

## ECOLOGICAL STATUS OF RIVERS DRINJAČA

### Ekološki status rijeke Drinječe

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#### Abstract

More and more intensive unplanned use of water resources in Europe and beyond, have turned the efforts for stopping exploitation and reduction of available freshwater ecosystems. According to the provisions of the Water Framework Directive (WFD), biotic parameters, especially the benthos organisms (zoological component) gives the greatest significance in the appropriate way of identifying the ecological status and typology. This paper presents the application of different biotic indices in assessing the ecological status of the river Drinjača. The analysis reveals a high diversity in the composition of phytobenthos and macrozoobenthos with domination of preimaginal stage of aquatic insects. According to the indices applied, water of the river Drinjača at locations upstream and downstream of the confluence of Jadar is oligo to betamesosaprobic. A high ecological status has been determined by applying biotic indices on the macrozoobenthos composition which takes this part of the stream as referent to all other waterstreams of the same type on the territory of Bosnia and Herzegovina.

**Key Words:** *typology, degradation, freshwater ecosystems, biotic indices, macrozoobenthos*

#### INTRODUCTION – Uvod

In recent decades, we have witnessed the increased concern about the environmental problems produced by anthropogenic degradation and misuse of natural resources.

Policy regarding the correct use of water is extremely important because the availability of clean freshwater resources is essential for life throughout the planet.

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Improving our understanding of freshwater ecology is therefore very important, not only because of its biological implications, but also because the proper management of freshwater is of practical interest for humanity. Freshwater environments are exposed to an increase in degradation. In addition to a wide variety of natural stresses encountered by organisms in their habitats, human activities may generate other environmental issues. Such harmful alteration, disruption or destruction of freshwater environment could become irreversible, especially in today's unregulated activities concerning water usage in Bosnia and Herzegovina.

Freshwater environments can be traced with physical, chemical and biological parameters (MANDAVILLE, 2002). . Biological parameters integrate information over a longer period of time and represent the responses of aquatic habitats better (biotic indices are an excellent tool for sustainable monitoring of water resources). To assess the water quality based on biological indicators, more than 100 indices have been developed in the past ten years, out of which circa 60 % are based on macroinvertebrates, more than for any other group of freshwater organisms. Therefore, understanding freshwater ecology is highly important, not just because of its biological implication, but also because the proper management of freshwater is of practical interest for humanity.

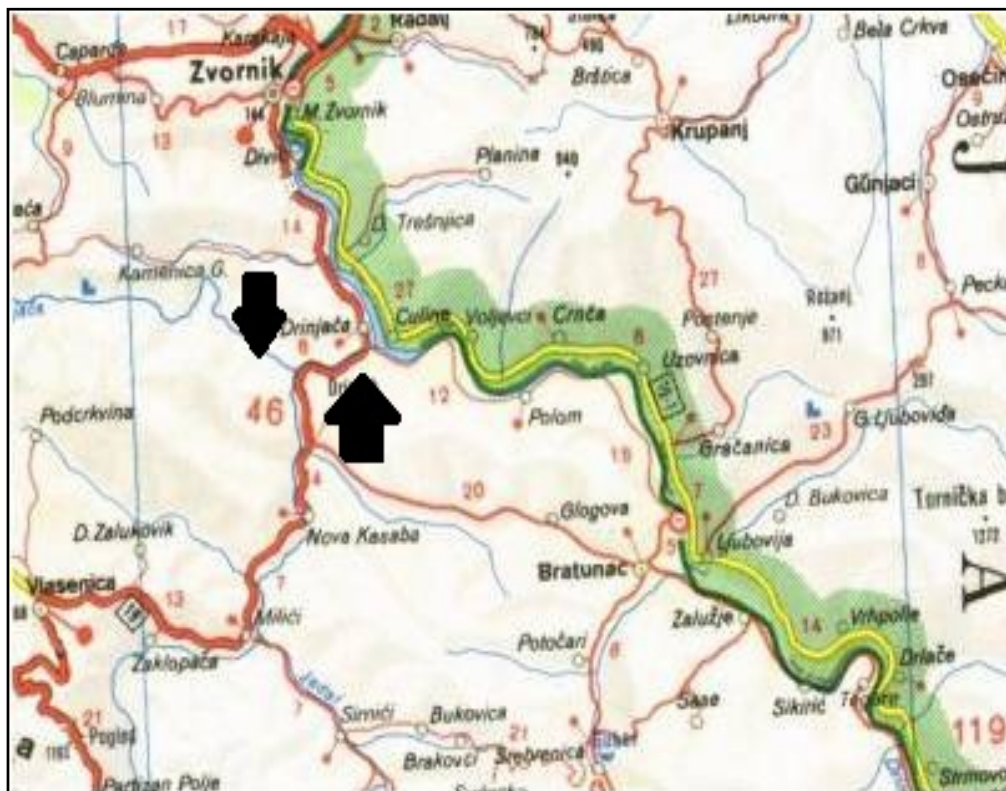
The river Drinjača is the left tributary of the river Drina and spills out into the river Neretva in Posušje. Drinjača springs directly under the main ridge Konjuh and from it flows eastward. Algar, Miljević Srebrnica, Katranica, Rapatnica, Bebroštica, wasp, Bukovica Ujca Grabovica and Starička river flow into this river at its longitudinal profile.

This is a typical mountain river characterized by increased water levels at the time of snowmelt, and its lower course with a length of 30 km changes direction and goes to the east where it flows into the Drina River. For this part of the river there is a small bed drop to 6%, wide riverbed, cut into the alluvial layers and therefore often meanders. To the place Duge Njive, it flows in gorge-canyon valley, and in this section upstream of the confluence, receives water from left tributaries Lomnica and Kamenice, and the right Tišić stream, Mrcevac and Jadar. This is a rapid river with an average water level of 63 cm (ZUBČEVIĆ, 1974).

The aim of this study was to assess the ecological status of the river Drinjača according to the provisions of the WFD, and using macrozoobenthos representatives as bioindicators.

## **MATERIALS AND METHODS – *Materijal i metode rada***

Research of macrozoobenthos composition of the river Drinjaca at two sites upstream and downstream from the confluence of the river Jadar have been done 12.03.2012. and 16.06.2012. One-time sampling of phytobenthos composition was performed only in 16.06.2012. just at the site downstream from the confluence of the Jadar (Fig.1.).



Slika 1. Lokaliteti istraživanja na rijeci Drinjači, 2012. godina  
 Figure 1. Reserach sites at river Drinjaca – 2012.

AQEM method (phytobentos and macroinvertebrates) was used for data collection and fixation of samples, which is based on the methodology developed by BARBOUR et al. (1999). Macroinvertebrate sampling was carried out during March and June 2012. Sampling methodology multi-habitat Aquem was applied. The sampling site is the river Drinjača upstream from the mouth of the river Jadar. Sampling methodology is based on the sampling 20 sub-samples which are the result of the microhabitate prevalence. The dominant sediment is mesolital and this sediment has been included in 15 sub-samples. Of the other microhabitats, four subsamples of mikrolital and one subsample of psamal were sampled. The presence of sludge and FITA is less than 5% (Fig. 2).



Figure 2. The sampling site: the river Drinjača upstream from the mouth of the river Jadar (N 44.278913 X, E19.103898 Y) and downstream from the mouth of the river Jadar (N 44.280142, E19.113940), 2012.

*Slika 2. Lokalizacija uzorkovanja: Drinjača uzvodno od ušća Jadra (N 44.278913 X, E19.103898 Y) i nizvodno od ušća Jadra (N 44.280142, E19.113940), 2012. god.*

Saprobic index Pantle-Buck, 1955 was used for the evaluation of water quality and biotic indices BMWP and ASPT (Armitage et al. 1983) for the composition of macroinvertebrates.

Measuring the physical/chemical parameters: water temperature, concentration, oxygen saturation (OXI 3205 set WTW) was performed.

## **RESULTS AND DISCUSSION – *Rezultati rada i diskusija***

The measured values are high oxygen which moved in the range of 11.5 mg / l in March to 10.5 mg / l in June, in the waters of the river Drinajče.

Just the presence of the species from the class Bacillariophyceae (diatoms) was noted in the composition of phytobenthos of the river Drinjača at the site downstream from the confluence of the Jadar. A total of 21 species has been determined, whilst the greatest abundance is achieved by *Gomphonema olivaceum* (5), *Fragilaria ulna* (5), a vrste *Melosira varians*, *Navicula gracilis*, *Diatoma vulgaris* and *Surirella ovata*, but, even abundant, are less present (3). According to saprobic values, all of these species indicate betamesosaprobic water or II category water quality. Due to the presence of other species (RA=1) with lower saprobic value, saprobic index (1.58) indicates oligo/betamesosaprobic water or I/II category of water quality.

Table 1. Qualitative-quantitative phytobenthos composition of the river Drinjaca at the site downstream of the river Jadar, 16.06.2012.

Tabela 1. Kvalitativno-kvantitativni sastav fitobentosa rijeke Drinjače na lokalitetu nizvodno od Jadra, 16.06.2012. godine

TAXON	R.A.	s
<i>BACCILARIOPHYCEAE</i>		
<i>Cocconeis placentula</i>	1	1,6
<i>Cymatopleura solea</i>	1	2,2
<i>Cymbella</i> sp.	1	1,7
<i>Cymbella tumida</i>	1	2,2
<i>Diatoma moniliformis</i>	1	
<i>Diatoma vulgare</i>	3	2,2
<i>Fragilaria</i> sp.	1	1,4
<i>Fragilaria ulna</i>	5	2
<i>Gomphonema constrictum</i>	1	1,9
<i>Gomphonema olivaceum</i>	5	2
<i>Gyrosigma</i> sp.	1	2,1
<i>Melosira varians</i>	3	2
<i>Meridion circulare</i>	1	1,1
<i>Navicula cari</i>	3	
<i>Navicula gracilis</i>	3	1,7
<i>Nitzschia vermicularis ili sigmoidea</i>	1	2
<i>Pinnularia brebissonii</i>	1	
<i>Surirella angustata</i>	1	1,7
<i>Surirella minuta</i>	1	
<i>Surirella ovata</i>	3	2
<i>Surirella ovata var.pinnata</i>	1	
<i>Saprobni indeks</i>	<b>1,58</b>	

On two occasions in 2012, 24 taxa with 200 individuals (Table 1) was noted in samples of the river Drinjača upstream from the mouth of the Jadar. Greater diversity of individuals within the macrozoobenthos was found in samples from June 2012 (15 taxa) with domination of preimaginal stage of aquatic insects (12 taxa). Four species of aquatic snails with dominant species *Theodoxus fluviatilis* (Linnaeus, 1758) have been identified in late spring/early summer. Within the partridges there are *Perla marginata* (Panzer, 1799) and *Perla abdominalis* Burmeister, 1839, as well as species of the genus *Leuctra* Stephens, 1836th

Table 2. Qualitative-quantitative macrozoobenthos composition of the river Drinjaca upstream from the mouth of Jadar, 2012.

Tabela 2. Kvalitativno-kvantitativni sastav makrozoobentosa rijeke Drinjače uzvodno od ušća Jadra 2012. godine

TAXON	12.03.2012.		16.06.2012.	
	No. of individuals	R.A.	No. of individuals	R.A.
<b>GASTROPODA</b>				
<i>Ancylus fluviatilis</i> 3			8	2
<i>Holandriana holandri</i>			4	2
<i>Theodoxus fluviatilis</i>			12	3
<i>Viviparus viviparus</i> 7			3	1
<b>CRUSTACEA</b>				
<b>Amphipoda</b>				
<i>Gammarus fossarum</i> 6	3	1		
<b>INSECTA</b>				
<b>Ephemeroptera</b>				
<i>Baetis</i> sp.			12	3
<i>Ecdyonurus</i> sp.	15	3	8	2
<i>Rhythrogena semicolorata</i>	10	2	14	3
<i>Ephemerella ignita</i>			8	2
<b>Plecoptera</b>				
<i>Perla abdominalis</i>	4	2		
<i>Perla marginata</i>	6	2	4	2
<i>Leuctra</i> sp.			12	3
<b>Trichoptera</b>				
<i>Cheumatopsyche lepida</i>	10	2		
<i>Hydropsyche incognita</i>	18	3		
<i>Hydropsyche</i> sp.			4	2
<i>Limnephilus</i> sp.			3	1
<i>Sericostoma</i> sp.			14	3
<b>Diptera</b>				
Chironomidae	6	2		
Limoniidae	8	2	6	2
Athericidae				
<i>Atherix ibis</i>	2	1	2	1
<b>Coleoptera</b>				
<i>Noteorus</i> sp.				
<i>Elmis</i> sp. larvae	12	3		
<i>Limnius</i> sp. larvae	10	2	6	2
<i>Gyrinus</i> sp.	3	1		
<b>Σ No. of individuals</b>	<b>107</b>		<b>93</b>	
<b>Σ No. of taxa</b>	<b>13</b>		<b>16</b>	

During the one-off samplings in March and June 2012, 26 taxa was noted in samples of macrozoobenthos of the river Drinjača downstream from the confluence of the Jadar. These taxa are representatives of the orders of insects that spend a part or all their life in water (table 2).

Dominance of the species from EPT groups is noted, whilst representatives of orders Diptera, cleoptera and individually Odonata are also present. A greater variety of the order Plecoptera with species *Isoperla grammatica* (Poda, 1761), *Perla abdominalis*, *Perla marginata*, *Taeniopteryx sp.* i *Protonemura sp.* is also noted. The only identified species in the samples from June is *Perla abdominalis*. A larger number and variety in preimaginal stage of the order Ephemeroptera is determined in the samples from June. Presence of five species with *Ephemerella ignita* (Poda, 1761) (28 individuals) has been noted. The identification of the species *Oligoneuriella rhenana* (Imhoff, 1852) in the samples from June has been of most importance.

Table 3. Qualitative-quantitative macrozoobenthos composition in samples of the river Drinjača downstream from the mouth of Jadar, 2012.

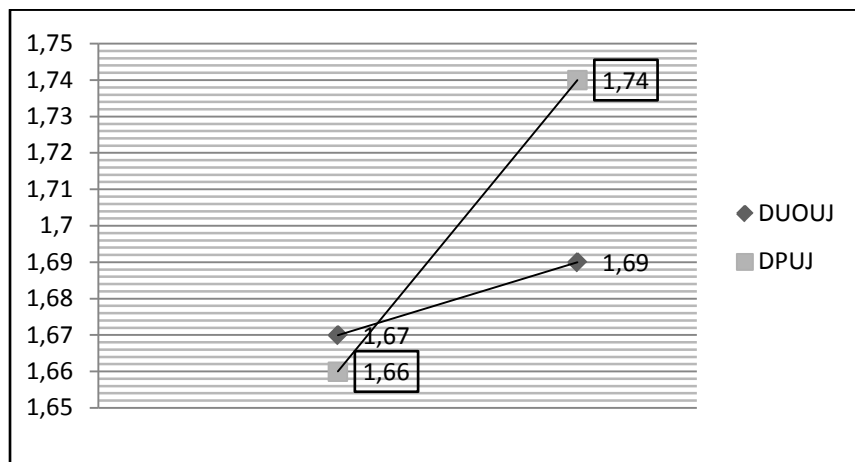
Tabela 3. Kvalitativno-kvantitativni sastav makrozoobentosa u uzorcima rijeke Drinjače nizvodno od ušća rijeke Jadar, 2012

TAXON	12.03.2012.		16.06.2012.	
	No. of individuals	R.A.	No. of individuals	R.A.
1	2	3	4	5
<b>INSECTA</b>				
<b>Ephemeroptera</b>				
<i>Baetis sp.</i>	18	3	6	2
<i>Ecdyonurus sp.</i>	12	3	16	3
<i>Oligoneuriella rhenana</i>			4	2
<i>Rhythrogena semicolorata</i>	16	3	8	2
<i>Ephemerella ignita</i>			28	3
<b>Plecoptera</b>				
<i>Isoperla grammatica</i>	4	2		
<i>Isoperla sp.</i>	6	2		
<i>Perla abdominalis</i>	3	1	8	2
<i>Perla marginata</i>	12	3		
<i>Taeniopteryx sp.</i>	6	2		
<i>Protonemura sp.</i>	2	1		
<b>Trichoptera</b>				
<i>Cheumatopsyche lepida</i>	3	2		
<i>Hydropsyche incognita</i>	12	3		
<i>Hydropsyche sp.</i>	20	3	6	2
<i>Limnephilus sp.</i>			12	3
<i>Oligoneuriella maculatum</i>			8	2
<i>Rhyacophila sp.</i>	10	2		
<i>Sericostoma sp.</i>			6	2

1	2	3	4	5
<b>Diptera</b>				
Chironomidae			12	3
Limoniidae				
Athericidae				
<i>Atherix ibis</i>				
Simuliidae	6	2		
<b>Coleoptera</b>				
<i>Noteorus sp.</i>			2	1
<i>Elmis sp. larvae</i>	8	2	8	2
<i>Limnius sp. larvae</i>	5	2	3	1
<b>Odonata</b>				
<i>Anisoptera gen.spec.</i>			3	1
<b>ΣNo. of individuals</b>	143		130	
<b>Σ No. of taxa</b>	16		15	

### Water quality – kvalitet vode

In assessing water quality saprobic index by Pantle-Buck, 1955 was applied, and the obtained values indicate a higher category of water (Graph 1.) According to the composition of the macrozoobenthos of Drinjača river, upstream from the mouth of the Jadar, water is in the category of oligo to betamesosaprobic (I to II category of quality) with saprobic index values of 1.67 to 1.69, and the site of the river Drinajče after the mouth of Jadar of 1.67 in March to 1.74 (I to category II) in June 2012.



Legenda: **DUOUJ** – Drinjača uzvodno od ušća Jadra; **DPUJ** – Drinjača poslije ušća Jadra

Graph.1. Saprobic index values for the macrozoobenthos composition of the river Drinjaca upstream and downstream from the mouth of Jadar

Grafik.1. Vrijednosti saprobnog indeksa za sastav makrozoobentosa rijeke Drinajče uzvodno i nizvodno od ušća Jadra



Biotic indices Biological Monitoring Working Group (BMWP) are applied, which are based on a summing up the tolerant values of different families (the higher the score, the better the water quality because it contains more representative of the families intolerant to pollution). The average score per taxon (ASPT) can also be worked out by dividing the result BMWP with the number of found families. The result ranges between 0 and 10 (ARMITAGE ET ALL. (1983); FREIDRICH ET AL. (1996); HYNES (1998); MACKIE (2001)).

Table 4. Categories for the values of BMWP i ASPT applied on the macrozoobenthos composition of the river Drinjaca at the site upstream and downstream from the mouth of Jadar  
*Tabela 4. Kategorije za vrijednosti BMWP i ASPT aplicirane na sastav makrozoobentosa rijeke Drinjače na lokalitetu uzvodno i nizvodno od ušća Jadra*

Site	BMWP		ASPT	
	Value	Class	Value	Class
Drinajča upstream from Jadar	112	I - Clean and is not significantly changed	7,25	Clean water
Drinajča downstream from Jadar	117	I - Clean and is not significantly changed	6,88	Clean water

In reserach up to this date, the river Drinjaca has been covered from the areas of fisheries during the 1970s. According to the analyzed data, ecological circumstances in the given stream pointed to the high diversity of flora and fauna, whilst the water quality, according to biotic parameters, has been at a high level. According to the dispositions of the European Water Framework Directive, waterflows in Bosnia and Hercegovina require typology and therefore appropriate guidelines for adequate monitoring.

The river Drina is bordering with Serbia and therefore, in general terms of condition and protection measures, must be observed in accordance with the protocol for these types of waters.

In its lower course, the river Drinajča receives water from the river Jadar that is rich in oxygen and of high level of quality. Conducted research of qualitative and quantitative analysis of the composition of the benthos of Drinajča River at the site of the upstream and downstream from the confluence of the Jadar, emphasized the need to involve more indexes in assessing the state and conservation of water supplies. Within the analysis of the phytobenthos composition, the presence of alga as indicators oligo to betamesosaprobic water was noted, pointing to a relatively high status of this watercourse. Species that build macrozoobenthos have been identified in earlier studies (1978) so consequently, degradation initiated by anthropogenic actions has not been registered. A high status of the watercourse in the investigated area was determined by applying the three biotic indices In accordance with the provisions of Regulations book characterization of water bodies of both surface waters and

groundwaters, methodology for determining specific referent conditions and classification of water status, class 10a Low and medium high hill-mountainous waterstreams with medium coarse substrate of the soil, Continental Dinaride subregion. Unaltered state of the environmental conditions is reflected through the appearance constant species registered in studies that had been done over four decades ago: *Oligoneuriella rhenana*, *Perla marginata* and *Perla abdominalis* as well as other registered representatives of preimaginal stages of aquatic insects from EPT group.

### **CONCLUSION – Zaključak**

River Drinjacica in the part upstream from the mouth and at the mouth, according to the biotic parameters, shows a stable and high ecological status. The high status or unaltered natural state had been determined by using different biotic indices (saprobic index, BMWP and ASPT) in accordance to the Regulations of WFD. According to the outlined, this part of the watercourse can be taken as a reference profile for the type 10a small and medium high hill-mountainous waterstreams with medium coarse substrate soil according to the Regulations. These are the true encompassing research for the watercourse of the river Drinjacica.

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## SAŽETAK

Rad je rezultat analize ekoloških parametara vodotoka rijeke Drinjače na lokalitetima uzvodno i nizvodno od ušća rijeke Jadar u periodu 2012 godine. Pri uzorkovanju bentosa primjenjena je metodologija po AQEM-u koja je sastavni dio Okvirne direktive o vodama (WFD – 2000/60/EC). Na osnovu analize sastava bentosa utvrđena je velika raznovrsnost sastava makrozoobentosa sa dominacijom preimaginalnih stadija vodenih insekata skupine EPT.

Na osnovu apliciranog saprobnog indeksa utvrđeno je da oba biološka parametra ukazuju na oligo do betamesosaprobnu vodu (čistu).

Na sastav makrozoobentosa aplicirani su indeksi u ocjeni ekološkog statusa BMWP i ASPT. Prema ovim indeksima rijeka Drinjača je u visokom ekološkom statusu sa blagim ili neznatnim promjenama.

Ovo je ujedno prva primjena ovih indeksa u ocjeni stanja ovog dijela podsliva rijeke Drine u Bosni i Hercegovini. U radu su analizirani i drugi parametri, ali se makrozoobentos pokazao kao najrelevantniji za adekvatnu determinantu stanja vodotoka kao i prema odredbama Okvirne direktive o vodama.