THE NERETVICA RIVER – HYDROECOLOGICAL CHARATERISTICS

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The Neretvica River is a right tributary of the Neretva river. Its delta is located in Jablanicko lake, downstream from the settlement of Buturovic polje. The river system of the Neretvica drains surface waters from the central Bosnian shale mountains; the southern foothills of the Zec mountain and partly of the Bitovnja mountain.

The Neretvica river has a highly developed river system formed by a dendroid river net conditioned by a hydrogeological water-resistant series of Paleozoic formations. The main stream and its tributaries have quite large dips on the longitudinal mismatch and stepped profile.

Draining surface waters from high mountain foothills, the Neretvica river carries clean and clear water, so it is considered as a very important natural resource for drinkable water. The river system of Neretvica and the basin represent a natural landscape of extremely high quality, which, even according to the most rigorous criteria, meets the criteria for being declared as a protected area of the highest rank.

The domicile inhabitants from the Neretvica river valley and basin are disturbed because of intention of the Public Institution "Elektroprivreda" Bosnia and Herzegovina to build 15 mini hydroelectric power plants on this river, which would permanently destroy this natural watercourse.

Key words: Neretvica, natural-geographic elements, landscape, mini hydropower plant, Environmental impact study

INTRODUCTION

The Neretvica river belongs to the hydrographic system of the Neretva river. It mainly drains surface waters from the southern exposure wing of the central Bosnian shale mountains, which are represented as the oldest geological formations and facies in Bosnia and Herzegovina. The geological material determined the surface inflow of water from the quite branched denroid river system of the Neretvica. The main river flow of the stepped and inconsistent longitudinal thalweg has advance in relation to the smaller aquifer tributary systems thanks to fluvial evolution. Because of that, some of them end up with big falls, and some of them with smaller waterfalls.

The river system is balanced aquifer during the year and is conditioned primarily by a hydrogeological water-resistant series of limited crack porosity and a large amount of precipitation. The morphographic and morphometric features of the oval basin, as well as the indented river system, have included Neretvica in a post-pathological peculiarity, which demonstrates a high level of landscape diversity. The basic indication elements of the

natural landscape, expressed by the relief diversity, include this flow in composite valleys with a high level of diversity. It is defined by numerous canyon, gorge and pediment valley structures that alternate at a very close distance. The Neretvica valley in the middle and especially at the upper basin is anthropogenically untouched, which further increases the landscape value.

The pre-mountain and mountain climate type, with altered Mediterranean influence, significantly affected the pluviometric regime, which produces a rich amount of precipitation. During the colder period of the year, it changes its pluvial and nival structure, and is conditioned by the regular height-band decrease of the thermal regime towards the highest altitudes of the basin. Nival effects are reflected in the occurrence of snow retention of the river regime of the Neretvica.

The river regime of the Neretvica, expressed by the flow, which is derived from the components of precipitation, river basin surface and other morphometric features, shows a high and quite balanced yield of surface swelling from the river basin. Apart from them, permanent springs especially in the tributary river net, also participate in the water enrichment of the Neretvica. The Neretvica's waters are clean and clear, and represent a large supply of fresh water, which is by years less in the Neretvica river basin. They further enhance the landscape impression in an already diversified morphological landscape.

The natural geographically networked system has produced a very rich biogeographical representation of diversified vegetation and fauna, both aquatic and terrestrial. Their habitats depend on the waters from Neretvica basin, whether it is the main stream or its tributaries.

Anthropogenic activities of any content, would destroy the overall natural heritage, possessed by the Neretvica basin and river system. There is no Study of this kind of environmental impact by which any anthropogenic action could be accepted as justified. Morphological and post-pathological research of the Neretvica river basin and valley documents the stated views and include this flow in the protection priorities, in order to prevent the planned concessions of this watercourse for the purpose of building mini hydropower plants.

HYDROGRAPHIC SYSTEM OF THE NERETVICA RIVER

The hydrographic system of the Neretvica river forms a branched part of the surface streams, which belong to the Neretva basin in the area of Jablanicko lake, whose waters submerged its former natural estuary and turned it into a delta of the liman appearance. The Neretvica is one of the most important tributaries of the Neretva from its right catchment area, which drains surface flows from the foothills of Bitovnja, Pogorelica, Zec mountain and the extreme slopes of Vranica. It is a large part of the central Paleozoic hull, best treated by F. Katzer (1920) and proclaimed as the Vranica group or horst.

Complex geological structure and orographic structure in a very mosaic climate from the modified Mediterranean in the lower basin, to the mountainous and subnival climate type in the upper basin, conditioned a generous surface network united into a common hydrographic system of the Neretva. The presentation of the hydrographic system was done upstream, ie reversibly, in order to create a clearer picture of the enrichment of the main watercourse with tributary waters (Fig. 1).

Upstream from the liman estuary into Jablanicko lake, the Neretvica intersects first Buturovic and upstream Goransko field. In both fields, especially on the right basin, the

Neretvica flows with smaller periodic flows, which have a significant water aquifer only during floods. The average altitude of these fields, which represent the river terraces of the Neretvica, is about 280 m and they are slightly higher than its delta, which has an altitude of 270 m at the maximum water level of Jablanicko lake.

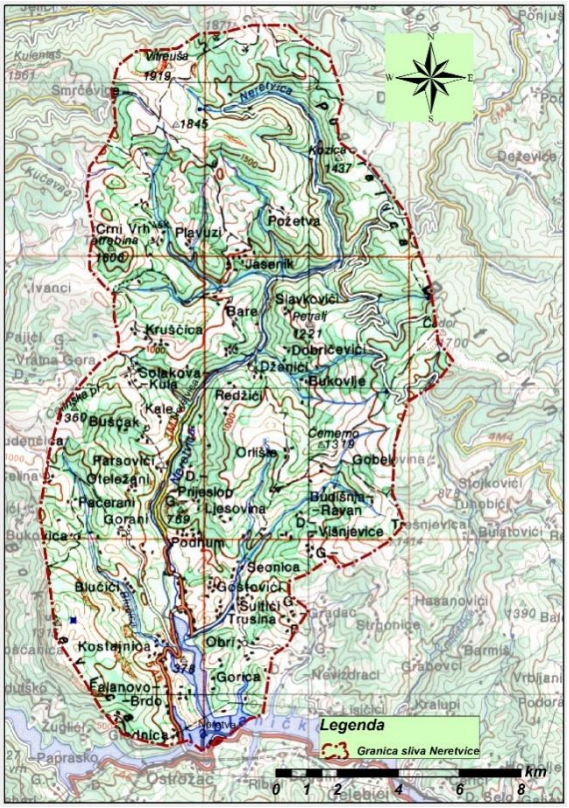

Fig. 1. Hidrographic system in the Neretvica river basin

The river valley of the Neretvica is narrowing upstream, and the altitudes are rising and towards Parsovici they are 362 m. To this profile, the Neretvica from the left side receives the most important tributary called Krvavac, which is formed from the source Dabravica at an altitude of 910 m, on the southern foothills of the peak Vala (936 m). The mouth of Krvavac is located at 300 m above sea level. The total fall of Krvavec is significant and amounts to 610 m, and the average is about 13.5%. Krvavac receives several tributaries of lower hydrographic rank, and all are formed from low to medium abundant springs on the southwestern slope of Bojisce and Borovica kosa, whose average altitude is 910 m and forms an orographic divide towards the source ridge of Kraljuscica.

On the right side of the valley, the surface extends to 600 m above sea level, which gradually narrows in the direction of the settlement called Otelezani, from where the Neretvica receives several weakly aquifers, and therefore na-meless tributaries. The largest tributary on the right side is Scukovac, which is formed by quite rich hydrographic network, especially on the right side due to the aquifer verfen geological base. Scukovac flows into the Neretvica downstream about 600 m from the settlement Parsovici.

From Parsovici (365 m) upstream, Neretvica's flow becomes richer by waters of smaller tributaries. The most important of them is Gorovnik on the right side of the basin. Gorovnik has a fairly dense river network, and it originates from the source headland, ie. gradual merging of surface streams, as well as tributaries that arise directly from springs, among which the most important are Husina water at 1300 m above sea level, on the northeast side of Rudine, from which, like a series of springs of broken type in Draicevici, becomes the left tributary Ravanjac. In the southeast of Rudine and east about 1 km from Ostra kosa (1355 m) there are two springs, named as Leganj at 1300 m above sea level. Downstream from Solakova Kula, Gorovnik receives a short stream, which originates from Zmraljeva vrela. The mouth of the Gorovnik into the Neretvica is located at 414 m above

sea level. The total drop on the longitudinal profile of Gorovnik is 886 m, and the average is 9.8%.

Upstream from the mouth of Gorovnik, all the way to the confluence of Mala Neretvica and Neretvica, which is upstream called Duboki potok, the valley is a gorge of average depth about 400 m on transverse profiles. On this longitudinal profile in the length of about 12.8 km, Neretvica receives a small number of short and occasional tributaries, which are closer to the Zeljeznica river basin, which drains rainwater into the basin of the river Bosna in the north. Among these tributaries, the most significant are Poscak and Rjecica, both on the left, while on the right there are several smaller occasional tributaries.

The Rjecica is the longest tributary of the Neretvica in this segment of the basin and it drains from the east-southeast and east. Upstream from the mouth at about 4 km, this tributary forks into two branches. Both branches go deep towards the orographic distribution of the source headland of Kraljuscica in the southwestern foothills of Bitovnja mountain. The springs of the southern branch of the Rjecica are located in the area of Oglavak, one at 1510 m and the other at 1548 m above sea level. The northern branch of the Rjecica drains Bukovlje, Zelenik and Rudine. It originates in the foothills of Rudine, at an altitude of 1550 m. The confluence of the Rjecica and Neretvica rivers is located at 520 m, so the total decline of the southern branch is 1028 m, on average 7.8%, and the northern 1030 m or 12.8%.

Upstream from the mouth of the Rjecica, the Neretvica enters into a narrowed valley in a north-south direction with a total average of transverse slope about 250 m. In this sector of the longitudinal profile, the Crni potok flows into the Neretvica, as the most important tributary. Crni potok drains the western and northern part of the Neretvica river basin. Its source is very dense and the main stream originates from a series of springs and shorter streams in the area of Blazine, which form an orographic divide towards the source of the Vrbas river. The most important source of Crni potok is Pasino vrelo in the settlement called Mustafici at an altitude of 1316 m. Crni potok has a dense net of tributaries. The first of them, about 1 km before the mouth, is Racava voda, which drains the northern part of the Neretvica basin and forms a parallel course to the next right tributary of the Mala Neretvica. Its source is located at 1230 m above sea level, and its confluence with Crni potok at 680 m. Its total fall is 550 m and the average is 9.1%.

Upstream, the right tributary to Crni potok is the Zagrajcica, which drains the southwestern part of the basin towards the source ridge of Gorovnik. Zagrajcica has a very branched tributary net, the most important of which is Vranje, which originates directly from the spring Bijela Voda at an altitude of 1420 m. The tributaries of the Vranje are smaller and nameless, and arise from sparsely abundant springs. The most important left tributary of the Crni potok is the Plavuska river, which drains the northern part of the Crni potok basin. It originates from a strong spring southwest of Jasenicke staje (1507 m) at an altitude of 1320 m. The mouth of this tributary into the Crni potok is located at an altitude of 947 m, so its total decline is 373 m, and the average is 5.3%.

Upstream of the Neretvica, from the mouth of Crni potok is the confluence of Mala Neretvica and Neretvica. Mala Neretvica superficially drains spring and precipitation waters from its northern basin, at the level of the latitude of the Plavuska river, a tributary of the Crni potok. The spring of Mala Neretvica is located on the eastern slope of Jasenicke staje (1507 m), at an altitude of 1310 m. Its total fall is 600 m, and the average is 7.5%. From the mouth of the Mala Neretvica, the Neretvica changes its direction upstream, first parallel in a canyon valley to about 3 km in length, and then abruptly turns into the northern meridian,

and at the final branch has a northwestern direction. This upstream part of the Neretvica often changes hydrotoponymically into Duboki potok, probably due to its considerable depth of the river valley, which is quite deep on the transverse profiles. In the lower part, the valley is gorge with average depths of 400 m, and the upstream gorge turns into a canyon with depths over 600 m and they are quite steep, whose average falls are 26%. In this sector of the stream, the Neretvica has significant thalweg drops. From the end of the canyon to the source of the Neretvica in the foothills of the Zec mountain at an altitude of 1720 m, the falls along the thalweg are constantly increasing and total 915 m or an average of about 9.2%.

At the point of change of the flow into the northern median, the Neretvica receives the left tributary Prolaz, which is first parallel to the main flow, and then turns to the east and goes deep into the mountain morphostructure of Pogorelica. Its main spring is located at an altitude of 1224 m. The total decline of this tributary is 499 m or 7.6%. The most important right tributary of the Neretvica in the water source is the Otunski stream, which drains rainwater south of Otunski vis (1698 m). The main source of the Otunski stream is located southeast below the top of Medjugorje (1784 m) at an altitude of 1720 m. The total fall of the Neretvica river is 1450 m, and on average 46 ‰ or 46 m for every 1 km of flow length.

THE NERETVICA RIVER WATERSHEED AND HIS POTAMOLOGICAL CHARACTERISTICS

Natural-geographic position of the Neretvica river basin

The Neretvica river is a surface flow and, as has been said, it is a right tributary of the Neretva, ie Jablanicko lake, and drains surface waters from the foothills of Bitovnja, Pogorelica and Zec mountain, ie the southeastern part of Vranica. The estuary in the Jablanicko lake is located near the settlement Buturovic polje.

The lower and middle part of the basin belongs to the extreme southern parts of the High karst region, and the upper part of the basin enters the region of central Bosnia, ie the subregion of the Upper Vrbas region. It is the southern wing of the central trunk of the shale mountains, the end part of which is covered with younger Middle Triassic carbonate formations, while the lower parts of the basin are under Quaternary formations, with some higher Miocene and lowest alluvial. In such geological relations, there have been developed specific forms of relief with high energy and vertical morphological analysis. These are actually parts of the Neretva valley and catchment area, represented by the slopes of the southern exposures from the highest peaks of the shale mountains, turned and dissected by river systems directly towards the Jablanicko lake. They also include the morphographic system of the Neretvica, parallel to other tributaries, which end in this part of the Jablanicko lake.

With such an oriented orographic structure and exposition structure, the Neretvica basin belongs to the modified Mediterranean climate type, which is modified by altitude into a pre-mountain and mountain type of climate with a significant share of the level factor in the highest mountain morphological structures. Modified Mediterranean influences, first by continental and then by height-band factors, reflected on the quantity and structure of the isothermal and isohyetic regime.

In the existing natural-geographical circumstances, the Neretvica basin has a very diverse vegetation system, which follows the climatogenic influences in terms of altitude

and zone, and the geological background. In the lower part of the basin, towards the confluence with the Jablanicko lake, there is an ecosystem of thermophilic deciduous forests with cer; Quercion cerris. This vegetation formation, according to higher altitudes, is followed by the ecosystem of subalpine beech forests; Fagetion moesiace subalpinum. The highest catchment areas, which go deep into mountain morphostructures, are covered with an ecosystem of beech-fir forests; Abieto-Fagetion moesiacae (Lakušić, R. 1981). The vegetation landscape is inhabited, at lower altitudes and especially from the right catchment area, on calcocambisol substrates on Middle Triassic limestone, while the vegetation in the rest of the basin inhabits the pedological base of predominantly district cambisols, which are formed on acidic silicate rocks. (Burlica, Č., Vukorep, I. 1983).

Lithospheric and atmospheric complexes predetermined the formation of the surface river system in the Neretvica basin. Hydrogeological aquifers have conditioned the formation and maintenance of a surface river network on a water-resistant substrate and the existence of moderately abundant springs within Paleozoic facies. The diverse morphological habitus predetermined the hydrological system into a unique one, named with the hydronym Neretvica. It is hydrologically stable and brings a fairly uniform amount of spring and precipitation water into Jablanicko lake.

Geological and hydrogeological predispositions of the Neretvica hydrographic system

The hydrographic system of the Neretvica has developed in a very complex tectonic structure, which belongs to the varicose and alpine orogenic cycle. Varicose structures have been modified by younger alpine orogeny.

Thanks to this tectonic and hydrogeological complex, the formations and facies of aquifers, whose foundation is connected to the central Bosnian shale mountains, to which verfen deposits superimposedly and ending with Anisian carbonates, enabled the formation and maintenance of the surface flow of the Neretvica.

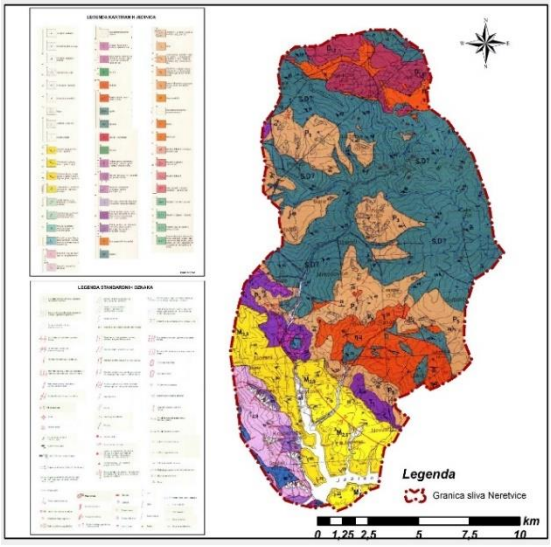

Fig. 2. Geology map of the Neretvica river basin

Only the southern part of the basin, in the narrow belt on the right side and immediately next to the confluence with Jablanicko lake is based on Miocene deposits of breccia conglomerates and sandstones with interlayers of clay and marl.

Upstream to Parsovici, the valley and the narrow basin intersect the hydrogeological water-resistant stratified and bank Anisian limestones. The wider area of Parsovici in the Neretvica basin consists of Permian deposits of red clays, sandstones and conglomerates. This series are referred to in the geological literature as Konjic's development.

Upstream, the river valley and the Neretvica river basin have developed their hydrographic network in predominantly Silurian-Devonian deposits of shale, argiloshist, mica shale, meta-sandstone and breccia. All these lithological members act as aquifers, so a surface river network was formed on them, which drains into the Neretvica river. This geological base of the Neretvica is maintained almost to the extreme source head.

The change of the geological substrate occurs on the wings of the basin and makes the base to the larger tributaries. Thus, in the basin of the tributary Crni potok, the water-resistant series consists of geological formations of the upper Permian, identical to those on the right catchment area near Parsovici. The source head of Crni potok furrowed the verfen deposits, which are concordantly interspersed with carbonates, in which a series of more abundant springs were formed, which supply and maintain the Crni potok aquifer throughout the year.

The source headwaters of the Neretvica drain massive dark gray limestones of Devonian age. Apart from them, the Neretvica basin drains the surface of rhyolites and quartz porphyries, which are subvolcanically imprinted in the Silurian Devonian structure. They are seldom fresh, as they are most often metamorphosed several times. By such a metamorphosis, Devonian limestones were recrystallized into marble. Hydrogeologically, these are rocks of crack porosity with limited but uniform capacity. Within this serie in the extreme northern basin, in several places, volcanic eruptions are encountered, the most significant of which are rhyolites.

Morphological characteristics of the Neretvica river watersheed and a basin

The catchment area of the Neretvica is framed by the southern slopes of Zec mountain, northwestern of Pogorelica, part of eastern Bitovnja, and the southeastern slopes of Dobruska Vranica from the northwest and the horst cups of Vranica and Bitovnja. It is represented from north to south by the orographic structure of the Paleozoic Central Bosnian mountains, which in tectonic terms was formed during the Hercynian orogenic phase, during the Mesozoic, and subsequently modified by Alpine morogenesis in the Tertiary. In addition to these, the current natural landscape was significantly affected by the subsequent tectonic disturbances in the composition of the Sava and Styrian orogeny. Exogenous processes and phenomena, including fluvial ones, act simultaneously with them, as in post-tectonic cycles, when river systems that are the forerunners of today are formed. The formation of flows in defined orographic diversions was initiated by orogenic structure and fluvial processes, which intensified during and after the Pleistocene, when river systems in this tectonic evolution were finally formed, and subsequent fluvial uniform and stress processes modified into today's physiognomy.

The Neretvica river basin is located within the orographic boundaries, which are divided by rainwater in the east towards the Kraljuscica basin, the right tributary of the Neretva, the Zeljeznica, tributary of the Bosna river in the northeast and north, the source ridge Vrbas in the northwest and the river Rama in the west. Orographic watersheds are quite stable, so are the watersheds. Since the orographic watersheds are in some places built of Paleozoic shales, the river flows show piracy properties, which is especially visible of the watersheds towards Kraljuscica whose tributaries approached the tributaries of the Neretvica at only 250 m by regressive cutting. The watershed is approximately elliptical in shape, which was favorably maintained for the formation of a stable and fairly uniform water balance of the Neretvica. The total length of the orographic watershed is 65 km. Its average

height is 1244 m and it is one of the high basins of Bosnia and Herzegovina and has a favorable effect on the accelerated outflow of precipitation towards the river network without losses to evaporation, underground infiltration and intensive biopedospheric production.

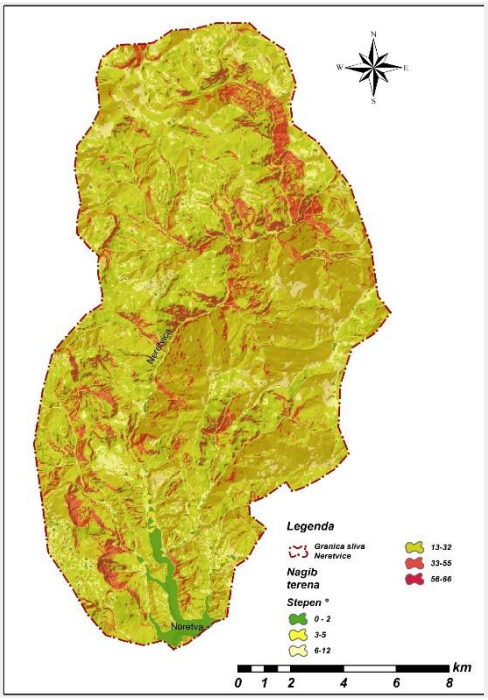

Fig. 3. Slopes in the Neretvica river basin

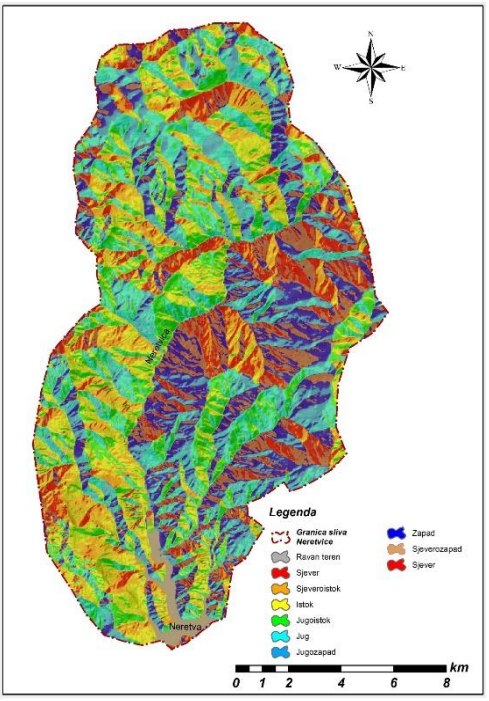

Fig. 4. Exposures in the Neretvica river basin

According to the contents of (Fig 3) in the basin are evident quite large falls, and in some places they amount is to 60°. Such pronounced falls are also recorded in those parts of the basin where the valleys are cut in the form of gorges and canyons. According to the appendix FIG. 4. the basin is dominated by slopes from the southern quadrant.

Within the defined orographic boundaries, as shown in (Fig. 1) the catchment area is defined, with an area about 210 km² that classifies it in smaller river basins in Bosnia and Herzegovina, so it is expected that they are less aquifer. The basin is completely symmetrical according to the main flow, as indicated by almost identical morphometric indicators of the left and right catchment areas. The left catchment area is 104.5 km², and the right 105.5 km². The ellipsoidal elongation of the oval catchment area is indicated by data on the length of the basin of 23.5 km and an average width of 8.9 km, so its development coefficient is almost equal to one.

The Neretvica river basin morphographically reminds of an amphitheater hillside on which the relief morphostructures gradually change altitudes from the periphery of the orographic watersheds towards the Neretvica valley, and especially from the north, ie. its source. According to the hypsometric levels, the Neretvica basin can be divided into low to 500 m, medium high from 500 to 1000 and high 1000 m above sea level. The lower part of

the basin includes the delta towards Jablanicko lake, and fields in the valley of the main stream and tributaries.

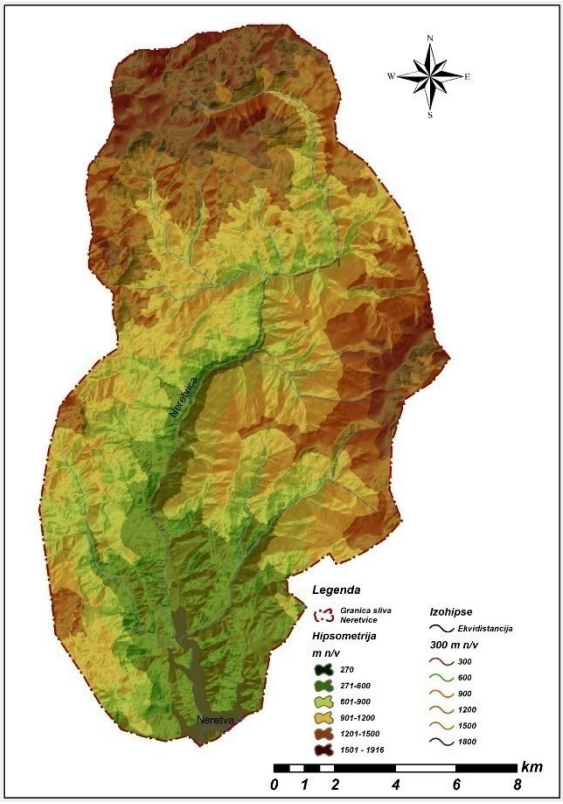

Fig. 5. Hypsometric relief structure of the Neretvica river basin

A medium-high basin is actually a mid-mountain or foothill staircase. These are morphostructures, which in this Paleozoic hull have a Horst physiognomy and form a connection or link to the high mountains on the edges of orographic watersheds.

All these morphological members significantly influenced the horizontal and vertical dissection of the catchment area. The large heterogeneous shift of morphological members in the basin and to orographic divisions conditioned the formation of tectonic predisposed meandering of both, the main stram of the Neretvica and its tributaries. With them, river flows pass by the foothills, thus creating slightly smaller falls on the longitudinal profiles of the main stream and tributaries of the first rank. Beside this, some tributaries have less harmonized longitudinal profiles towards the Neretvica, so they end by the larger falls and smaller waterfalls.

The river valley of the Neretvica is of polymorphic genesis, whose morphological members alternate from the mouth to the branched source headland in the high foothills of the central Paleozoic formation in which predominantly participate the Silurian Devonian shale facies. In such circumstances in the lower parts of the river basin, the river valley is quite indented, and towards the higher hypsometric mountain slopes, it narrows considerably, as do its tributaries. In these sectors, the river valley is like gorge, and in the foothills of the Zec mountain it has the appearance of a deep canyon, which in some segments from the bottom of the riverbed to the orographic watershed exceeds a depth of 800 m.

Polymorphic elements that participate in the structure of relief diversity, give to the river valley a special landscape stamp and include it in unique of that kind in the Neretva basin, and also in Bosnia and Herzegovina. The polymorphic structure has maintained the polyphase nature of the river valley, which has been evolving since the Pliocene geological epoch, when began an intensive phase of exodynamic processes under the influence of fluvial furrowing and incision of precipitation waters into the main substrate. At the same time, with weak tectonic movements, when the aquifer was discovered above the upstream layer were formed springs, which formed some tributaries and the main river artery of the Neretvica hydronym. Polymorphism and polyphase still make the Neretvica river valley

polygenetic, because several factors participated in its formation. Apart from tectonic predisposition and fluvial processes, a significant imprint was also left by slope processes, which were dominated by landslides, urns, colluvial-proluvial deposits, and also snow during the colder period of the year at higher altitudes, especially in the Pleistocene period. Changes of different morphological forms on the longitudinal profile of the valley, from the mouth to the source, include the Neretvica in composite river valleys, which have a high aesthetic value, which is expressed in the recording of natural tourist heritage.

According to the longitudinal profile, ie. section through the riverbed thalweg given in Fig. 6, it can be observed gradation from the source to the mouth. The highest falls are in the upper stream sector, and the lowest in the lowest parts of the riverbed. In the middle and upper part of the thalweg, there are significant fractures, over which the water overflows in the form of a waterfall, whose heights in some parts of the middle course are over 3.5 m. Waterfalls occur at faults, which are conditioned by the change of the geological base or minor tectonic faults. Below them, due to eorsion and circulatory movement of overflow waters, the riverbed is hollowed out and beeches have formed in it.

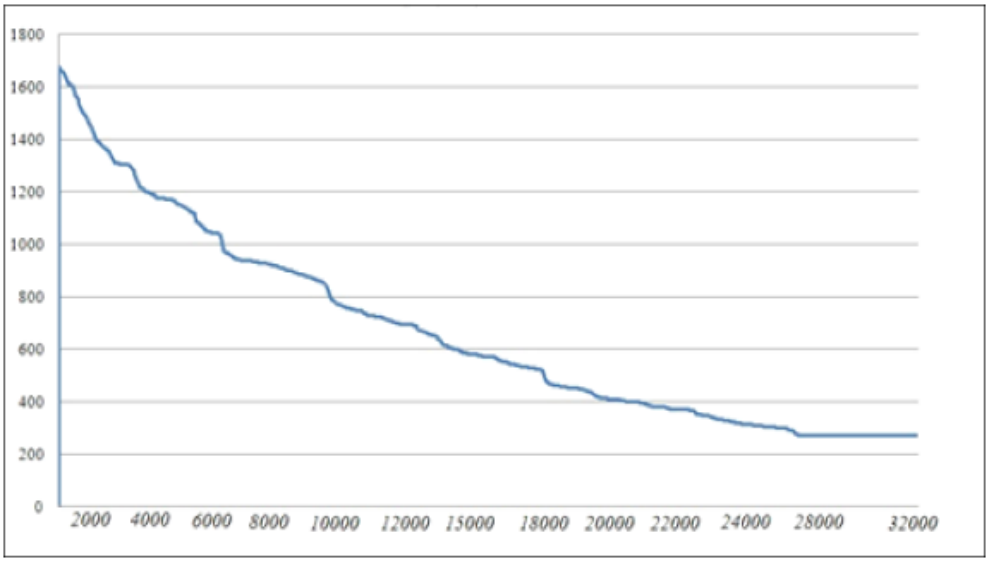

Fig. 6. Longitudinal river profile of the Neretvica river. It is possible to see fractures-resulting from tectonic faults.

These are impressive segments of the Neretvica flow, which are included in its uniqueness, in which noise of water come to the fore, which enhances the aeration, and thus causes a high level of purity of flowing water. The riverbed, especially in the middle and upper sector, is completely natural, intact and fluvially shaped according to established natural patterns. This is evidenced by natural fluvial bents from river sediments and trees, which were formed during extremely high water levels. All of them collectively fit into the existing potamological and morphological diversity, and classify the Neretvica in exceptional landscape values, with highly valued indicative tourist elements, which can be valorized for tourist purposes with a high level of protection.

Potamological characteristics of the Neretvica river

Rainwaters from the Neretvica basin, due to the aquifer geological base and highly developed vertical morphological dissection, are drained from the surface and with very little loss they reach some of the watercourses of the Neretvica river system. At a length of 31.7 km, it receives all tributaries from the basin that have a dendroid shape and whose total length is 58.0 km. If we put the total length of the main stream with tributaries in a relation to the catchment area, then it is obtained the density of the river network of the Neretvica,which is 427 m/km². This practically means that rainwater flows on an average surface of 427 m, in order to reach a watercourse. In the Neretvica basin, this length is very favorable for undisturbed contact of precipitation without losses, which is influenced by: water-resistant geological base, morphological vertical disintegration and vegetation coverage, whose coefficient is 57%. This favorable circumstance is also indicated by the basin fullness coefficient of 0.38 km of flows per each km of catchment area.

The post-pathological characteristics of some stream, ie. the Neretvica river are defined by the water regime, which includes the categories of water level, flow and water outflow. In order to define these categories, it is necessary to consider the isohyetic regime for the basin, which is planimetrically determined from the isohyet maps. In order to determine the structure of precipitation, in considering the isohyetic regime, it was necessary to consider the distribution of the isothermal state according to their distribution on the isotherm map. Both of these climatic elements, which also define the basin climate, predominantly as a pre-mountain climate type with Mediterranean influences, are considered according to the data contained in the climate diagram (Fig. 7).

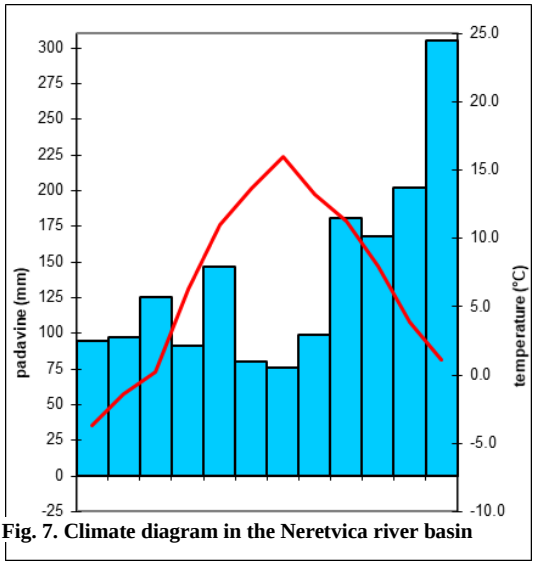

Fig. 7. Climate diagram in the Neretvica river basin

The modified Mediterranean influence of the isohyetic regime is recognizable by the increased winter precipitation, especially in December, when the maximum is regularly recorded. This pluviometric distribution of precipitation was modified by the altitude of the southern premountain expositions. The isohyetic distribution of precipitation shows a certain regularity of about 20 mm with an increase in altitude of 100 m in relation to the lowest point in the basin. There was also a regular decrease in air temperature of 1 °C every 200 m altitude. A climate diagram was constructed based on these regularities (Fig. 7).

The isothermal distribution in the colder period of the year, especially during the winter months in which the air temperature for January and February is below and slightly above 0 °C in December, indicates nival effects, which persist for a longer period since there is no snow retention, which extends to early spring. Therefore, winter, mostly snowfall, reduces the inflow, which is from hydrological point of view unfavorable for the water

balance. Also, nival effects are favorable during the spring, when combined with the fluvial effects increase the water regime in that period, and at the same time maintain this river without drying out. Nival effects favorably affect on the filling of the crack, which contributes to the maintenance of sources and springs during the year and actively participate in the component of constant water inflow.

The disadvantage of the river regime occurs regularly in the summer, when the amount of precipitation is significantly reduced. The average minimum amount of precipitation occurs regularly during July, when it is about 4 times lower than the December maximum.

Since there is no official hydrological monitoring on the Neretvica river, it was necessary to indirectly calculate the conclusions on the water regime through the isohyetic regime. If the total annual rainfall, shown in Fig. 10. multiply by the catchment area, then divide by the number of seconds of that period and bring to the ratio that over 70% of precipitation reaches the main water flow, it is obtained that the average water flow on the Neretvica at the mouth is about 3.32 m^3/s. This water flow classifies the Neretvica into medium-sized streams in Bosnia and Herzegovina, given the relatively small catchment area. This fact is justified by favorable natural-geographical relations in the basin, and above all by hydrogeological water-resistant layers, morphological relations, morphometric characteristics, etc. less important post-pathological elements and factors.

The average annual specific river outflow from the catchment area is 17 liters per second from each km of the catchment area. If the specific river outflow is brought into the relation of the average annual river outflow height of 535.5 mm, then a layer of water over 0.5 m is excreted annually in the basin. These indicators indicate a fairly high yield of basin waters, which almost without sinking, touch and flow through the main stream.

A fairly uniform flow, which carries approximately 1 m^3/s of water even in the dry months, suggests that planktonic, nectonic and benthic organisms can survive in the Neretvica riverbed. It also should be added the fact that beeches downstream from waterfalls and overflows with a large amount of river water, are ideal places for the natural survival of aquatic wildlife. If the current, average annual natural flow was disturbed and reduced to a minimum, providing that the natural morphography of the riverbed is preserved, over time the beeches would disappear by backfilling with drawn and suspended sediments, so aquatic species could not survive in lower water levels. Obviously, some species would extinct in constantly minimal water levels and flows. River water in the basin is also used by terrestrial fauna, especially wild animals. The Neretvica river is the only watering place for wild animals, which live in this basin and they are not represented in small count.

HYDROECOLOGICAL DIFFICULTIES - THE NERETVICA RIVER

Neretvica water exploitation project

The project of small hydropower plants on the Neretvica river, which is financially supported by the European Bank for Reconstruction and Development, threatens inconceivable hydroecological problems, which, if the project becomes real, would occur in the existing natural hydrographic system of the Neretvica. According to the available documentation, which refers to the Additional Environmental and Social Impact Assessment (Preliminary Report) from March 2017, the public company responsible for the production, distribution and sale of electricity in Bosnia and Herzegovina called "Elektroprivreda" plans

to build and use 15 small hydropower plants, which would stretch over 27 km of the Neretvica river and its tributaries.

This complex infrastructure should have an installed capacity of 26 MW. The project envisages 15 small hydropower plants of derivation (pipeline) type, which interrupt the natural river flow and introduce it into the pipe, through a sluice which is then lowered into the water level and redirected to the machine. For this Project in totally are planned 34 km of pipelines, with a diameter of 500 mm to 1800 mm. According to the Project, the planned water intakes would be located behind each of the 15 constitutions, and there should be water tanks between the water intakes and the machine. The constitutions should have heights in the range between 0.9 m and 3.1 m, in order to increase the fall on the longitudinal profile.

The project envisages additional infrastructure, which includes the construction about 25 km of underground channels for laying cables to connect small hydropower plants. In addition, about 5 km of new access roads should be built for the Project, and 10 km of existing local roads should be upgraded to allow delivery of equipment to the construction site and access to various components of the construction site, such as machines, pipelines and constitutions. There are also alternative solutions in the Project, which we will not deal by this occasion due to the lack of project documentation.

Based on the previously compressible project content, as the starting program basis for the Environmental Impact Study, it is clear that the planned construction of 15 small hydropower plants completely destroys the natural hydrographic system of the Neretvica. If this Project, by any chance would be realized, then the natural shape and natural function of the Neretvica River would be completely destroyed. Thus, it is pointless to analyze the content of the Environmental Impact Study, because the hydrographic system of the Neretvica is completely abstracted by program research. Diagnostic and prognostic research, which should primarily be dealt with by the Environmental Impact Assessment Project, has been neglected because the Project plans to replace the natural system with completely new anthropogenic pipeline systems. It is completely illusory to talk further about the ecologically acceptable flow or biological minimum in the future, non-existent hydrographic system, and thus life in it, and those who need it today. The natural flow, with the natural elements of the river regime and water balance, completely excludes the survival of the living world in it, as well as for the numerous living world in its basin.

Environmental impact assessment project - analysis of some parameters

In the introductory part, the Study deals with the position of the project in which it initially analyzes its topographic location within a wider geographical position versus protected areas, relying on Natura 2000, stating that the Neretvica, which is the object of research, are the closest protected areas of Blidinje and Prokosko lakes. Both of these protected areas, especially Prokosko Lake, due to anthropogenic pressure do not deserve the epithets assigned to them in the level of protection (Spahić, M. 2015), they are far enough away that they should not even be referred to.

When it comes to this statement, it is necessary to state that protected areas, especially in Bosnia and Herzegovina, should not be a limiting factor, which would prove the level of preservation of the natural environment. Thus, the basin and valley of the Neretvica river, especially in the middle and upper course, is far more preserved and more natural in relation to the mentioned protected areas of Blidinje or Prokosko lakes. Given the high level of

preservation of natural landscapes in Bosnia and Herzegovina, almost all without exception, could be declared a high gradation of protection. Environmental protection means preserving and nurturing the original natural elements and factors, ie. enabling self-development of natural processes and phenomena, without or with limited participation of anthropogenic factors. This does not mean that the declared protected areas only in this way can be preserved as a pristine natural. Therefore, the fact or statement in the Environmental Impact Assessment, in this case for the Neretvica river, that the basin does not belong to protected areas is not justified, so all anthropogenic actions planned by the Project are allowed.

Environmental Impact Assessment primarily treats living organisms and the degree of their diversity. According to this, there are listed all known animal and plant species living in the area. The presentation of them is based on previous other people's, scientific or professional research. This way of presenting the biogeographical picture of the mentioned area is only fragmented. In case that previous research had not covered certain elements of the natural environment, they have been unjustifiably omitted from the existing Environmental Impact Assessment. Thus, some elements of the natural environment can be destroyed without noticing, because they were not discovered until the Project was made. Likewise, some partial research, parts of the hydro system should not be taken to be representative of the entire water system. Thus, ichthyological research of the lower course of the Neretvica cannot be equally related to the upper, typically mountainous, gorge and canyon part of its river system. It is wrong to choose that the term diversity, which proves the level of natural heritage, refers only to the living world. The living world is one, but not the primary element of the natural environment or landscape. In that context, the natural landscape in which the leading element is morphology is more diverse, and thus more illustrative if it is heterogeneous and dissected. The environmental impact assessment must rely on program research of all elements of the natural environment, in the same way as it is undertaken in the research of the basic project task.

The Environmental Impact Assessment for the Neretvica river through the chapter of hydrology cannot be processed with a total of 9 sentences, of which the last three do not belong to this topic and refer to the object of the whole issue - water flow, where mini hydropower plants are planned. The hydrographic systems of the Neretvica were treated as "karst mountain watercourses". It is inadmissible that the Project of such a serious title does not distinguish the Paleozoic shale basement, which forms more than 80% of the basin, from the carbonate karst geological material, which is partly present in the basin.

It is hard to believe that in this chapter the snow retention is associated with the autumn period. The river valley is explained by the letters V and U. It is incomprehensible that the Environmental Impact Assessment treats the river and the river system of the Neretvica, which is the basic object of research, with a few sentences that are incorrect, unnecessary, confusing, unproductive and not in the subtitle function.

The next chapter, which deals with climate, is very similar, with a total of 4 sentences with presence of incorrect data. In defining the climate, it is stated that it is humid, which is not a determinant that corresponds to the climate of the Neretvica basin. The humid climate can be very warm with constant rainfall, moderately warm with dry periods and cold. The definition of climate is usually made up of two basic parameters, namely air temperature and precipitation, which is not stated in this particular case. Considering that the average altitude of the basin is 1200 m in the existing zonal sectors and azonal or altitude-band conditions, it cannot be accepted that the average annual temperature in the basin is identical to the

average annual temperature of Konjic and is 10.8°C. In addition, it is incorrectly stated that the monthly minimum temperature is -8°C, and the maximum is 20.1°C, without specifying the months in which they occur. The average January temperature in the basin is not lower than -3.7°C, and on average higher than 16°C (Fig. 7). Extreme temperature data; a maximum of 39 °C and a minimum of -21.5°C are also highly questionable.

Climate is undoubtedly the most important natural-geographical element for defining hydrological relations, in this case sub-pathological, which refers to the Neretvica river. Climatic indicators of importance for post-pathological considerations, especially river regime and watercourse balance, cannot be considered without very precise isochioetic and isothermal indicators in the basin, which are missing in the Environmental Impact Assessment.

The chapters air quality and greenhouse gases in the Study are presented by indicators for Bosnia and Herzegovina, which is certainly unacceptable because the above averages can not be applied to the Neretvica river basin, which has completely clean air of any impurities harmful to plants and animals. The Environmental Impact Assessment with its content completely unnecessarily deals with this chapter, and the abbreviated and inaccurate ones that are necessary for this part of the Project.

Fig. 8. Delta of the Neretvica river. Background - the landscape of the central basin of the Neretvica river

In the chapter “Landscape and visual space” the text boils down to the fact that: “Within the Project area there are no landscape markings; the nearest legally protected area is Prokosko kake, a natural monument located about 10 km northwest of the Project area”.

According to the definitions of landscape, such statements are completely irrelevant and make no sense in explaining the Environmental Impact Assessment, although they are the most important according to the leading typological unit.

It cannot be rationally understood that a regional geographical unit does not have landscape markings, because landscape is an experience of objective geographical reality, which some geographical schools, especially posibilistic orientation, define objective overall geographical reality by impression (Spahić, M. 2010). In addition, it is irrelevant to link the notion of natural landscape in natural heritage tourism only to protected areas. The Neretvica river basin, given to the natural geographical features, which are presented in an elementary and networked manner in this paper, represent a completely natural landscape of high touristic value, which in tourist taxonomy, with slight adaptation can be defined as a tourist area (Spahić, M. 2018). The Neretvica basin has a greater landscape diversity, and thus regional elements of natural heritage in relation to the often mentioned Prokosko lake, which has been unjustifiably declared as a natural monument.

The valorization of the river is underestimated with the view that: "The Neretvica river basin has no significant value in terms of socio-economic use (eg tourism) or recreational

value for the local population, but has significant value for the "Fishermen's association Konjic", which are the main beneficiaries of fishing rights on all waters in the Konjic Municipality". In the analysis of the valorization of the Neretvica river, there is not a single view that this is an unpolluted flow, which in the scarcity of drinkable water in the future, as a result of global warming, has a high value and significance.

The diagnostic analysis of the Environmental Impact Study envisages, among other things, all actions that contribute to the disappearance of the existing river system, endangering the living world, of which the Study considers only aquatic and nectonic living organisms, while those that occasionally come to the river or river valley plants do not analyze. Without going into detailed analyzes of the Environmental Impact Study, it was noticed that it approves the destruction of the existing hydrographic system of the Neretvica and its transformation into a technogenic system, which cannot function as a natural hydrographic system under any anthropogenic measures.

Fig. 9. The Neretvica river is characterized by clean and clear water with numerous tributaries. Some of them end in waterfalls, which leads to the conclusion that fluvial incision is not simultaneous between the main stream and tributaries.

As part of these diagnostic analyzes, an assessment of the environmentally acceptable flow was performed, which was determined at 10% of the average flow. This would be 0.8 m³/s of water in the best case. When it comes to ecologically acceptable flow or biological minimum, it should be noted that in technogenic systems it is not possible to imitate, no matter how hard geosystems try, because they do not subject to natural laws and patterns, which arise from the reciprocity of natural geographic processes. Thus, by converting the river into a pipe system, the underground outflows cease to function, and thus the river loses the constant flow formed by the overflow of the outflow water into the river bed. In addition to all the above, the natural regime, which includes the river flow, has its own natural rhythm, which can be seasonal, to which aquatic organisms are very easily adapted. A natural system of ecologically acceptable flow, no matter how hard man tries, cannot be established in any technogenic system. The biological minimum is not only the calculated minimum flow in which the survival of aquatic living beings is possible, but it represents a complex of natural geographical processes and phenomena. In addition, the Environmental Impact Study envisages the interruption of watercourses through pipeline systems, so it is superfluous to

analyze the environmentally acceptable flow. The study recognizes in the impact assessment criteria that the damage from the future technogenic system is great.

Environmental Impact Study on the Neretvica river does not deal with environmental forecasts, although it should. This stage of the research should offer an assessment of future conditions. Obviously for such a forecast, the Study is not ready because that technogenic systems in which pipelines and machinists predominate cannot be compared with the existing natural hydro system of the Neretvica river.

CONCLUSION

The Neretvica river belongs to the hydrographic system of the Neretva river. It mainly drains surface waters from the southern exposure wing of the central Bosnian shale mountains, which are represented as the oldest geological formations and facies in Bosnia and Herzegovina. The main course of the stepped and inconsistent longitudinal thallus, by fluvial evolution, considerably has advance in relation to the smaller aquifer tributary systems. Therefore, some of them end in large falls, and some of them with smaller waterfalls of high level of landscape value.

The basic indication elements of the natural landscape, expressed by the relief diversity, include this flow in composite valleys with a high level of diversity. It is defined by numerous canyon, gorge and pediment valley structures, which alternate at a very close distance. The Neretvica river valley in the middle and especially the upper basin is anthropogenically untouched, which further increases its landscape value.

The waters of the Neretvica river are clean and clear, and represent a large supply of drinking water, which is becoming less and less in the Neretva river basin. They further enhance the landscape impression in an already diverse morphological landscape.

The Neretvica river basin is located within the orographic boundaries, which are divided by rainwater in the east towards the Kraljuščica river basin, the right tributary of the Neretva, the Željeznica river- ributary of the Bosna river in the northeast and north, the source ridge of the Vrbas river in the northwest and the Rama river in the west. Orographic watersheds are quite stable, so they are the watersheds. Within the defined orographic boundaries, the catchment area is defined as 210 km² and it counts in smaller basins in Bosnia and Herzegovina, so it is to be expected that they are less aquifer.

Polymorphic elements, which participate in the structure of relief diversity, give the river valley a special landscape stamp and make it unique for the Neretva river basin and also for Bosnia and Herzegovina. The polymorphic structure was reflected in the polyphase of the river valley, which has been evolving since the Pliocene geological epoch, when began an intensive phase of exodynamic processes that started under the influence of fluvial furrowing and incision of precipitation waters into the main substrate. Shifts of different morphological forms on the longitudinal profile of the valley, from the mouth to the source ridge, include the Neretvica in composite river valleys, which have a high aesthetic value, which is expressed trough natural heritage records.

According to the longitudinal profile, ie. cross-section through the thalweg riverbed, it can be seen a marked gradation from the river source to the delta. In the middle and upper part of the thalweg, there are significant fractures, over which the water overflows in the form of a waterfall, whose heights in some parts of the middle course are over 3.5 m. Below them, due to eorsion and circulatory movement of overflow waters, the riverbed is hollowed out and there where formed beeches. These are impressive segments of the flow of the

Neretvica, which are included in its uniqueness, and in which the properties of noise of the water come to the fore, which enhances the aeration, that further causes a high level of purity of flowing water.

The riverbed, especially in the middle and upper sector, is completely natural, intact and fluvially shaped according to established natural patterns. This is evidenced by fluvial bents from river sediments and trees, which were formed during extremely high water levels. All of them collectively fit into the existing potamological and morphological diversity and define the Neretvica river with an exceptional landscape values with highly valued indicative tourist elements, which can be valorized for tourist purposes with high level of protection.

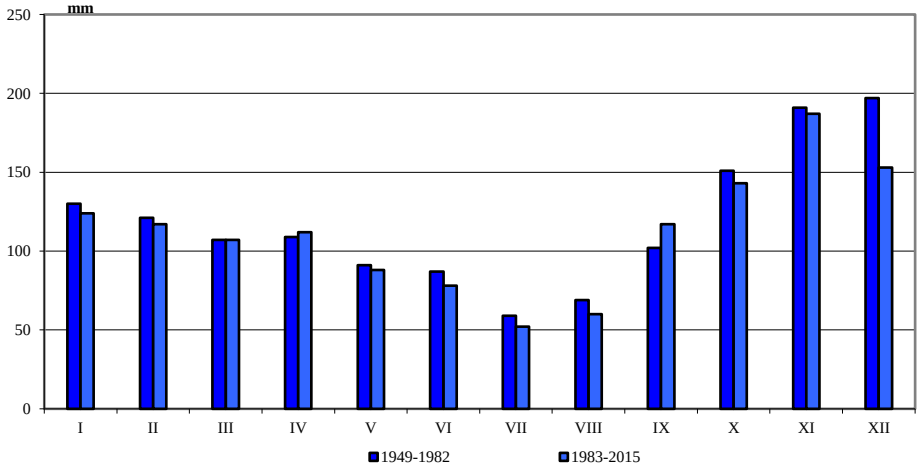

Fig. 10. Monthly precipitation in altered continental climates with maritime influences in the geographical region of the High Karst

Since there is no official hydrological monitoring on the Neretvica river, it was necessary to indirectly calculate the conclusions on the water regime through the isohyetic regime. According to them, the average water flow on the Neretva at the mouth is about 3.32 m³/s. This flowing amount of water classifies the Neretvica in medium-sized streams in Bosnia and Herzegovina due to the relatively small catchment area.

A fairly uniform flow, which carries approximately 1 m³/s of water even in the dry months, suggests that planktonic, nectonic and benthic organisms can survive in the Neretvica riverbed. It also should be added the fact that beeches downstream from waterfalls and overflows with a large amount of river water, are ideal places for the natural survival of aquatic wildlife. If the current, average annual natural flow was disturbed and reduced to a minimum, providing that the natural morphography of the riverbed is preserved, over time the beeches would disappear by backfilling with drawn and suspended sediments, so aquatic species could not survive in lower water levels. Obviously, some species would extinct in constantly minimal water levels and flows. River water in the basin is also used by terrestrial fauna, especially wild animals. The Neretvica river is the only watering place for wild animals, which live in this basin and they are not represented in small count.

Due to the fact of climate fluctuations, the Neretvica river system has to be preserved due to constant warming, which results by a reduction of precipitation, and thus of drinking water. Recent research on warming shows that there has been an increase in monthly temperature relative to the amount of decline in 10 months of the year, which can be applied from Figs. 10. (Spahić M. 2019). The reduced amount is falling in its continuity, which is not jumpy, so the lack of available drinking water bays will be questionable. Therefore, any further establishment of river system with new anthropogenic interventions accelerates the reduction and disappearance of drinking water, which will happen in the coming climate period.

The natural system of the Neretvica river is completely mutual and causally-consequently interconnected and does not suffer from anthropogenic actions of any content, because they would completely destroy it. Nowday, there is no Environmental Impact Study that could accept any anthropogenic action as justified. Morphological and post-pathological researches in the Neretvica river basin and valley are documenting the views that are expressed and include this flow in the protection priorities in order to prevent the planned concessions of this watercourse for the purpose of building mini hydropower plants. These views are also expressed in the context of the Regulation on Strategic Environmental Assessment of Plans and Programs ("Official newspaper of the Federation of Bosnia and Herzegovina" No. 33/03 and 38/09 No. 24/03 - consolidated text) "by which the first paragraph of Article 3, which refers to The basic principles of strategic assessment imply that: *"Preservation of natural resources in such a way that the level of consumption of renewable materials, water and energy resources does not exceed the limits in which natural systems can compensate and that the level of consumption of non-renewable resources does not exceed"* and the third paragraph of the same Article *"Continuous conservation of biological diversity, human health and air, water and soil quality according to standards that are always sufficient for life and well-being of humans, flora and fauna" are the basis on which this work relies.*

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