

Ecological Assessment of the Rivers Luda Yana and Banska Luda Yana as Based on Selected Biological Parameters

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Abstract. The hydrobiological study of the Luda Yana River, and its right tributary - the Banska Luda Yana River, has been performed seasonally in 2011. Ecological status of the both rivers was analyzed according to the basic biotic indices, characterizing the composition and structure of the macrozoobenthic communities. The taxonomic structure and density showed that the bottom invertebrates community (the macrozoobenthos) was heavily disrupted and the saprobic index fluctuated around α -mesosaprobity probably as a result of municipal organic loads and the industrial wastewaters. The effects of the heavy metals pollution, incidentally occurred in the Banska Luda Yana River and originating most probably from the Assarel-Medet JSC, were discussed.

Key words: ecological conditions, Luda Jana River, structure of the macrozoobenthos.

Introduction

The European Water Frame Directive (2000/60/EU) determines the ecological status of the water bodies as an expression of the quality of the aquatic ecosystem structure and functioning. Its main objective is to obtain a "good status" for all water bodies by 2015 and "good ecological potential" for the artificial and heavily modified water bodies.

In this connection the scope of the present study was to determine the recent ecological status of the Luda Yana River and its right tributary - the Banska Luda Yana River in 2011 year by using a set of metrics,

consistent with the included in the WFD, Annex V, biological quality elements (benthic macroinvertebrates) and confirmed with the Ordinance H-4 and Order 412/2012, operating in Bulgaria at the time. Luda Yana River is a left tributary of the Maritsa River. The area along the rivers Luda Yana and Banska Luda Yana is part of the protected area of the National Network NATURA 2000 with number BG0000426, part of the protected by the Habitats Directive zones (92/43/EEC). Along the river the erosion and denudation are very intensive, the water is used for irrigation and part of it is lost in the alluvial

sediments, leading to drying up of the river almost every year. Biodiversity is strongly influenced by the negative anthropogenic impacts - cultivation, mining, settlements, disposal of industrial and municipal waste, flooding, spills, etc. The mines near the town of Panagiurishte and along the Luda Yana River - mine "Radka"; mine "Tsar Asen" and the numerous mines (geological exploration drillings done in the past) affect the ecological condition in the studied area. Some contribution to the overall chemical and ecological status of waters along has the natural metal anomalies in the area, leading to the higher natural background levels of heavy metals in the water.

The studies on the saprobic status of the Maritsa River started in the middle of the 20th century (RUSEV, 1966, 1967; EFREMOV, 1968) and was repeated in details in the 80^s by RUSSEV *et al.* (1981); UZUNOV & KOVACHEV (1981); UZUNOV *et al.* (1981); UZUNOV (1981); KOVATCHEV & UZUNOV (1981). In spite of all, its tributaries are not well studied and there is nearly no data about the ecological status in Luda Yana River and no data at all for the Banska Luda Yana River. Scanty data about the ecological status of the rivers Luda Yana and Banska Luda Yana are given by UZUNOV *et al.* (1991). Nowadays the catchment area has been studied in the execution of the NATURA 2000 project but yet no data was published.

In 2010, after an accidental pollution with wastewaters from the "Asserel Medet - JSC", resulted in mass fish death, registered in the villages Banya and Buta (Banska Luda Yana River), a new process of stocking has began.

"Asserel Medet - JSC" is the largest open pit mining and primary processing of copper ore in the Balkans. The copper extracting and processing factory has situated several filed stations for operative monitoring of the hydrochemical parameters of the water. Most of them coincided with our sampling points.

Materials and Methods

Geographical distribution and sampling

The current study was carried out in 10 sampling point, selected mainly from the area, where death fish was registered, as well as downstream of the Luda Yana River (Fig. 1). During the first sampling season (April 2011) only 4 samples were taken (at st. 2, 4, 5 and 6). During August st. 8 was not sampled and in October. Two new points were added (6' and 6'') to assess the ecological conditions in the rivers Liuliakovitsa and Mechenska.

Studied sites include sampling points along the rivers Luda Yana, Banska Luda Yana, Liuliakovitsa and Mechenska (Fig. 1). They refer to ecoregion 7 (Eastern Balkan) and the -East-Aegean River Basin. Single time samples were taken in 2011 during the high-water level (April-Jun) and the low water-level period (August - October).

Qualitative samples of benthic macroinvertebrates were taken according to the standard methods ISO 7828:1985/EN 27828:1994 and ISO 9391:1993, included in the methodic for biomonitoring, defined by order RD-412/15.06.2011 of the Minister of Environment and Waters). Field and cameral work was done in accordance with the standard EN/ISO 5667-3:2003/AC:2007. After the laboratory work, a taxonomic determination was done to such level that is enough for determination of the ecological condition, according to the approaches for applying the WFD (Directive 2000/60 EEC) introduced in Bulgaria (CHESHMEDJIEV & VARADINOVA, 2013).

Physical and chemical parameters

The physical and chemical parameters of water: water temperature ($^{\circ}\text{C}$), oxygen concentration ($\text{mg}\cdot\text{dm}^{-3}$), nitrate nitrogen ($\text{N}\cdot\text{NO}_3$, $\text{mg}\cdot\text{dm}^{-3}$) and phosphate phosphorus $\text{P}(\text{PO}_4^{3-})$, $\text{mg}\cdot\text{dm}^{-3}$ were measured *in situ* with portable microprocessor oximeter type WTW 315i/SET and in the laboratory, according to BSS 3758-85 and BSS 7210-838.

Cenosis structure

A complex of chosen hydrobiological methods was applied for assessing the biological parameters: methods for investigation of taxonomical composition, abundance and spatial dynamics of the benthic invertebrate fauna: number of taxa

(S) and total abundance (N) (CHESHMEDJIEV & VARADINOVA, 2013); method for evaluation of the correlation between the sensitive and tolerant to pollution organisms: EPT (RESH & GRODHUS, 1983);

methods for assessment the general ecological state: Adapted Biotic Index (BI) (CLABBY & BOWMAN, 1979; CHESHMEDJIEV & VARADINOVA, 2013); and EQR (Ecological Quality Ratio).

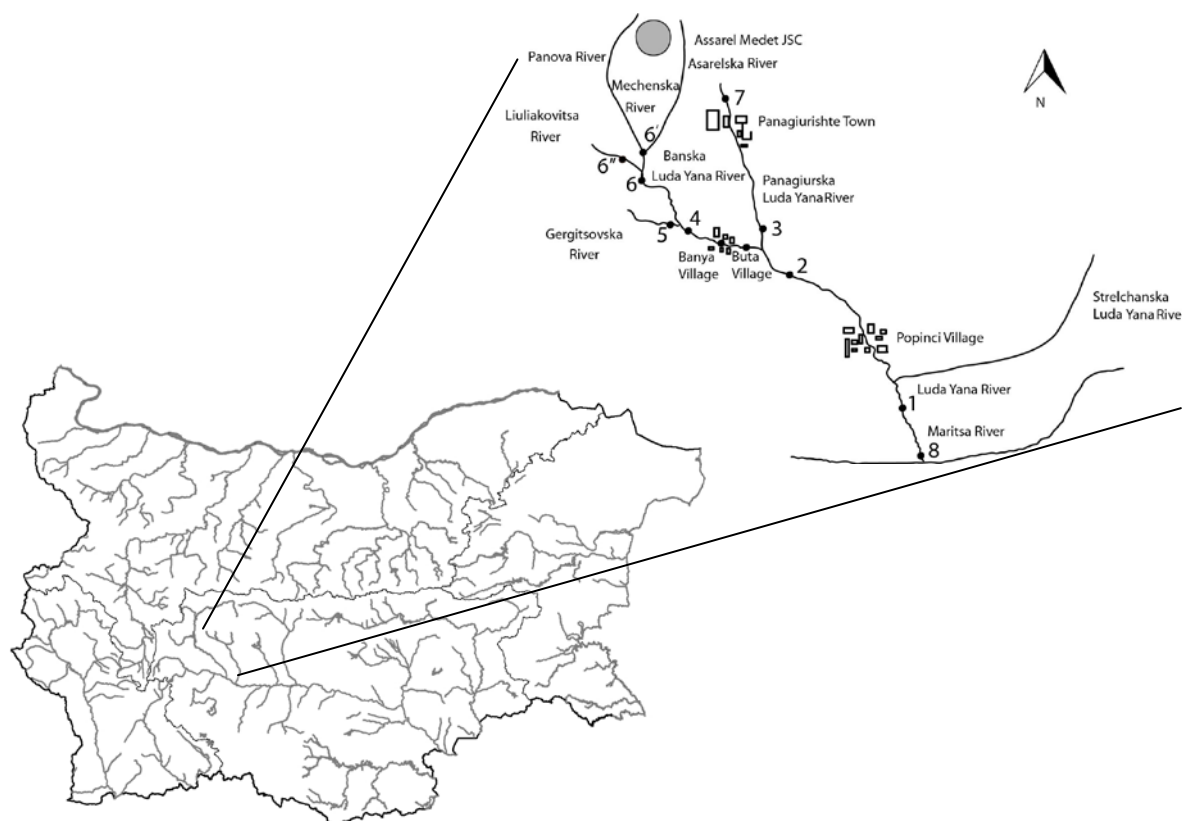


Fig. 1. Map of the sampling points.

Results and Discussion

Hydrophysical and hydrochemical parameters

Hydro-physical and hydrochemical analysis of the water main indicators were conducted before the fish stocking of the Baska Luda Yana River, in order to assess its quality at the beginning of the reconstruction activities of the ichthyofauna. The water samples were taken fourfold in 2011 (Fig. 2). Water sample analyses at st. 8 were done only in two seasons.

The sampling area is within the nitrate vulnerable zones of Bulgaria. Hydro-physical and hydrochemical parameters of the st. 4, 5, 6 and 7 were typical for surface, unpolluted waters, and provide satisfactory conditions for native fish species in the studied areas. The poorest results, especially in August and October, were at the st. 3. At

this station this was the collecting point of the water from the rivers Baska Luda Yana and Luda Yana downstream the Panagurishte Town. The low level of dissolved oxygen, high levels of total inorganic nitrogen and phosphate tended to strong anthropogenic impact of different sources. In the direction of st. 3 to st. 8 there was a gradual improvement of the values of the hydrophysical and hydrochemical parameters of the st. 1 and 2, located at the Luda Yana River before and after the Popintsi Village, and the st. 8, before Maritsa River. It was clearly recorded for st. 8, which may be an indicator of good self-purification capacity of the river.

Biological parameters

For the whole period of investigation totally 50 taxa with different taxonomic levels (Table 2, appendix) were determined

to such level that is enough for determination of the ecological condition. The total abundance/numbers (N, ind./sample) varied from 5 (st. 4, August) to 1118 (st. 6', October) (Fig. 3a). The low values of the total abundance might have been due to both anthropogenic pollution (including organic and industrial waste)

and low water levels at the times of sampling or periods of drying of the river.

The values of the EPT-richness % varied between 0 and 59.54% (Fig. 3b). Only at st. 5 sensitive species occurred in high numbers. In all of the rest stations relatively tolerant macrozoobenthic groups dominated.

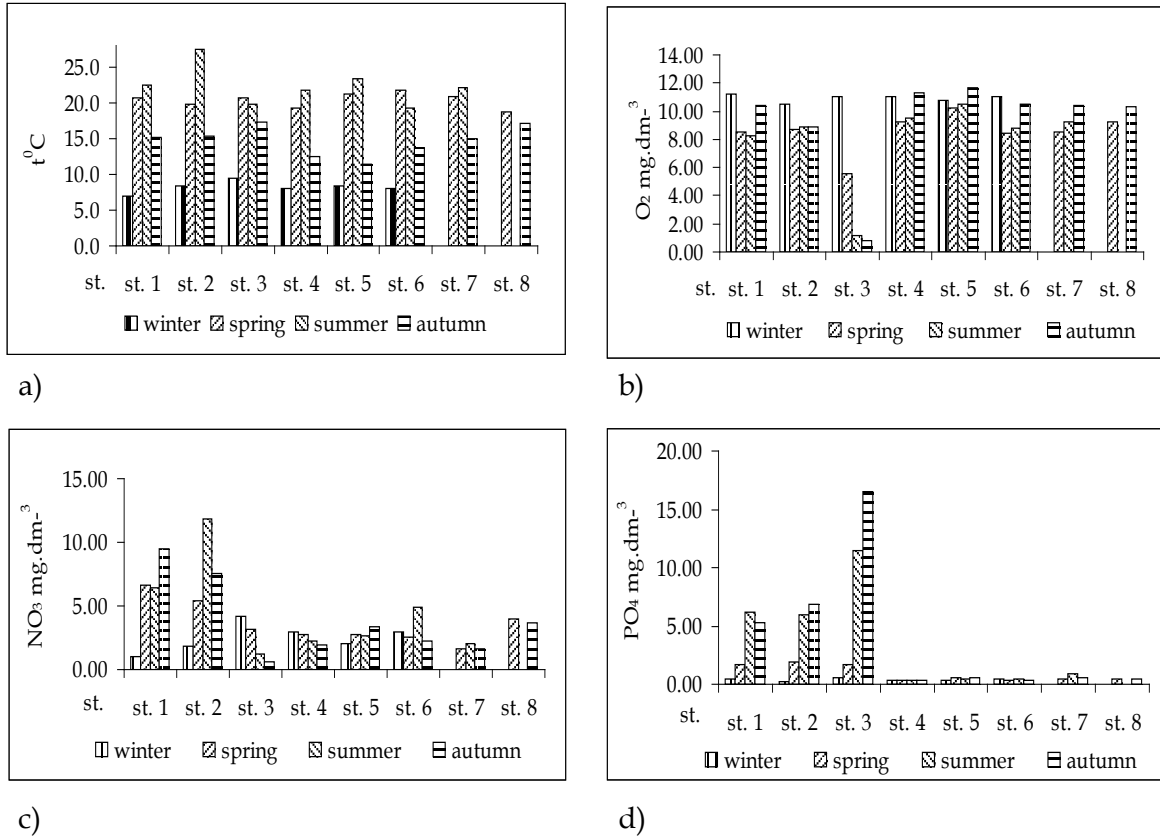


Fig. 2. Hydrophysical and hydrochemical parameters: temperature(a); dissolved oxygen (b); nitrate nitrogen (N-NO₃)(c), and phosphate phosphorus P(PO₄³⁻) (d).

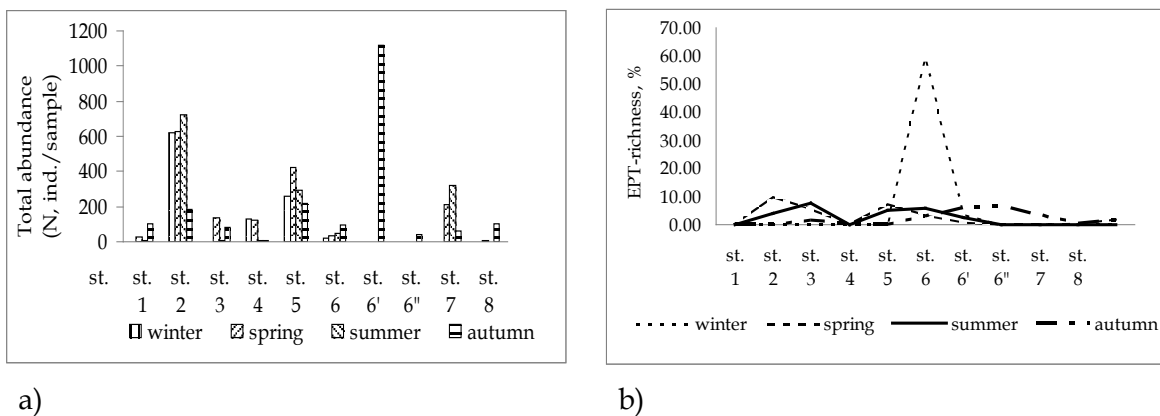


Fig. 3. Variation of the total abundance - N (a) and EPT-richness (b)

Biotic index – BI

The values of the BI (Table 1.) were comparatively constant and varied between 2 and 3, except the values 1 at st. 3 in August and 3-4 at st. 6' in October.

UZUNOV *et al.* (1991) defined the saprobic status of the rivers Banska Luda Yana (at Banya Village) and Luda Yana (at Rosen Village) as a β -mesosaprobic. According to the East Aegean Basin Directorate -, the BI, in the period 2000-

2006, in the section of the Luda Yana River between Popintsi Village (st. 1 and st. 8) and the flows in the Maritsa River, has values of 2-3. Based on benthic invertebrates the ecological status has been assessed as "moderate" to "poor". In this study the saprobic status of the sampled points varied between polysaprobic (at st. 2 and 4 in April, and at st. 1. In August) to β -mesosaprobic (at st. 6' in October). At the most sites α -mesosaprobic state has dominated.

Table 1. Values of BI and color representation of EQR.

	Station:	st. 1	st. 2	st. 3	st. 4	st. 5	st. 6	st. 6'	st. 6''	st. 7	st. 8
winter	BI		2		2	3	2				
spring	BI	2-3	2-3	2	2	3	2-3			2-3	2
summer	BI	2	2-3	1	2	2-3	3			2	
autumn	BI	2	2-3	2	2	2-3	2-3	3-4	2-3	2	2

Legend:

- red - "very bad status"
- orange - "poor status"
- yellow - "moderate status"
- green - "good status"

The st. 3 at the Luda Yana River was after the Panagiuirishte Town and the variability of the ecological status from "poor" to "moderate" could be as a result of an organic impact of the town and the nearby fields. The higher values of the IBI for st. 2 could be explained with the inflow of purer waters from the Banska Luda Yana River. Some attention had to be paid to the stations 5, 6, 6' and 6''. St. 5 (Gergitsovska River) was located before the village of Banya and was considered that there was no entry (discharge) of the wastewater plant of the Assarel Medet - JSC. The high level of the BI (3-4) at st. 6' could be explained with the lake of municipal wastewater.

In 2010, as a result of pollution with wastewaters, discharged by the Mining and Processing Complex "Asarel Medet", a mass fish death had been observed at the Banya and Buta villages. Nevertheless the mining complex discharges wastewater only in Asarelska River, the toxic effect of the rich of heavy metals waters might have caused the fish death. Although it is believed that pollution is accidental and the river is not

exposed to a chronic toxicity load, and after one year the analysis of the main hydrochemical and hydrobiological parameters in the river could be done, the ecological status of the river could be assessed so the recovery procedures of the local native ichthyofauna species could begin.

Conclusions

Banska Luda Yana River is used for irrigation and in order to reduce the river water velocity, several concrete barrages had been built, some of them with height 3-4 m. They were an insurmountable barrier to the free migration of the fish along the river and led to interruption of the river continuum, drastic changes in the river hydromorphology and turning the river in to a heavily modified water body. . Having in mind this and the fact that the Luda Yana River is assessed as a highly modified river in risk, further monitoring is recommended. It is necessary to monitor the ecological status of the river parallel with the establishment of the barbell stocked in 2011.

The current study revealed the unfavorable ecological situation of/in Luda Yana River, a left tributary of the Maritsa River. It is necessary to identify the contaminants and implement appropriate steps to eliminate their negative impact on riverine environment.

It is recommended biological value and water quality in the Maritsa River to be subjects of further studies.

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