

Original Research

EVALUATION OF ECOLOGICAL POTENTIAL OF VETERNICA RIVER BASED
ON CHEMICAL QUALITY PARAMETERS

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Abstract

This study aimed to assess the ecological potential of the Veternica River based on chemical parameters in the part of its course through the city of Leskovac. Before entering the city, the Veternica River flows through rural areas of intensive agricultural production and is therefore susceptible to pollution from runoff of mineral fertilizers and pesticides. A significant problem is also the accumulation of waste on certain parts of riverbanks, where construction debris, household and plastic waste can be found. Based on chemical indicators, the ecological status of the Veternica River ranged from III (moderate) at the sampling locations 1, 2, and 3 to IV (bad) at sampling location 4.

Keywords: ecological potential, Veternica River, biological oxygen demand, chemical oxygen demand.

INTRODUCTION

The exceptional properties of water and its crucial importance for existence of life formed a very specific relationship of individuals and human societies towards this unique resource. Water is the most valuable fluid with a great capacity to receive and transport various pollutants. The intensive industrial development is primarily characterized by a constant increase in the consumption of water which is sent back after usage to watercourses but qualitatively altered [1].

In order to assess the impact of pollution on aquatic ecosystems, it is necessary to be familiar with the nature and the amount of pollution, as well as the capacity of receivers to accept pollution [2]. The river water pollution is associated with the type of wastewater originating from urban, industrial and agricultural activities that reaches surface and underground waters [3].

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Human activities affect aquatic ecosystems through deforestation, urbanization, and agricultural development, soil drainage, discharge of pollutants and regulation of watercourses. Water quality can vary greatly depending on morphological characteristics, vegetation and activity in the river basin [4]. Furthermore, water conveyed by rivers and the heterogeneous materials they transport to coastal seas, can provide a significant information on the processes occurring within their drainage basins [5].

The Veternica River is a left tributary of the South Morava River. The length of the river is 73 km and the area of the river basin up to the confluence with South Morava is 515 km². Given that it passes by numerous settlements, of which the largest is the city of Leskovac, the pollution of the Veternica River is pronounced. The inhabitants often dispose different types of solid waste, next to the river or into the river itself. The undermining of the bottom, due to the frequent and illegal extraction of gravel in certain places, led to a change in the substrate and the creation of "convenient" places for waste disposal. Since it flows through the area with significant agricultural production, the river is also susceptible to pollution from runoff of mineral fertilizers and pesticides.

Therefore, the aim of this research was to conduct a detailed analysis of parameters and assess water quality, so some further actions could be taken to improve the current state in the field.

MATERIALS AND METHODS

River water sampling was carried out in April 2025, approximately 20 cm below the surface, at four locations: 1) after the estuary of Sušica into Veternica (42° 55' 19" N, 21° 55' 39" E), 2) the entrance into Leskovac - south suburb (42° 58' 35" N, 21° 56' 41" E), 3) the centre of Leskovac (43° 00' 12" N, 21° 56' 35" E) and 4) the northern exit from Leskovac (43° 1' 24" N, 21° 56' 54" E). The samples were collected in polyethylene bottles, preserved by adding chloroform, stored at 4 °C and analysed as soon as possible. Numerous parameters were determined.

Water temperature (°C) and pH were measured *in situ*.

Total suspended solids (TSS) were determined via standard SM 2540 D gravimetric method which implies filtering certain volume of river water through a pre-weighed glass-fiber filter and drying the residue to a constant weight at 105 °C [6].

The concentration of dissolved oxygen (DO) was determined according to well-known Winkler titration method [7]. Total water hardness (TWH) was measured by complexometric titration using EDTA and the indicator Eriochrome black T to determine the total concentration of Ca²⁺ and Mg²⁺ ions [8]. Chloride concentration (Cl⁻) was determined by using Mohr's titration method with AgNO₃. Potassium chromate was used as an indicator.

A rapid and simple spectrophotometric method was applied for nitrate analysis (NO₃-N). Nitrates absorb UV light, and the first recording was performed on 220 nm. The second recording on 275 nm was used as correction for organic dissolved matter. Furthermore, for ammonia nitrogen content (NH₄-N), Nessler method was applied, and the absorbance was recorded at 425 nm [9].

The content of orthophosphates (PO_4^{3-}) was also determined spectrophotometrically at 690 nm. The method relies on reaction of orthophosphates with molybdate in acidic conditions to form phosphomolybdic acid, which is then reduced to an intense blue compound, proportional to the orthophosphate concentration [10].

Chemical Oxygen Demand (COD) was applied to determine water pollution levels by quantifying the consumption of $\text{K}_2\text{Cr}_2\text{O}_7$, which is a strong oxidant for both organic and inorganic substances. Biochemical Oxygen Demand over 5 days period (BOD_5) was measured in order to determine the amount of dissolved oxygen required by aerobic microorganisms to decompose organic matter in river water samples.

Analysis of river water was also carried out on an inductively coupled plasma-optical emission spectroscopy (ICP-OES) instrument (ARCOS FHE12, SPECTRO, Germany), and the concentrations of trace elements (Cr, Fe, and Mn) were determined. ICP-OES parameters were as follows: RF strength 1500 W, flush pump rate 30 rpm, analysis pump rate 30 rpm, nebulizer gas flow rate $0.95 \text{ dm}^3/\text{min}$, coolant gas flow rate $13 \text{ dm}^3/\text{min}$, auxiliary gas flow rate $0.8 \text{ dm}^3/\text{min}$, and axial viewed plasma mode.

RESULTS AND DISCUSSION

The results of the analysis are presented in the Table 1.

Table 1 The results of examined parameters of Veternica River water according to sampling locations

Parameter	Sampling location			
	1	2	3	4
T ($^{\circ}\text{C}$)	11.5	11.8	12.0	11.8
TWH ($\text{mg CaCO}_3/\text{dm}^3$)	133	126	138	144
pH	7.94	7.87	7.98	8.12
DO ($\text{mg O}_2/\text{dm}^3$)	7.12	7.16	7.19	6.93
Cl^- (mg/dm^3)	9.94	10.21	10.34	10.65
$\text{NO}_3\text{-N}$ (mg/dm^3)	2.8	2.8	3.9	3.8
$\text{NH}_4\text{-N}$ (mg/dm^3)	0.27	0.43	0.39	0.32
PO_4^- (mg/dm^3)	0.12	0.13	0.13	0.12
BOD_5 ($\text{mg O}_2/\text{dm}^3$)	4.21	4.53	5.32	6.77
TSS (mg/dm^3)	13.62	12.41	15.75	17.48
COD ($\text{mg O}_2/\text{dm}^3$)	12.55	13.84	12.11	14.84
Cr ($\mu\text{g}/\text{dm}^3$)	11	13	13	19
Mn ($\mu\text{g}/\text{dm}^3$)	16	12	18	12
Fe ($\mu\text{g}/\text{dm}^3$)	315	353	345	376

According to the Rulebook on determination of surface and underground waters [11] Veternica River was defined as a watercourse significantly altered by human activity, due to utilization or protection. Furthermore, according to the Rulebook on the parameters of the ecological and chemical status of surface waters and the parameters of the chemical and quantitative status of groundwater [12], Veternica River was classified as type 3 - small and medium-sized watercourses, altitude up to 500 m, with a coarse substrate predominance in the riverbed. Based on water quality, five classes of ecological potential were defined as follows: class I – high, class II – good, class III – moderate, class IV – poor and class V – bad. For

type 3 watercourse, parameters were defined as well as limits for each class and given in the Table 2.

Table 2 Chemical parameters and limits among classes of ecological potential

Parameter	Limits among classes of ecological potential			
	I-II	II-III	III-IV	IV-V
pH	6.5-8.5	6.5-8.5	6.5-8.5	<6.5, >8.5
DO (mg O ₂ /dm ³)	8.5	7.0	5.0	4.0
Cl ⁻ (mg/dm ³)	50	100		
NO ₃ -N (mg/dm ³)	1.5	3.0	6.0	15.0
NH ₄ -N (mg/dm ³)	0.05	0.1	0.8	1.0
PO ₄ ⁻ (mg/dm ³)	0.02	0.1	0.2	0.5
BOD ₅ (mg O ₂ /dm ³)	1.5	5.0	6.0	20.0

In addition, Regulation on limit values of pollutants in surface and groundwater and sediment and deadlines for their achievement [13], defined closer the levels of other parameters for assessing the class of ecological potential of surface water, as given in Table 3.

Table 3 Classes of ecological potential of surface water according to the limit values of pollutants

Parameter	Limit values of pollutants in surface waters				
	I class	II class	III class	IV class	V class
TSS (mg/dm ³)	25	25			
COD (mg O ₂ /dm ³)	10	15	30	125	>125
Fe (µg /dm ³)	200	500	1000	2000	>2000
Mn (µg /dm ³)	50	100	300	1000	>1000
Cr (µg /dm ³)	25	50	100	250	>250

When the value of the ecological status or ecological potential parameter corresponded to the value at the boundary between the classes, the surface water body was classified in a worse class. If one or more ecological status or ecological potential parameters exceed the threshold values of good status, the ecological status or ecological potential of the surface water may be classified at most as moderate [12]. Summary ecological potential of river water on each of the sampling locations was estimated after comparing the obtained data via numerous analysis (Table 2) with the lawfully regulations (Tables 3 and 4) and presented in the Table 4.

The temperature and pH of the river water were fairly uniform at all locations. The contents of chlorides, Cr and Mn did not exceed the limits defined for the I class. The Fe content and TSS did not exceed the limits defined for the II class.

Considering the content of DO, NO₃-N, NH₄-N and PO₄⁻, the water quality corresponded to the III class, therefore described as moderate. Although nitrates and phosphates are growth supporting, essential plant nutrients, increased amounts of these anions contribute to eutrophication of aquatic systems, which consequently leads to higher consumption of dissolved oxygen in water. Excess amounts of nitrates and phosphates in watercourses can be caused by several factors: agricultural runoffs (mineral fertilizers and animal manure), septic drainage, industrial wastewater discharge or household garbage dumps [14].

Table 4 Ecological potential of Veternica River water on each of the sampling locations

Parameter	Sampling location			
	1	2	3	4
pH	II	II	II	II
DO (mg O ₂ /dm ³)	III	III	III	III
Cl ⁻ (mg/dm ³)	I	I	I	I
NO ₃ -N (mg/dm ³)	III	III	III	III
NH ₄ -N (mg/dm ³)	III	III	III	III
PO ₄ ⁻ (mg/dm ³)	III	III	III	III
BOD ₅ (mg O ₂ /dm ³)	III	III	III	IV
TSS (mg/dm ³)	II	II	II	II
COD (mg O ₂ /dm ³)	II	II	II	II
Cr (µg/dm ³)	I	I	I	I
Mn (µg /dm ³)	I	I	I	I
Fe (µg /dm ³)	II	II	II	II
Summary ecological potential	III	III	III	IV

Regarding BOD₅, the water samples collected at sampling points 1, 2 and 3 corresponded to class III, but the sample collected at sampling location 4 corresponded to class IV. BOD₅ is correlated to microbiological contamination and is used to assess pollution levels of freshwater bodies. Higher BOD₅ values indicate more organic pollutants, which also results in lower oxygen availability for aquatic life. It is considered a reliable indicator of anthropogenic pollution [15].

Based on obtained results, summary ecological potentials for water samples at locations 1, 2 and 3 are categorized as moderate (III class), while the ecological potential at location 4 is categorized as bad (IV class). Evidently, the Veternica River water quality is deteriorating as it flows towards the estuary.

CONCLUSION

Given that the sampling of Veternica River water was carried out in the spring, application of fertilizers and pesticides and their runoff could be one of the causes of increase in NO₃-N, NH₄-N and PO₄⁻ loadings. However, the existence of illegal landfills on the riverbanks and in some cases domestic drainage, would be impossible to ignore. Therefore, it is necessary to put more effort in training and educating farmers and raising of ecological awareness of people living by the river about the preservation of natural resources. Even the slight deterioration in river water quality may cause very serious consequences—not just disturbance in aquatic biota but pose a risk to human health when rivers are used for irrigation or to obtain drinking water. Also, strict legal regulations and significant penalties for reckless waste disposal should be implemented in practice.

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