

Current Ecological Status of Lotic Ecosystems in Vitosha Mountain Reserves (Torfeno Branishte and Bistrishko Branishte)

Radka P. Fikova¹, Emilia D. Varadinova^{1,2},
Lachezar P. Yakimov¹, Lyubomir A. Kenderov³*

1 - Bulgarian Academy of Sciences, Institute of Biodiversity and Ecosystem Research,
Department of Aquatic Ecosystems, 2 Gagarin St. 1113 Sofia, BULGARIA

2 - South-West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences,
Department Geography, Ecology and Environmental Protection,
66 Ivan Michailov St. 2700 Blagoevgrad, BULGARIA

3 - Sofia University "St. Kliment Ohridski", Faculty of Biology,
1164 Sofia, 8 Dragan Tsankov Blvd., Bulgaria

*Corresponding author: emily.varadinova@gmail.com

Abstract. The national legislation on surface waters characterization (Regulation N4/2012) was applied for the lotic ecosystems in Torfeno Branishte (Vladayska and Boyanska Rivers) and Bistrishko Branishte Reserves (Bistritsa and Yanchovska Rivers) in view of ecological status assessment. Water samples were collected and analysed both for physicochemical elements (pH, dissolved oxygen, conductivity, biological oxygen demand, nitrate and ammonium nitrogen, chlorides, sulphates) and macrozoobenthos (by calculating the regulated indices Total number of taxa and Biotic index). The assessment based on Total Number of Taxa, Biotic index and the supporting physicochemical parameters showed a "good" and "high" ecological status for four rivers. The results obtained for the representative studied water bodies, can be utilized in decision-making process to insure the relevant measures for prevention the anthropogenic pressure and further maintaining the high water quality of the aquatic ecosystems in the two reserves.

Key words: reserves, macrozoobenthos, biological quality element, physicochemical elements, rivers, ecological status.

Introduction

The Bistrishko Branishte and Torfeno Branishte Reserves are unique reserves located on the territory of Vitosha Nature Park. Torfeno Branishte preserves the most significant complex of mountain peatlands in Bulgaria, which supply the city of Sofia with drinking water. The Bistrishko Branishte Reserve is included in the UNESCO Biosphere

Reserve Network and protects valuable old-growth spruce ecosystems. The rivers in both reserves have not been a subject of prior systematized hydrobiological studies. More targeted studies on the lotic ecosystems running outside protected areas have been carried out. RUSEV (1961) conducted the first benthic study of four Vitosha rivers, including Vladayska and Boyanska, in parallel with

measurements of the basic physicochemical parameters of the aquatic environment. Data on physicochemical water parameters were found in the later study of BLASKOVA & IORDANOVA (2007), which were conducted seasonal monitoring of five main rivers in the central part of the mountain. Subsequent physicochemical studies on the waters of the Vladayska and Boyanska rivers also were made by KIROVA (2012).

The Vitosha Park Management Plan (2005-2014) summarized previous information sources that have been used to analyze the characteristics of the rivers flowing through the mountain. In the period May-June 1996-1991, the data showed values of parameters comparable to the first category for water quality, the status of the surveyed sites was defined as oligosabrobic. Later hydrobiological (benthological) studies that concerned the ecological status of the Bistritsa River were found in the publication of MITKOVA (2013). GEORGIEVA *et. al.* (2013) made an analysis of the trophic structure of the macrozoobenthos in the Bistritza River at 5 points, the highest of which was situated immediately below the boundary of the Bistirshko Branishte Reserve. The assessment at that point was defined as "high" according to the trophic index RETI/PETI (CHESHMEDJIEV & VARADINOVA, 2013). KANEV (2014) performed research specifically on the *Austropotamobius torrentium* population from some Vitosha rivers, including the Bistrihka and Yanchovska rivers in stretches running through the territory and below the border of Vitosha Park.

The national regulations for characterization of the running waters in Torfeno Branishte Reserve (TBR) and Bistirshko Branishte Reserve (BBR) by physicochemical and biological quality elements (macrozoobenthos) was applied in view of their ecological status assessment.

Material and Methods

The benthic sampling and *in situ* measurements of the physicochemical parameters were carried out in June 2015 at 4 selected representative sites: two for TBR-on

the Vladayska and Boyanska Rivers, both defined as a mountain rivers type R2, according national typology and two for BBR - mountain streams forming the Vitoshka Bistritsa and Yanchovska Rivers found to be river type R15 Karst spring (Fig. 1; Table 1).

The basic physicochemical water parameters (pH, electrical conductivity ($\mu\text{S}\cdot\text{cm}^{-1}$), dissolved oxygen concentration ($\text{mg}\cdot\text{dm}^{-3}$) and oxygen saturation were measured *in situ* with calibrated portable equipment. Concentrations of some major inorganic ions, as nitrate (NO_3^{2-}), ammonium (NH_4^+), sulfates (SO_4^{2-}) and chlorides (Cl^-) were measured photometrically. The permanganate oxidation, total and suspended solids, and biochemical oxygen demand (BOD_5) were determined in the Laboratory of Chemistry at the University of Forestry. The benthic samples were taken by hand net (500 μm mesh size) in accordance with an adapted version of the multihabitat sampling methodology developed on European AQEM/STAR projects (CHESHMEDJIEV *et al.*, 2011) in accordance with the standards BDS EN ISO 5667-3:2012. The ecological status was assessed by Biotic index (BI), Total number of taxa (TNT) and supporting physicochemical parameters, according to type specific scale developed in Regulation N4/2012. The map of the studied sites was prepared with software product ArcGIS 10.1.

Result and Discussion

Torfeno Branishte Reserve

High status has been achieved based on the results for conductivity, BOD_5 and nitrate nitrogen, as well as for the non-classified in water legislation parameters - oxygen saturation, total and suspended solids, permanganate oxidation, chlorides and sulphates (Table 2). Relatively substantial difference was found between the waters of both rivers tested with regard to ammonium nitrogen and dissolved oxygen. According to them, the assessment of the status for Boyanska River indicated presence of nutrient pollution and evaluation was determined as "good". According to the

biological quality element macrozoobenthos, the waters of the Vladayska River was defined within the limits of "high" ecological status for the R2 river type by both regulated indices – BI and TNT. This assessment coincided with the official one presented in the [River Basin Management Plans of Danube Region \(RBMP\) \(2016-2021\)](#). The

waters of the Boyanska River were defined in "good" ecological status by index BI and in "high" by TNT. In this way, the Vladayska River can be characterized as unaffected and optimally functioning aquatic ecosystem, while the Boyanska River was slightly influenced but assessed in the boundaries of the target "good" ecological status.

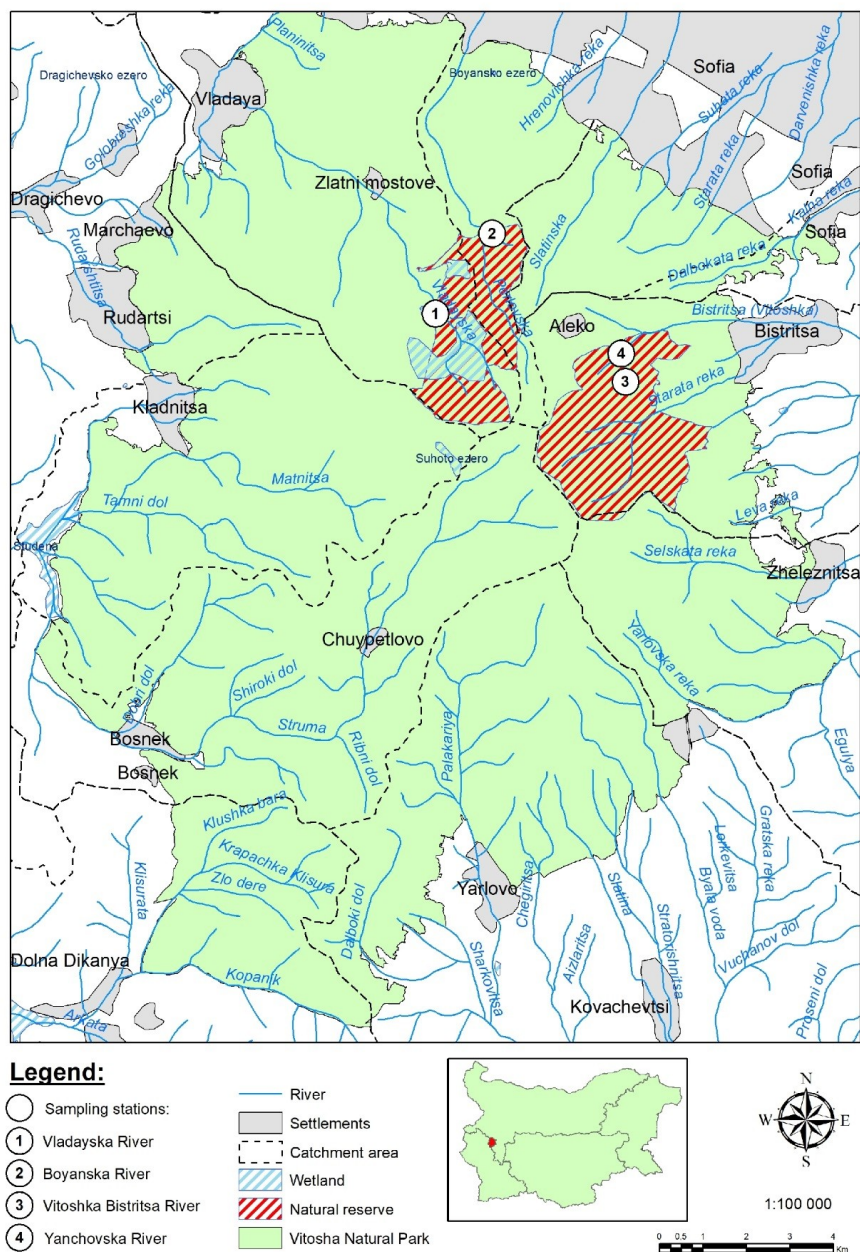


Fig. 1. Location of Torfeno Branishte and Bistrishko Branishte Reserves on the territory of the Vitosha Nature Park.

Table 1. Description of the sampling sites.

Reserve	River site	Coordinates of sampling site	Elevation (m a.s.l)	River type	Water Body Code	Danube River Basin/catchment
Torfeno Branishte	Vladayska River	42°53'15,1" N 23°15'40,8" E	1810	R2	BG1IS500R1130	Iskar River
	Boyanska River	42°36' 09,8"N 24°23'16,2" E	1800	R2	BG1IS500R1109	Iskar River
Bistrishko Branishte	Vitoshka Bistritsa River	42°34'28,8" N 23°18'37,3" E	1700	R15	BG1IS700R1107	Iskar River
	Yanchovska River	42°34'43,1" N 23°18'33,7" E	1635	R15	BG1IS700R1107	Iskar River

Bistrishko Branishte Reserve

The hydrochemical analyzes of the waters showed that both studied sites in BBT are in "high" status for parameters conductivity, dissolved oxygen and ammonium nitrogen. According to [Regulation N4/2012](#), a "good" status was found only for BOD₅ (Vitoshka Bistritsa) and for nitrate nitrogen (Yanchovska River). The additional indicators (oxygen saturation, total and suspended solids, permanganate oxidation, chlorine and sulphate ions) had optimal values which could characterized running ecosystem as clean and undisturbed. The ecological status based on biological indices of the Yanchovska River was determined as "high" with maximum value of the BI and TNT according type specific scale for R15 river type. It could be assumed that there is no anthropogenic impact on the studied water body. The specific characteristics of the bottom substrate (fine sand and forest soil, covered with leaf litter) reflected the relatively poorer macrozoobenthic taxonomic diversity in Vitoshka Bistritsa. This could be the reason for the lower value of the TNT. The values of two biological metrics responded to "good" status for the R15 river type (Table 2).

It should be emphasized that the ecological status of the two rivers (Vitoshka

Bistritsa and Yanchovska) in the reserve is not defined in the [RBMP \(2016-2021\)](#). For comparison, in the [RBMP \(2010-2015\)](#) the ecological status of the Vitoshka Bistritsa and Vladayska River was assessed as "good". Till now, during the implementation of the two RBMP evaluation of the waters of the Boyanska River in the area had not been made. This is the first ecological status assessment of the lotic ecosystem in the studied section.

Conclusions

The present study gave for the first time a complex information of ecological status of the main rivers of two reserves based on physicochemical and biological (benthological) quality elements. The evaluation showed that the waters formed and running through the territory of TBR and BBR can be described as an undisturbed or slightly affected, and characterized with optimally functioning aquatic ecosystems. The results obtained for the representative surveyed river sites, could be utilized in decision-making process to insure the relevant measures for prevention the potential anthropogenic pressure and further maintaining the high quality of the waters in the studied reserves.

Table 2. Classification of ecological status of the studied rivers.

Parameters	Torfeno Branishte Reserve		Bistirshko Branishte Reserve	
	Vladayska River	Boyanska River	Vitoshka Bistritsa River	Yanchovska River
T (°C)	8.4	7.8	10	9.7
pH	6.4	7.5	6.08	6.58
Conductivity ($\mu\text{S}\cdot\text{cm}^{-1}$)	46	39.48	45	19.8
Oxygen saturation (%)	79.7	80.0	92.5	97.1
Dissolved oxygen ($\text{mgO}_2\cdot\text{dm}^{-3}$)	7.67	7.17	8.61	8.88
Total solids ($\text{mg}\cdot\text{dm}^{-3}$)	24	24	45	73
Suspended solids ($\text{mg}\cdot\text{dm}^{-3}$)	2	3	4	15
Permanganate oxidation ($\text{mg O}_2\cdot\text{dm}^{-3}$)	0.69	0.76	0.75	2.63
BOD ₅ ($\text{mg O}_2\cdot\text{dm}^{-3}$)	0.39	0.12	1.23	1.18
N-NO ₃ ($\text{mg}\cdot\text{dm}^{-3}$)	0.11	0.14	0.14	0.66
N-NH ₄ ($\text{mg}\cdot\text{dm}^{-3}$)	< 0.01	0.08	< 0.01	< 0.01
Cl ⁻ ($\text{mg}\cdot\text{dm}^{-3}$)	2.5	< 2.0	< 2.0	3.4
SO ₄ ²⁻ ($\text{mg}\cdot\text{dm}^{-3}$)	2.6	2.6	6.5	14.3
Physicochemical status	High	Good	Good	High
TNT	16	15	9	16
BI	4.5	4	3	4
Hydrobiological (benthological) status	High	Good	Good	High
Ecological status	High	Good	Good	High

Acknowledgements. This study is financed by the Ministry of Environment and Waters as a part of the Management Plans for the "Torfeno Branishte" and "Bistirshko Branishte" Reserves – <https://www.moew.government.bg/bg/priroda/zastiteni-teritorii/planove-za-upravlenie-na-zastiteni-teritorii-v-procedura/>.

References

- BLASKOVA S., L. IORDANOVA. 2007. Precipitation and river quality at the highest part of the Vitosha Mountain. - In: *Proceedings of the International Conference on Alpine Meteorology*, pp. 4-8, June 2007, Chambéry, France. Available at: [cnrm.meteo.fr]
- CHESHMEDJIEV S., R. SOUFI, Y. VIDINOVA, V. TYUFEKCHIEVA, I. YANEVA, Y. UZUNOV, E. VARADINOVA. 2011. Multi-habitat sampling method for benthic macroinvertebrate communities in different river types in Bulgaria. - *Water Research & Management* 1, 3: 55-58.
- CHESHMEDJIEV S., E. VARADINOVA. 2013. Bottom invertebrates. - In: Belkinova, D., G. Gecheva, S. Cheshmedjiev, I. Dimitrova-Dyulgerova, R. Mladenov, M. Marinov, I. Teneva, P. Stoyanov, S. Mihov, L. Pehlivanov, E. Varadinova, Ts. Karagyozova, M. Vasilev, A. Apostolu, B. Velkov, M. Pavlova. *Biological Analysis and Ecological Status Assessment of Bulgarian Surface Water Ecosystems*. University of Plovdiv Publishing House, Plovdiv, pp. 147-164. ISBN 978-954-423-824-7 (In Bulgarian).

- GEORGIEVA S., Y. MITKOVA, L. KENDEROV, E. VARADINOVA, P. MITOV, D. PARVANOV, M. PAVLOVA, Y. PRESOLSKA, N. SIMOV, V. TYUFEKCHIEVA, I. YANEVA. 2013. Preliminary results on the trophic structure of the bottom invertebrate fauna in some Vitosha mountain's rivers (Bulgaria). - *Proceedings of seminar of ecology, 2013*. April 2013, Section "Biology", USB/IBER- BAS, pp. 25-26.
- KANEV E. 2014. Studies on the *Austropotamobius torrentium* from some Vitosha rivers. University of Sofia, Department of General and Applied Hydrobiology.
- KIROVA Y. 2012. Current state of Vitosha pluton. - *Water resources - justification, description, quality and justification for storage*. Available at: [voda.bg].
- Regulation N4/2012 for characterization of the superficial waters. 2013. *State Gazette*, № 22, 2013. Available at: [bsbd.org].
- MITKOVA Y. 2013. *Saprobiological assessment of Bistrishka river*. Department of General and Applied Hydrobiology, Faculty of Biology, Sofia University "St. Kliment Ohridski ". 61 p. (In Bulgarian).
- River Basin Management Plans of Danube Region (2010-2015). Available at: [bd-dunav.org] (In Bulgarian).
- River Basin Management Plans of Danube Region (2016-2021). Available at: [moew.government.bg] (In Bulgarian).
- RUSEV B. 1961. [Hydrobiological studies of some Vitosha rivers]. - *Exc. Zol. Inst., BAS*, 10: 211-265. (In Bulgarian).

Received: 06.08.2019
Accepted: 02.12.2019