

Indicative Ecological Status Assessment of the Južna Morava River Based on Aquatic Macroinvertebrates

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Abstract

The paper presents the results of the study on the quality of Južna Morava water, based on the analysis of aquatic macroinvertebrate community. Investigations were performed in June and September 2011. The sampling area covered five sites: Mojsinje, Aleksinac, Grdelica, Vladičin Han and Ristovac. The following metrics were used: Saprobic Index (Zelinka & Marvan), BMWP (Biological Monitoring Working Party) Score, ASPT (Average Score Per Taxon), number of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa, total number of taxa and Shannon-Weaver Diversity Index for the assessment of the ecological status. Based on analyses of selected parameters, the indicative ecological status of the Južna Morava River in the investigated stretch could be assessed as moderate (Class III). A total of 83 aquatic invertebrate taxa were recorded. With respect to the taxa richness, the dominant taxa were found to be Ephemeroptera, Trichoptera and Gastropoda. With regard to the relative abundance/percentage participation, Trichoptera, Hirudinea and Gastropoda were recorded as principal components of the macroinvertebrate community.

Keywords: aquatic macroinvertebrate community, Južna Morava River, water quality parameters, indicative status assessment

Introduction

The paper states conclusions about the water quality of the Južna Morava River based on the analyses of aquatic macroinvertebrate community. The results of qualitative, quantitative as well as saprobiological analyses were included in the study.

The Južna Morava River is 295 km long and it begins in the mountain of Skopska Crna Gora in Macedonia. Its own catchment area is 15,469 km² and average discharge at the mouth is 100 m³/s. Streams of Ključevska and Slatinska reka join together to form the river Golema, which is, after passing the Macedonian-Serbian border, known as the Binačka Morava. After 49 km it meets the Preševska Moravica at Bujanovac, and for the remaining of 246 km flows as the Južna Morava. It flows generally in the south to north direction, from the Macedonian border to Central Serbia, where it meets the Zapadna Morava River at Stalać, to create the Velika Morava River. The Južna Morava has 157 tributaries. The most important left ones are: Jablanica, Veternica, Pusta reka and Toplica. Right tributaries are: Vrla, Vlasina, Nišava (the longest) and Sokobanjska Moravica.

The Serbian stretch of the Južna Morava River covers six water bodies (Official Gazette of the R. of Serbia 96/2010), and four of them are situated within the investigated area: JMOR_1, JMOR_2, JMOR_4 and JMOR_6.

According to the national typology of surface waters, the Južna Morava River belongs to Type 2 - large rivers with medium grain-size mineral substrates, except Pannonian plain rivers (Official Gazette of the R. of Serbia 74/2011). With regard to ecoregions delineation for the territory of Serbia, the Južna Morava River belongs to Ecoregion 5 (ER5) (Paunović et al., 2012).

Material and Methods

Sampling was conducted during periods of high (June, 2011) and low (September, 2011) water level at five sampling sites (Table 1, Figure 1), according to AQEM protocol (AQEM 2001). The semi-quantitative sampling was performed using a hand net (25x25 cm, 500 µm mesh size). The multi-habitat sampling procedure (Hering et al., 2004) was applied. Samples were preserved using 70% ethanol solution and further analysed in the laboratory.

Table 1: Sampling sites

	Mojsinje	Aleksinac	Grdelica	Vladičin Han	Ristovac
Latitude, N	43° 37' 50"	43° 31' 39"	42° 53' 30"	42° 42'30"	42° 28' 21"
Longitude,E	21° 29' 27"	21° 42' 51"	22° 04' 06'	22° 03' 29"	21° 50'37"
Altitude (m)	204	257	363	328	383
Distance from mouth (rkm)	18.1	61.8	163	195	237
Water Body	JMOR_1	JMOR_2	JMOR_4	JMOR_6	JMOR_6



Figure 1: Map of sampling sites

Mean annual water temperatures at sampling sites (according to the Annual Water Quality Report, 2011) are shown in Figure 2.

The following metrics were selected to be used for indicative assessment of ecological status: Zelinka and Marvan Saprobic Index (Zelinka & Marvan, 1961), BMWP (Biological Monitoring Working Party) Score, ASPT (Average Score Per Taxon), number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa (Armitage et al., 1983), total number of taxa and Shannon-Weaver's Diversity Index (Shannon, 1948). Saprobiological analyses were carried out by using a list of bioindicator organisms according to Moog (Moog, 1995). Some taxa were not identified to the species level due to low level of confidence and the complex identification process. The metrics calculation was done using AQEM software (AQEM, 2002). Indicative status assessment was performed according to the national legislation (Official Gazette of the R. of Serbia 74/2011), based on ecological status classes for rivers Type 2 (large rivers with medium grain-size mineral substrates, except Pannonian plain rivers), as shown in Table 2. Methodology of investigation was designed according to recommendations provided by the EU Water Framework Directive (WFD, 2000).

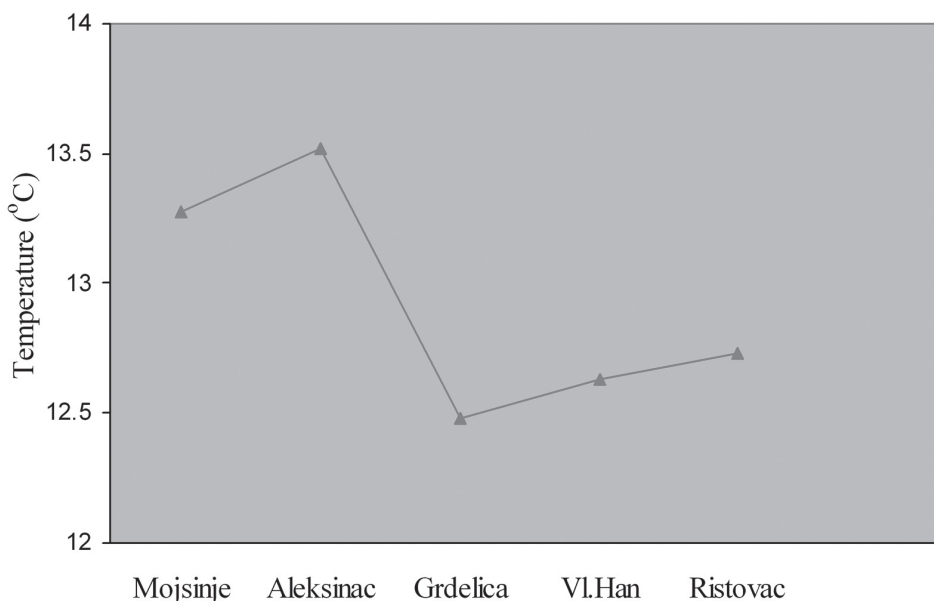


Figure 2: Mean annual water temperatures (°C) at sampling sites during 2011

Table 2: Ecological status class boundaries of used indices

PARAMETER	class	I -II	II -III	III-IV	IV -V
Total No.of Taxa		17	10	9	5
Shannon-Weaver		2.20	1.50	1.20	0.50
EPT taxa		7	5	2	1
Zelinka & Marvan SI		2.00	2.50	3.00	3.20
BMWP Score		60.00	45.00	30.00	10.00
ASPT Score		6.00	5.00	4.00	3.00

Results and Discussion

A total of 83 aquatic invertebrate taxa were identified (Table 3). Insecta was the most dominant component of the community with 51 taxa, followed by Mollusca (12 taxa), Oligochaeta and Hirudinea, both with 6 taxa. Diversity of other groups was significantly lower. Among Insecta, the dominant groups were found to be Trichoptera (17 taxa) and Ephemeroptera (15 taxa), while subdominant were Diptera (7 taxa) and Odonata (5 taxa).

Table 3: List of taxa recorded at the Južna Morava River

TAXON NAME	TAXON NAME
Nematoda sp.	Crustacea
Nematomorpha	<i>Asellus aquaticus</i> (Linnaeus,1758)
<i>Gordius aquaticus</i> Linnaeus,1758	<i>Gammaridae</i> spp.
Turbellaria	Hydrachnidia sp.
<i>Dendrocoelum lacteum</i> (Müller,1774)	Arachnida
<i>Dugesia polychroa</i> (Schmidt,1861)	<i>Araneae</i> sp.
Oligochaeta	Insecta
<i>Branchiura sowerbyi</i> Beddard,1892	Ephemeroptera
<i>Nais</i> spp.	<i>Baetis buceratus</i> Eaton,1870
<i>Limnodrilus</i> spp.	<i>Baetis fuscatus</i> (Linnaeus,1761)
<i>Stylogdrilus heringianus</i> Claparede,1862	<i>Baetis lutheri</i> Muller-Liebenau,1967
<i>Tubifex tubifex</i> (Müller,1774)	<i>Baetis rhodani</i> (Pictet,1843)
<i>Tubificidae</i> spp.	<i>Baetis scambus</i> Eaton,1870
Hirudinea	<i>Caenis luctuosa</i> (Burmeister,1839)
<i>Dina lineata</i> (O.F.Müller,1774)	<i>Caenis macrura</i> Stephens,1835
<i>Erpobdella octoculata</i> (Linnaeus,1758)	<i>Caenis robusta</i> Eaton,1884
<i>Erpobdella testacea</i> (Savigny,1820)	<i>Ecdyonurus aurantiacus</i> (Burmeister,1839)
<i>Glossiphonia complanata</i> (Linnaeus,1758)	<i>Ecdyonurus dispar</i> (Curtis,1834)
<i>Helobdella stagnalis</i> (Linnaeus,1758)	<i>Ecdyonurus</i> sp.
<i>Hemiclepsis marginata</i> (O.F.Müller,1774)	<i>Ephemerella notata</i> Eaton,1887
Gastropoda	<i>Ephemerella</i> sp.
<i>Holandriana holandrii</i> (C.Pfeiffer,1828)	<i>Dacnogenia coeruleans</i> Rostock,1878
<i>Lithoglyphus naticoides</i> (C.Pfeiffer,1828)	<i>Torleya major</i> (Klapálek,1905)
<i>Physella acuta</i> (Dreparnaud,1805)	Trichoptera
<i>Planorbidae</i> sp.	<i>Anabolia nervosa</i> (Curtis,1834)
<i>Radix ampla</i> (W.Hartmann,1821)	<i>Brachycentrus</i> sp.
<i>Radix labiata</i> (Rossmassler,1835)	<i>Cynurus trimaculatus</i> (Curtis,1834)
<i>Theodoxus danubialis</i> (C.Pfeiffer,1828)	<i>Cheumatopsyche lepida</i> (Pictet,1834)
<i>Theodoxus transversalis</i> (C.Pfeiffer,1828)	<i>Halesus radiatus</i> (Curtis,1834)
Bivalvia	<i>Halesus tessellatus</i> (Rambur,1842)
<i>Sinanodonta woodiana</i> (Lea,1834)	<i>Hydropsyche angustipennis</i> (Curtis,1834)
<i>Unio crassus</i> Philipson,1788	<i>Hydropsyche contubernalis</i> McLachlan,1865
<i>Unio pictorum</i> (Linnaeus,1758)	<i>Hydropsyche dissimulata</i> Kumanski & Botosaneanu,1974
<i>Unio tumidus</i> (Linnaeus,1758)	<i>Hydropsyche exocellata</i> Dufour,1841

TAXON NAME
<i>Hydropsyche incognita</i> Pitsch,1993
<i>Hydropsyche pellucidula</i> (Curtis,1834)
<i>Hydropsyche saxonica</i> McLachlan,1884
<i>Leptoceridae</i> sp.
<i>Limnephilus</i> spp.
<i>Limnephilidae</i> sp.
<i>Neureclipsis bimaculata</i> (Linnaeus,1758)
Odonata
<i>Calopteryx splendens</i> (Harris,1782)
<i>Calopteryx virgo</i> (Linnaeus,1758)
<i>Cordulegaster boltonii</i> (Donovan,1807)
<i>Ophiogomphus cecilia</i> (Fourcroy,1785)
<i>Stylurus flavipes</i> (Charpentier,1825)
Diptera
<i>Atherix ibis</i> (Fabricius,1798)
<i>Ceratopogonidae</i> sp.
<i>Chironomidae</i> spp.
<i>Ibisia marginata</i> (Fabricius,1781)
<i>Limoniidae</i> sp.
<i>Pediciidae</i> sp.
<i>Tipula</i> sp.
Coleoptera
<i>Hydrophilidae</i> sp.
<i>Potamophilus acuminatus</i> (Fabricius,1792)
Hemiptera
<i>Aphelocheirus aestivalis</i> (Fabricius,1794)
<i>Gerris</i> spp.
<i>Hydrometra stagnorum</i> (Linnaeus,1758)
<i>Mesovelgia furcata</i> Mulsant & Rey,1852
Megaloptera
<i>Sialis lutaria</i> (Linnaeus,1758)

Snails were represented with 8 taxa: *Holandriana holandrii*, *Lithoglyphus naticoides*, *Physella acuta*, *Planorbidae* sp., *Radix ampla*, *R.labiata*, *Theodoxus danubialis* and *T. transversalis*. Bivalves were not frequent in samples, a four species were recorded: *Sinanodonta woodiana*, *Unio crassus*, *U. pictorum* and *U.tumidus*.

With regard to the relative abundance/percentage participation in the community, Trichoptera, Hirudinea and Gastropoda were found to be principal components of the community. The most abundant taxa were: *Hydropsyche incognita* (Trichoptera), *Limnephilus* species (Trichoptera), *Erpobdella octoculata* (Hirudinea) and *Chironomidae* species (Diptera).

The total number of taxa per sample varied from 21 and 19 (Mojsinje, June,September) to only 8 (Ristovac, September). The average number of total taxa recorded points good status of the river (Class II).

The greatest diversity was noticed in Mojsinje (values of Shannon-Weaver Diversity Index is 2.94 in September and 2.87 in June). On the other hand, the lowest diversity was in Ristovac in September (Shannon-Weaver value is 2.00). Average values of Shannon-Weaver Diversity Index indicate an overall high water quality (Class I).

Number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa ranged from 10 (Grdelica, September) to 0 (Aleksinac and Ristovac, September). Average values of EPT taxa corresponds to Class III (moderate status).

Values obtained for Zelinka & Marvan Saprobic Index varied from 1.93 (β -mesosaprobity; Mojsinje, September) to 2.60 (α - β -mesosaprobity; Ristovac, September), which indicate moderate presence of organic pollution. Average values of Zelinka & Marvan SI correspond to Class II (good status), as shown is in Figure 3.

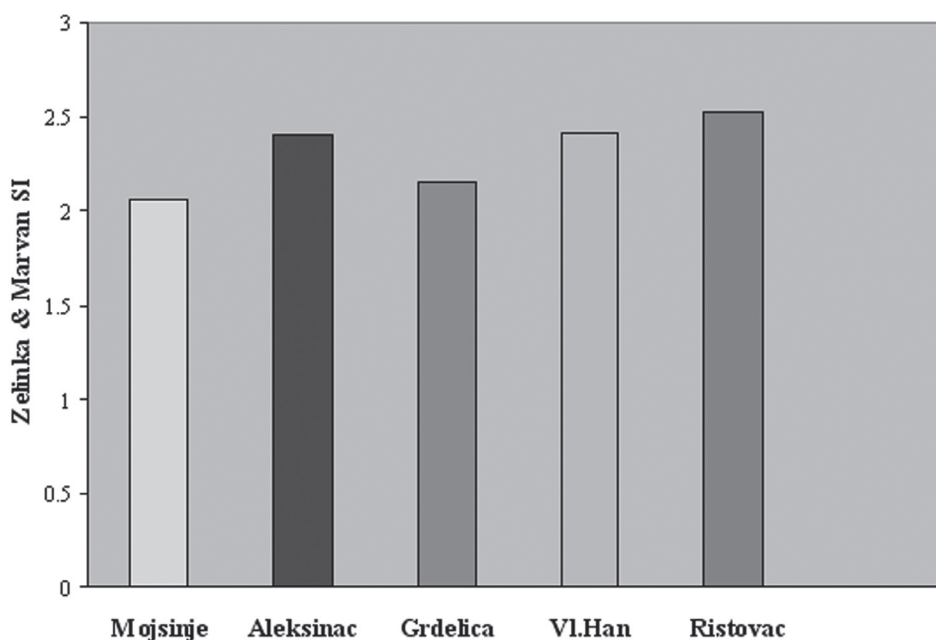


Figure 3: Average values of Zelinka & Marvan Saprobic Index

Some taxa were not identified to the species level (mainly Oligochaeta and Diptera) due to complex and long-term identification process. On the other hand, some taxa in different taxonomic ranks are not included in the used list of indicator taxa (Moog, 1995). Therefore calculated values of SI index were lower than expected.

According to this study, the lowest BMWP Score value was 13 (Ristovac, September). In the opposite, the highest value was 70 (Mojsinje, September). Average values of BMWP Score during investigations reflect that water quality is good (Class II).

The lowest ASPT value was recorded in Ristovac (2.60), and the highest in Grdelica (6.70), both in September. Average ASPT values indicate poor status of the river (Class IV).

Values of selected assessment parameter and overall status assessment are given in Tables 4, 5 and 6.

Table 4: Values of examined parameters in June 2011

SAMPLING SITE	Mojsinje	Aleksinac	Grdelica	Vladičin Han	Ristovac
Total No.of Taxa	19	11	14	13	16
Shannon-Weaver	2.87	2.36	2.59	2.48	2.66
EPT taxa	6	2	5	5	8
Zelinka & Marvan SI	2.20	2.32	2.29	2.46	2.45
BMWP Score	63	37	66	43	57
ASPT Score	4.85	4.11	6.60	4.78	5.18

Table 5: Values of examined parameters in September 2011

SAMPLING SITE	Mojsinje	Aleksinac	Grdelica	Vladičin Han	Ristovac
Total No.of Taxa	21	13	18	16	8
Shannon-Weaver	2.94	2.41	2.70	2.57	2.00
EPT taxa	5	0	10	9	0
Zelinka & Marvan SI	1.93	2.49	2.01	2.36	2.60
BMWP Score	70	40	67	30	13
ASPT Score	5.39	4.00	6.70	4.29	2.60

Table 6: Ecological status classes with respect to average values of examined parameters and overall status assessment

SAMPLING SITE	Mojsinje	Aleksinac	Grdelica	Vladičin Han	Ristovac	Overall Status
Total No.of Taxa	I	II	II	II	II	II
Shannon-Weaver	I	I	I	I	I	I
EPT taxa	II	IV	I	II	III	III
Zelinka & Marvan SI	II	II	II	II	III	II
BMWP Score	I	III	I	III	III	II
ASPT Score	II	V	I	III	IV	IV

Based on analyses of all parameters, it is concluded that the indicative status of the Južna Morava River in the investigated stretch could be assessed as moderate (Class III).

Generally small number of recorded taxa, with dominance of one or a few species reflects the presence of different types of stress. The results of our study confirmed that the Južna Morava River is under influence of various types of pressures, primarily organic and nutrient pollution and other. The river is also under the influence of substances originating from industry) as well as hydromorphological pressures (river bed degradation, channelling, gravel and sand extraction).

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