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EVALUATION OF THE SELF-PURIFICATION IN THE WATERS OF THE MICRO-DAMS IN THE SMALL HYDROELECTRIC POWER PLANTS (HEPPS) LAKATNIK AND SVRAZHEN: POTENTIAL OF THE BIOALGORITHMS

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Abstract

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Environmental management requires the solution of problems through a comprehensive and thorough examination of all levels – from biochemical analysis to bio managerial approaches. The chemical and microbiological parameters of water in depth in micro-dams Lakatnik and Svrazhen have been investigated in June and September, 2011. Linear correlations between microbiological and hydrochemical indicators have been found. They give key information about the biochemical processes underlying the self-purification. Moreover, these correlations create a highly effective indicator system. The information from this indicator device will enable the preparation of forecast bioalgorithms for the express diagnostics of risk events in the waters of the studied micro-dams in the small HEPPs Lakatnik and Svrazhen. Our results show that these small dams provide excellent conditions for the implementation of self-purification processes in the water because of slow speed of the water in these reservoirs. The dams can be considered as natural treatment reactors where the microbial communities, operating in different layers of water, play a key role.

Key words: bioalgorithms, correlations, self-purification, waters
Abbreviations: AeH – aerobic heterotrophic bacteria, COD – chemical oxygen demand, DSS – Dissolved Suspended Soils, Endo – endo-bacteria, HEPP – hydro electric power plant, TSS – total suspended soils, USS – Unsoluble Suspended Soils

Introduction

Waters and sediments in the valley of the Iskar River in the area between the town Svoge and village Gabrovnitsa accumulate pollutants of different organic and inorganic origin. The cascade of HEPPs in the valley of the Iskar River provides an opportunity to solve this environmental problem through properly use of biomanagement techniques in water management. During the last seven years, researches in this part of the Iskar river have been done by the team of Topalova (Topalova et al., 2005; Lincheva, 2010; Todorova and Topalova, 2010). Both the information from the previous years and the created indicator system, which includes information from microbiological and hydrochemical indicators as well as correlations between them, form the basis to derive bioalgorithms for biotransformation processes. This work focuses on the information core of the indicator approaches, and especially of the discovered bioalgorithms. The interpretation of these mathematical correlations would have key importance for control and management of biotransformation processes in the river ecosystem, where the small HEPPs are integrated. Information from these bio algorithms can be used to prevent risk events in the aquatic ecosystem.

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Materials and Methods

Experimental design: The experimental design includes the micro-dams in the small HEPPs – Lakatnik and Svrazhen. For tracking major changes in the quality and speed of self-purification processes of water in the two dams, two samplings were selected – in June and September of 2011. To build reliable depth profile of watersheds the points in depth were selected as follows: 1) Lakatnik – Water: 0 m; –1 m; –2.5 m; –3.5 m; Sediments – 0 m; –0.15 m; 2) Svrazhen – Water: 0 m; –2.5 m; –5 m; Sediments – 0 m; –0.15 m.

Hydrochemicals indicators: In the study of the hydrochemical parameters standardized methods according to the current environmental regulations were used (Table 1).

Microbiological indicators: To analyze the two dams the following microbiological parameters were used: Quantity of aerobic heterotrophic bacteria (AeH) cultivated on meat peptone agar (Scharlau, Brit. Phar.) for 1 day at 28°C and quantity of endo-bacteria (Endo) cultivated on Endo medium (Scharlau, Brit. Phar.) for 1 day at 37°C.

Statistical processing:The results were processed with Microsoft Excel. The algorithms were derived using correlation analysis. The determination coefficient (R^2) was used for determination of the relationship between two variables.

Results and Discussion

The analysis of the two figures (Figures 1 and 2) shows that there is a correlation between aerobic heterotrophic bacteria and endo-bacteria. The decreasing values of heterotrophic in Lakatnik in September is accompanied by increasing concentration of endo-bacteria. Similar relationship is established in Svrazhen in June. This indicates that endo-bacteria have a complementary and supportive role to the heterotrophic bacteria in the biotransformation processes. Although this group is primarily an indicator of the presence of fecal contamination, its role in the processes of biodegradation should not be underestimated.

Linear correlation between aerobic heterotrophic and available organic content (COD) in June ($R^2 = 0.85$) and in September ($R^2 = 0.97$) in the waters and sediments of Lakatnik (Table 2) shows that the high organic loads in the surface waters are accompanied and indicated by increased levels of heterotrophic bacteria. The heterotrophic bacterial segment is supported by the group of endo-bacteria. This is obvious due to the correlations of endo-bacteria with organic matter (COD) in water and sediments of Lakatnik ($R^2 = 0.99$ and $R^2 = 0.84$) (Table 2). The correlations between heterotrophic bacteria with nitrates ($R^2 = 0.84$ and $R^2 = 0.89$) (Table 2) and

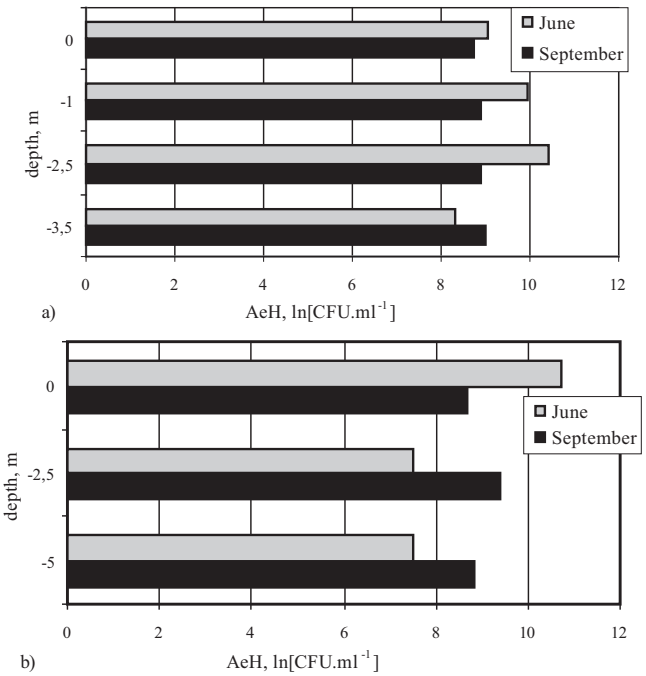

Fig. 1. Quantity of aerobic heterotrophic bacteria in the waters of Lakatnik (a) and Svrazhen (b) in June and September

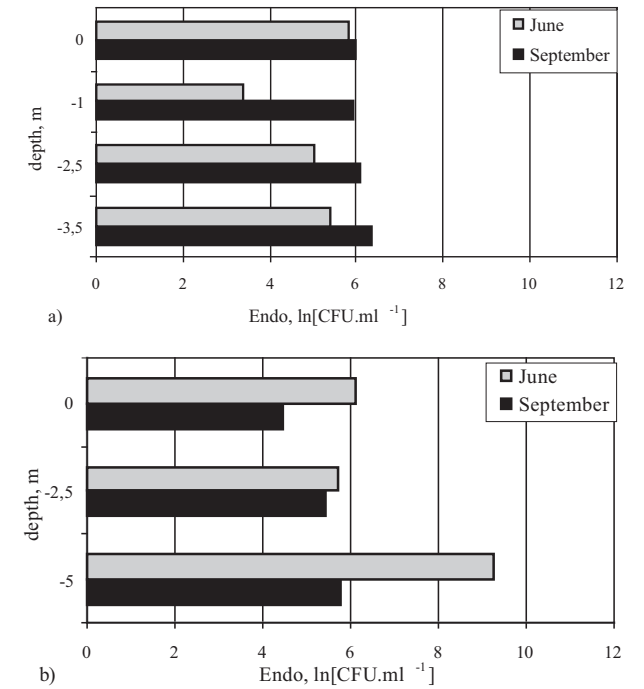

Fig. 2. Quantity of endo-bacteria in the waters of Lakatnik (a) and Svrazhen (b) in June and September

Table1

Used methods and indicators of hydrochemical parameters

Indicator	Metods	Description of the method
Total Suspended Solids (TSS), $g.l^{-1}$	BDS 17.1.4..04-80	Drying at 105°C and weight analysis
Unsoluble Suspended Soils (USS), $g.l^{-1}$	BDS 17.1.4.04-80	Filtration of the water sample through a membrane filter and plain and subsequent determination of dry matter retained on the filter by weight analysis.
Dissolved Suspended Soils (DSS), $g.l^{-1}$	BDS 17.1.4.04-80	Filtration of the water sample through a simple and membrane filter (0.45 μ) and subsequent drying of the filtered water sample at 105°C and weight analysis.
Chemical Oxygen Demand (COD), mg $O_2.l^{-1}$	BDS 17.1.4.02-77	Dichromate method with apparatus CR-2010 WTW company.
Ammonium ions, $mg.l^{-1}$	BDS ISO 7150/1	Spectrophotometric method for processing the sample with potassium sodium tartrate and Nesler reagent.
Nitrates, $mg.l^{-1}$	BDS ISO 7890-3	Spectrophotometric method. When processing the sample with sodium salicylate, sulfuric acid and sodium hydroxide.
Nitrites, $mg.l^{-1}$	BDS EN 26777	Spectrophotometric method. When processing the sample with acid's Kleve and sulphanilic acid.
Phosphates, $mg.l^{-1}$	BDS EN 1189	Spectrophotometric method. When processing the sample with ammonium molybdate and stannous chloride.

Table 2

Correlation between hydrochemical and microbiological parameters in water and sediments of Lakatnik in June (a) and September (b)

a)	COD	NH_4^+	NO_3^-	NO_2^-	PO_4^{3-}	USS	DSS	TSS
AeH	$R^2 = 0.85$	$R^2 = 0.86$	$R^2 = 0.84$	$R^2 = 0.85$	P	P	$R^2 = 0.77$	P
Endo	$R^2 = 0.99$	$R^2 = 0.89$	$R^2 = 0.93$	$R^2 = 0.92$	P	P	$R^2 = 0.71$	P
b)								
AeH	$R^2 = 0.97$	$R^2 = 0.82$	$R^2 = 0.89$	$R^2 = 0.59$	P	$R^2 = 0.87$	P	$R^2 = 0.95$
Endo	$R^2 = 0.84$	P	$R^2 = 0.94$	P	$R^2 = 0.78$	$R^2 = 0.96$	$R^2 = 0.73$	$R^2 = 0.89$

Table 3

Correlation between hydrochemical and microbiological parameters in water and sediments of Svrazhen in June (a) and September (b)

a)	COD	NH_4^+	NO_3^-	NO_2^-	PO_4^{3-}	USS	DSS	TSS
AeH	$R^2 = 0.91$	$R^2 = 0.69$	$R^2 = 0.99$	$R^2 = 0.99$	$R^2 = 0.99$	P	P	$R^2 = 0.63$
Endo	P	P	$R^2 = 0.59$	$R^2 = 0.61$	$R^2 = 0.58$	P	P	P
b)								
AeH	$R^2 = 0.97$	P	$R^2 = 0.74$	$R^2 = 0.99$	$R^2 = 0.61$	$R^2 = 0.97$	P	$R^2 = 0.95$
Endo	$R^2 = 0.81$	$R^2 = 0.82$	$R^2 = 0.75$	$R^2 = 0.94$	P	$R^2 = 0.97$	P	$R^2 = 0.98$

nitrite ($R^2 = 0.85$ and $R^2 = 0.59$), and between endo-bacteria with nitrate ($R^2 = 0.93$ and $R^2 = 0.94$) and nitrite ($R^2 = 0.92$) show a very high probability that there is a microbiological succession in the water – between microbial segment, performing the mineralization of organic matter, and nitrifying bacteria. This succession can be explained by the fact that the decreasing the content of trivial organics in the water, heterotrophic bacterial segment through their metabolism creates conditions for intense nitrification process.

Linear correlation relationships are reported between the amount of aerobic heterotrophic bacteria and COD ($R^2 = 0.91$ and $R^2 = 0.97$) in Svrazhen (Table 3), as well as in Lakatnik. In Svrazhen a succession of heterotrophic bacteria is also detected by the amount of N-oxidized form – nitrates and nitrites. This is supported by eight linear correlations and again for another water body it confirms that mineralization of nitrogen-containing organic matter is complete and leads to consistently accumulation of nitrate and nitrite (Table 3). In the waters and sediments of Svrazhen significant linear correlations between aerobic heterotrophic and the content

of phosphate ions have been establish (R^2 = 0.99 and R^2 = 0.61) (Table 3). They are expected due to the fact that the large biogenic loads correspond to the increased number of heterotrophic bacteria and the final stage of the complete mineralization is accompanied by accumulation of $PO_4^{3-}$and NO_3^- (Dimkov, 1994; Vlahov, 2006).

Conclusion

The both micro dams act as a very effective system in which a reduction for bacteria was associated with increasing amount of endo-bacteria, especially that of the oxidative metabolism of Endo – genus *Pseudomonas* and the genus *Acinetobacter*, which are among the most active biodegradable genera. Linear correlations with high accuracy (R^2 between 0.61 and 0.99) are established between AeH / COD, AeH / NO_3^-, AeH / PO_4^{3-} in the water of the two micro dams – Lakatnik and Svrazhen. These correlations are potentially applicable bioalgorithms in the express and comprehensive evaluation of the self-purification processes in scale, speed and mechanisms. On the other hand, the presence of such mathematically dependencies is a potential in the experimental, resource and temporal facilitation of control and monitoring.

Acknowledgements

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References

Dimkov, R., 1994. Physiology and Biochemistry of Microorganisms, University press "St. Kliment Ohridski", 252 pp. (Bg).

Lincheva, S., Y. Todorova and Y. Topalova, 2010. Spatial and seasonal fluctuations in microbial segment of Iskar river in the part of cascade of mini-hydroelectric power stations "Middle Iskar" (Proceeding of Scientific Conference for Young Researchers "Kliment`s days", 22–23 November, 2010, Sofia), Sofia University, Faculty of Biology, pp. 46–50.

Topalova, Y., I. Yaneva, D. Pyrvanov, Y. Todorova and L. Kenderov, 2005. Critical points in the Iskar River pollution in the area of future cascade "Middle Iskar" (Prokopanik-Eliseina), Materials of the Second Bulgarian-Austrian Seminar on Water and Environment Engineering, 27–28 October, Sofia.

Todorova, Y. and Y. Topalova, 2010. Dynamics of water microbial communities in middle part of Iskar river – a complex effect of hydrotechnical activity and pollution (Proceeding of Scientific Conference for Young Researchers "Kliment`s days", 22–23 November, 2010, Sofia), Sofia University, Faculty of Biology, pp. 50–53.

Vlahov, S., 2006. Microbiology. *Academic press "Prof. Marin Drinov*", 384 pp. (Bg).