which occur in the part of year with the greatest quantity of rainfall, when superficial draining out is noticeable due to the melting of snow. During that period, the river bed of the "Puljića potok" lost river is filled not only with the water from the spring whose abundance is increased, but also with the water of allogenuous flows. As it is a longer quantity of water than the chasm can take, the water is regressively spread flooding the vast valley system of the "Puljića potok". Through the experiments to determine the ground flow of the lost river, regarding fluorine-sodium, were not performed and, taking into consideration the fact that this is a short lost river, it is possible to conclude that its water would occur in the River Radnja, which can be proved by numerous springs near the riverbed of the River Radnja. Bearing in mind the geological structure and tectonic relations, this conclusion seems likely. The occurrence of springs is no wonder, keeping in mind the fact that limestone rocks in that area are in tectonic relation with neogenic sediments which, according to some opinions, represent hydrological embouchment, i.e. they determine the height of pouring out of ground karst waters and the depth of karstification. That is the reason why ground circulation in limestone rocks cannot occur below that height. Thus, we can conclude that the lost river "Puljića potok" is an occasional lost river in fossil valley system, which used to be a bed for the original river in the fluvial phase. We can classify it as a two-level lost river, due to its morphological and hydrological evolution.

CONCLUSION

The morphological and hydrological evolution of the lost river “Puljića potok” is connected to the successive change of genetic processes that formed this part of the Mala Ukrina river basin, i.e. to the beginning of karstification of the limestone oasis on which, by de-organising fluvial network, the process of karstification along the valley system was initiated. During that period, the opening of chasms in the original riverbed and ground forming of depressions happened. These chasms, due to their weak ability of porosity, represented small pools in the beginning. Though the chasms were filled with the alluvial material of allogenuous flows in the first phase, by their lowering and by transferring the canals of ground circulation deeper down there were conditions for karstification, i.e. for tearing down, which enabled, along with limestone rocks, the descendant draining out of the pooled water and establishing the ground hydrographic circulation. Therefore, the fluvial relief apart from geological and tectonic features of the area, represented predisposition for forming karst morphology and, by that, for occurrence of specific hydrological phenomena in karst. In conditions of a relatively shallow limestone base regarding the specific morphological and hydrological evolution, the lost river “Puljića potok” occurred as one of the hydrological phenomena of this geographic area. By geomorphological analysis of its morphological and hydrological evolution and the area surrounding it, two phases during which this lost flow developed were determined, which classifies it as a two-level lost river. The present-day hydrological function of the “Puljića potok” is that of an occasional lost flow, whose bed is only filled with water in the past of a year with minimum rainfall. The spring that supplies water for the flow was captured in order to provide continuous water exploitation over a year, especially in summer when the riverbed of this flow is dry and under cultivation.

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