INDICATIVE ECOLOGICAL STATUS ASSESSMENT OF THE PEK RIVER BASED ON AQUATIC MACROINVERTEBRATE COMMUNITIES

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ABSTRACT

The paper presents the results of aquatic macroinvertebrate communities research at the Pek River. The material was collected from three sampling sites (Kusiće, Kučevo and Neresnica) in the 2009-2013 period. A total of 84 taxa aquatic macroinvertebrate taxa were recorded. With regard to the taxonomic composition and relative abundance of taxa, it was concluded that taxa within insect orders Trichoptera, Ephemeroptera and Odonata represent the major components of macroinvertebrate communities of the river. For the ecological status assessment of the watercourse, the following biological parameters, relevant to the macroinvertebrate community were used: total number of taxa, percentage participation of Oligochaeta/Tubificidae in the total macroinverebrate community, Shannon-Weaver's Diversity Index, Zelinka and Marvan Saprobic Index, number of Ephemeroptera, Plecoptera and Trichoptera taxa (EPT taxa), Biological Monitoring Working Party (BMWP) Score, Average Score per Taxon (ASPT) and number of sensitive taxa (Austria), according to the national legislation (Regulation on the parameters of ecological and chemical status of surface waters and the parameters of chemical and quantitative status of groundwaters, Official Gazette of the Republic of Serbia, 74/ 2011). Based on analyses of all selected metrics, the indicative ecological status of the Pek River could be assessed as poor (class IV).

Keywords: *macroinvertebrates, Pek River, biological parameters, ecological status assessment*

1. INTRODUCTION

Biological monitoring represents one of the major tools for water quality assessment. Aquatic macroinvertebrates are commonly used organisms in biological monitoring. In the present work, the results of the ecological status assessment of the Pek River was introduced based on aquatic macroinvertebrate communities.

The Pek is a river in eastern Serbia. It is a 129 km long right tributary of the Danube River, flowing through the regions of Homolje, Zvižd and Braničevo. The Pek River originates from two major headwaters, Veliki Pek and Mali Pek Stream. The Mali Pek Stream comes down from the northern slopes of the Liškovac Mountain, flows to the southwest through the city of Majdanpek, one of the major mining centers of Serbia. After a short course, the Pek reaches the western side of the Homolje Mountains and flows in into the river Lipa at the village of Debeli Lug.

Figure 1. Locality Kučevo at the Pek River

The Pek drains an area of 1230 km² and belongs to the Black Sea drainage basin. It is not navigable. The river's course is characterized by many elbow turns, similar to the Danube's on this same section (most notably, the Đerdap), but on a much lesser scale. Average discharge is 8.5 m³/s and the river's mouth is known for the Danube's inverse flow (during high levels, water from the Danube flows up the Pek). The areas surrounding the Pek's course are rich in a variety of ores and minerals, like copper, iron, pyrite, zinc, wolfram and coal (Rakova Bara coalmine), but the river is famous for the gold which it brings from the mountains around Majdanpek in small amounts. For this, the river is called Zlatni Pek (the Golden Pek).

2. MATERIAL AND METHODS

Aquatic macroinvertebrate sampling was conducted during the spring, summer and autumn period from 2009 to 2013 at three sampling sites (Kusiće, Kučevo and Neresnica) according to AQEM protocol (AQEM, 2002). 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.

The following metrics were selected to be used for indicative assessment of ecological status, according to the national legislation (Official Gazette of the R. of Serbia, 74/2011):

total number of taxa, number, percentage participation of Oligochaeta/Tubificidae in the total macroinverebrate community, Shannon-Weaver's Diversity Index (Shannon, 1948), Zelinka and Marvan Saprobic Index (Zelinka & Marvan, 1961), number of

Ephemeroptera, Plecoptera and Trichoptera taxa (EPT index) (Armitage et al., 1983), Biological Monitoring Working Party (BMWP) Score, Average Score per Taxon (ASPT) and number of sensitive taxa (Austria). Saprobiological analyses were carried out by using a list of bioindicator organisms by Moog (Moog, 1995). The metrics calculation was done using ASTERICS software (AQEM, 2002).

Ecological status assessment in the investigated stretch of the Pek River was performed based on status class boundaries for rivers Type 2 - large rivers with medium grain-size mineral substrates, except Pannonian plain rivers (Official Gazette of the R. of Serbia, 74/2011). Methodology of investigation was designed according to recommendations provided by the EU Water Framework Directive (WFD, 2000).

To carry out a WFD biological assessment, each WFD defined biological quality element (BQE, defined in the WFD) is required to give a statistically robust definition of the 'health' of that element in the defined water body. The 'health' of a BQE is assessed by comparing the measured conditions (observed value) against that described for reference (minimally impacted) conditions. This is reported as an Ecological Quality Ratio (EQR) and calculated as relation of obtained to reference values of the parameters. An EQR of one represents reference conditions and zero represents severe impact. The EQR is divided into five ecological status classes (High, Good, Moderate, Poor, Bad) that are defined by the changes in the biological community in response to disturbance (Foden et al, 2010).

Ecological status assessment based on EQR values are used in this study and given in the Table 1.

Table 1. EQR values in relation to different classes of ecological status and colour codes

EQR Value	Ecological Status Class	Colour Code
0.80 – 1.00	High	
0.60 – 0.79	Good	
0.40 – 0.59	Moderate	
0.39 – 0.20	Poor	
0.19 – 0.00	Bad	

A total of 84 aquatic invertebrate taxa were recorded (Appendix 1). Insecta was found to be the most dominant component of the community with taxa 64 taxa. The most diverse insect groups were Trichoptera (21 taxa), Ephemeroptera (15 taxa) and Odonata (11 taxa). Diversity of other groups was significantly lower. With respect to the relative abundance/percentage participation in macroinvertebrate communities, Trichoptera (31.83 %), Ephemeroptera (14.19 %) and Odonata species (14.15 %) were found to be principal components of the communities.

Appendix 1: List of macroinvertebrate taxa recorded at the Pek River

TURBELLARIA

Dugesia lugubris
Dugesia polychroa

NEMATOMORPHA

Gordius aquaticus

OLIGOCHAETA

Enchytraeus buchholzii
Limnodrilus hoffmeisteri
Nais spp.
Stylodrilus heringianus
Tubifex tubifex
Tubificidae spp.

MOLLUSCA

Gastropoda

Ancylus fluviatilis
Bithynia tentaculata
Holandriana holandrii
Physella acuta
Radix balthica
Radix labiata

Bivalvia

Unio crassus

CRUSTACEA

Austropotamobius torrentium
Gammaridae spp.

Hydrachinidia sp.

INSECTA

Ephemeroptera

Baetis fuscatus
Baetis lutheri
Baetis pavidus
Baetis rhodani
Baetis scambus.
Baetis vernus
Baetis spp.
Caenis horaria
Caenis luctuosa
Ecdyonurus venosus
Ecdyonurus sp.
Heptagenia sp.
Ephemera danica
Serratella ignita
Ephemerella sp.

Plecoptera

Leuctra sp.
Perla marginata

Trichoptera

Athripsodes sp.
Brachycentrus sp.
Halesus spp.
Hydroptila sp.
Diplectrona felix
Hydropsyche angustipennis
Hydropsyche dissimulata
Hydropsyche exocellata
Hydropsyche incognita
Hydropsyche instabilis
Hydropsyche pellucidula
Hydropsyche saxonica
Hydropsyche sp.
Cheumatopsyche lepida
Limnephilus sp.
Lithax sp.
Trichoptera sp. indet.
Leptoceridae sp.
Limnephilidae spp.
Rhyacophila dorsalis
Rhyacophila spp.

Odonata

Calopteryx splendens
Calopteryx virgo
Coenagrion sp.
Ischnura elegans
Pyrrhosoma nymphula
Anax imperator
Cordulegaster boltonii
Gomphus spp.
Onychogomphus forcipatus
Ophiogomphus cecilia
Stylurus flavipes

Limnius volckmarii
Hydraena sp.
Pomatinus substriatus

Diptera

Antocha sp
Atherix ibis
Ibisia marginata
Chironomidae spp.
Empidiidae sp.
Limoniidae sp.
Simuliidae sp.
Tipula sp.
Tipulidae sp.

Coleoptera

Elmis aenea

Hemiptera

Aphelocheirus aestivalis
Nepa cinerea

An overall ecological status assessment of the Pek River with regard to examined metrics is shown in Table 2.

Average EQR values of total number of taxa, Shannon Weaver's Diversity Index and number of Ephemeroptera, Plecoptera and Trichoptera taxa (EPT taxa) correspond to class II (good ecological status). Mean EQR values of Zelinka & Marvan Saprobic Index and number of sensitive taxa according to Austrian list of sensitive taxa point to moderate water quality (class III). Generally a large number of sensitive taxa indicates better water quality. Because there is no national list of sensitive taxa, this data should be treated with a low level of confidence. Average EQR values of percentage participation of Oligochaeta/Tubificidae in the total macroinverebrate community, Biological Monitoring Working Party (BMWP) Score and Average Score per Taxon (ASPT) reflect poor ecological status (class IV).

Ecological status assessment of the Pek River in the investigated stretch was carried out by using aquatic macroinvertebrates as bioindicators and considering communities structure and composition. Relation between communities structure/composition and water status is important for the final assessment. Based on analyses of all selected parameters, it is concluded that the indicative ecological status of the Pek River in the investigated stretch could be assessed as poor (class IV), which indicates the presence of various types of stress.

Table 2. Overall ecological status assessment of the Pek River with regard to examined metrics

Parameter / Locality	Kusiće	Kučevo	Neresnica	Overall Status Assessment
Total no. of taxa				
Oligochaeta/Tubificidae (%)				
Shannon-Weaver Index				
Zelinka-Marvan SI				
BMWP				
ASPT				
EPT Taxa				
No. of sensitive taxa (Austria)				

The results of this study confirmed that the Pek River is under influence of different types of pressures, primarily organic and nutrient pollution as well as hydromorphological impacts (river bed degradation, channeling and habitat deterioration).

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