Bulgarian Journal of Agricultural Science, 20 (Supplement 1) 2014, 113–117
Agricultural Academy

VERTICAL FLUCTUATIONS OF KEY PARAMETERS OF THE SELF-PURIFICATION IN THE "MIDDLE ISKAR" CASCADE'S RESERVOIR LAKATNIK

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Abstract

YOTINOV, I., S. LINCHEVA and Y. TOPALOVA, 2014. Vertical fluctuations of key parameters of the self-purification in the "Middle Iskar" cascade's reservoir Lakatnik. *Bulg. J. Agric. Sci*., Supplement 1: 113–117

Iskar River is a highly modified ecosystem in the part Prokopanik-Gabrovnitza from the newly built small Hydroelectric Power Plants (HEPPs) in the "Middle Iskar" cascade. A 12-year monitoring program studies the ecological status of the river and gradually under construction, putting into operation the HEPPs and associated dams. This article covers the period when the one dam at HEPP Lakatnik were constructed and started its exploitation. The aim is to determine the influence of the vertical fluctuations of the key hydrochemical and microbiological indicators of the water column on the self-purification processes. On the base of these parameters the assessment of influence of technological exploitation, morphology and depth of water column on biotransformation processes has been made. An additional valuable information for the connection of self-purification potential and synchronize functioning of reservoir has been extracted by means of our results. In the micro-dam Lakatnik microbiological (aerobic heterotrophic bacteria and endo-bacteria) and hydrochemical parameters (content of nitrate, nitrite, ammonium and phosphate ions, chemical oxygen demand, content of oxygen, dissolved and unsoluble suspended solids, total dry weight) were investigated in the following water horizons: Lakatnik – 0, –1, –2.5 and –3.5 m. The used methods were according to the Bulgarian State Standards, therefore, our results are oriented to an assessment of the water quality in correspondence with existing regulations. These results indicate that the available local fluctuations are not significant. All data are in compliance with the existing ecological, hydrological and technological features of the studied water bodies, which plays an important role for the following: 1) Discovering of mechanisms and possibilities for increasing the efficiency and effectiveness of the monitoring strategy; 2) An adequate decision-making process in the technological exploitation of the Middle Iskar cascade.

Key words: Middle Iskar cascade, reservoirs, microbiological and hydrochemical indicators, depth fluctuations, self-purification
Abbreviations: AeH – aerobic heterotrophic bacteria, COD – chemical oxygen demand, DSS – Dissolved Suspended Solids, Endo – endo-bacteria, HEPP – hydro electric power plant, TSS – total suspended solids, USS – Unsoluble Suspended Solids

Introduction

In the cascade of small HEPPs "Middle Iskar" along the Iskar River there are an alternating fast flowing river section and dam areas with standing water masses in the walls of small hydropower plants. Key factors of investigation of the self-purification processes in water are chemical and microbiological parameters (Lincheva, 2011; Dursun, 2010). That's why it is important to identify existing fluctuations of these parameters in the depth of the reservoirs.

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Reservoir ecosystems are characterized by a highly dynamic hydrology expressed in considerable variations of water level, hydraulic residence time and establishment of gradient towards the dam (Kalchev, 2013; Kozuharov, 2009). Research dam is more intense changes of morphological and hydrochemical parameters, due to its nature of water exchange. Relatively little attention is given to anthropogenic regulate the water level. There is increasing evidence that the regulation of the hydrodynamic regime significantly affects the distribution of the different parameters in the depth of the water body. This affects various biotrans formation processes carried out in depth reservoirs (Koldinga, 2012; Madigan, 2010). Shallow artificial water bodies, such as small dams in the walls of cascade of small HEPPs "Middle Iskar" suffered the most powerful change in the level of its waters. This leads to an acceleration of biological processes (Lincheva, 2012).

This article aims to establish the importance of fluctuations in depth. The fluctuations of the chemical and microbiological parameters in depths are directly related to the environmental monitoring of the cascade of small HEPPs "Middle Iskar". Information would help to establish whether it is necessary to take samples at depth horizons of dams of this type (in subsequent samplings) or it is possible to use the average samples in the monitoring. This has an important practical importance, in view of the rapid diagnosis of the broad scale, long terming programs.

Materials and Methods

Experimental design: The experimental design includes the micro-dam in the small HEPP – Lakatnik. For tracking major changes in the quality and speed of self-purification processes of water in the dam, two samplings were selected - in June and September of 2012. To build reliable depth profile of watersheds the points in depth were selected as follows: Lakatnik – Water: 0 m; –1 m; –2.5 m; –3.5 m.

Hydrochemicals indicators: In the study of the hydrochemical parameters (DSS, TSS, USS, NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}, COD, O_2) standardized methods according to the current environmental regulations were used (Yotinov, 2013).

Microbiological indicators: To analyze the dam the following microbiological parameters were used: Quantity of aerobic heterotrophic bacteria (AeH) cultivated on meat peptone agar (Scharlau, Brit. Phar.) for 1 day at 28ºC and quantity of endo-bacteria (Endo) cultivated on Endo medium (Scharlau, Brit. Phar.) for 1 day at 37ºC. This are standardized microbiological methods for the assessment of water.

Statistical processing

The presented results were treated by Sigma Plot.

Results and Discussion

Figure 1 presents the fluctuations of hydrochemical indicators in depth dam Lakatnik. These results illustrate that nitrates in June (Figure 1f), fluctuate not more than – 0.715 $mg.l^{-1}$ (Table 1), and in September – 0.460 $mg.l^{-1}$ (Table 2). The other more significant fluctuation in depth refers to the content of COD in depth in September (Figure 1h), where calculated average difference between the various horizons is 0.457 mg $O_2.l^{-1}$ (Table 2). For other hydrochemical indicators significant differences in the depth of the two seasons have not been analyzed. This is due to the fact that researched reservoir is polymictic, and these fluctuations have a local character.

In terms of the amount of aerobic heterotrophic bacteria are reported weak fluctuations in dam depth Lakatnik in June (mean difference: 0.425 ln ($CFU.ml^{-1}$) (Table 1)) and in September (mean difference: 0.163 ln ($CFU.ml^{-1}$) (Table 2)). The fluctuations in the amount of endo-bacteria are too small – 0.329 ln ($CFU.ml^{-1}$) in June (Table 1) and 0.232 ln ($CFU.ml^{-1}$) in September (Table 2). The pollution by domestic wastewater may be the reason for the higher values in September of both groups of bacteria. This is due to the lack of wastewater treatment plants in the area.The described results indicate the high potential of self-purification processes in the waters of the studied reservoirs.

These minor differences probably due to the morphology and the depth of the dam Lakatnik as well as to the specific regime of operation of the HEPP. The highpolymictic specificity affects and regulates the rate and scale of the self-purification processes.

Conclusion

The polymictic specificity, morphology (of the dam Lakatnik) and the influence of particular operating regime of HEPP as well as maintaining a certain degree of flow of the river Iskar contribute to minor fluctuations of the hydrochemical and microbiological indicators in depth. These fluctuations are local, and in fact do not play significant role in the overall stratification of the

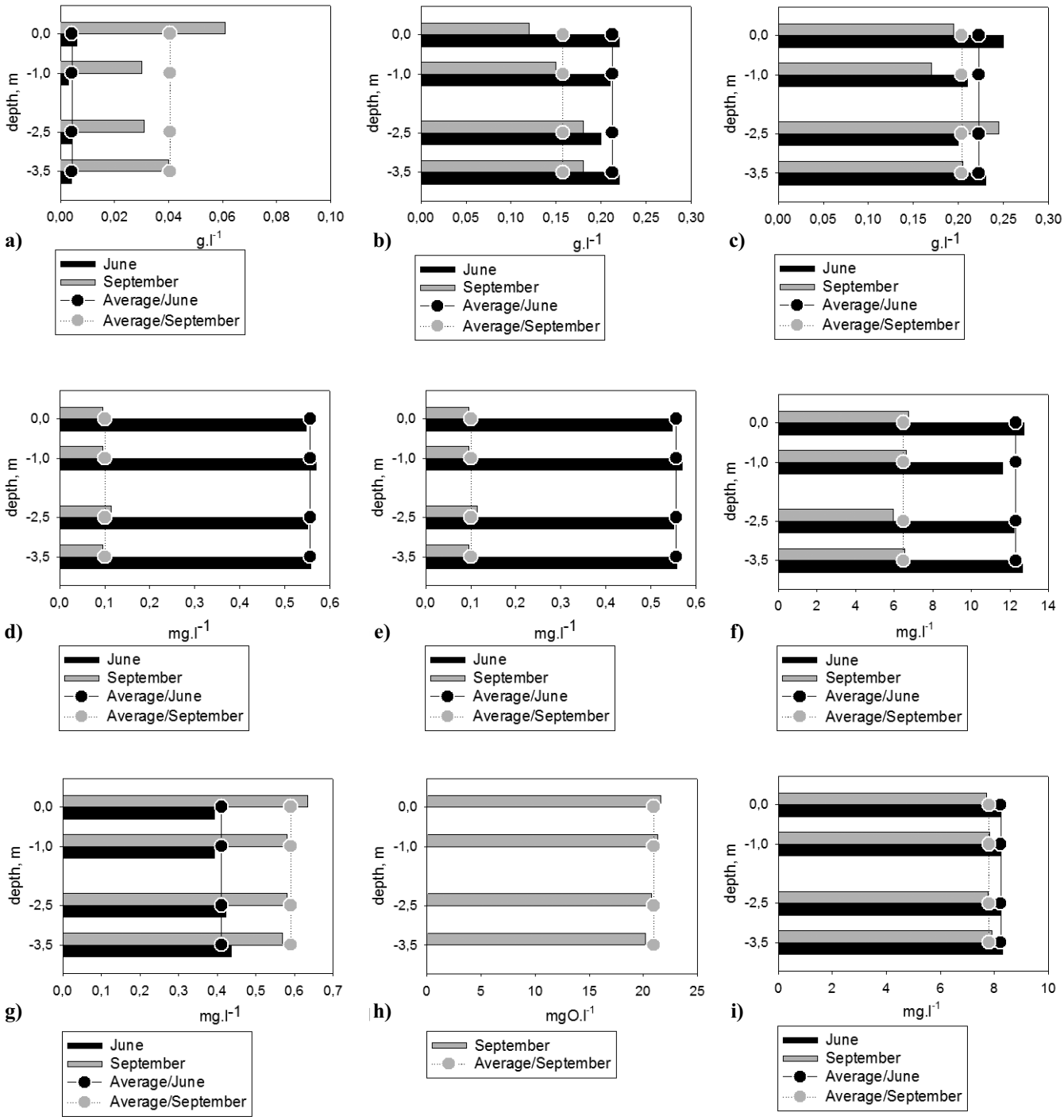

Fig. 1. Fluctuations of hydrochemical indicators in the waters of Lakatnik dam in June and September: *a*) Unsoluble suspended solids (USS); *b*) Dissolved suspended solids (DSS); *c*) Total suspended solids (TSS); *d*) NH_4^+; *e*) NO_2^-; *f*) NO_3^-; *g*) $PO4_3^-$; *h*) content of COD; *i*) O_2

Table 1

Differences in hydrochemical and microbiological parameters in water of Lakatnik in June

	USS , $g.l^{-1}$	DSS , $g.l^{-1}$	TSS, $g.l^{-1}$	NH_4^+, $mg.l^{-1}$	NO_2^-, $mg.l^{-1}$	NO_3^-, $mg.l^{-1}$	$PO4_3^-$, $mg.l^{-1}$	COD, $mgO_2.l^{-1}$	O_2, $mg.l^{-1}$	AeH ln [CFU. $ml.^{-1}$]	Endo ln [CFU. $ml.^{-1}$]
Δ (0–1 m)	0.003	0.01	0.04	0.147	0.022	1.128	0	–	0	0.167	0.594
Δ (1–2.5 m)	0.001	0.01	0.01	0.038	0.018	0.592	0.03	–	0.04	0.164	0.346
Δ (2.5–3.5 m)	0	0.02	0.03	0.016	0.007	0.426	0.014	–	0.06	0.944	0.048
Δ (Average)	0.001	0.013	0.027	0.067	0.016	0.715	0.015	–	0.033	0.425	0.329

Table 2

Differences in hydrochemical and microbiological parameters in water of Lakatnik in September

	USS , $g.l^{-1}$	DSS , $g.l^{-1}$	TSS, $g.l^{-1}$	NH_4^+, $mg.l^{-1}$	NO_2^-, $mg.l^{-1}$	NO_3^-, $mg.l^{-1}$	$PO4_3^-$, $mg.l^{-1}$	COD, $mgO_2.l^{-1}$	O_2, $mg.l^{-1}$	AeH ln [CFU. $ml.^{-1}$]	Endo ln [CFU. $ml.^{-1}$]
Δ (0–1 m)	0.031	0.03	0.025	0.019	0.001	0.141	0.054	0.274	0.12	0.377	0.442
Δ (1–2.5 m)	0.001	0.03	0.075	0.098	0.02	0.648	0	0.548	0.07	0.044	0.118
Δ (2.5–3.5 m)	0.009	0	0.04	0.284	0.019	0.592	0.01	0.548	0.16	0.067	0.137
Δ (Average)	0.014	0.02	0.047	0.134	0.013	0.46	0.021	0.457	0.117	0.163	0.232

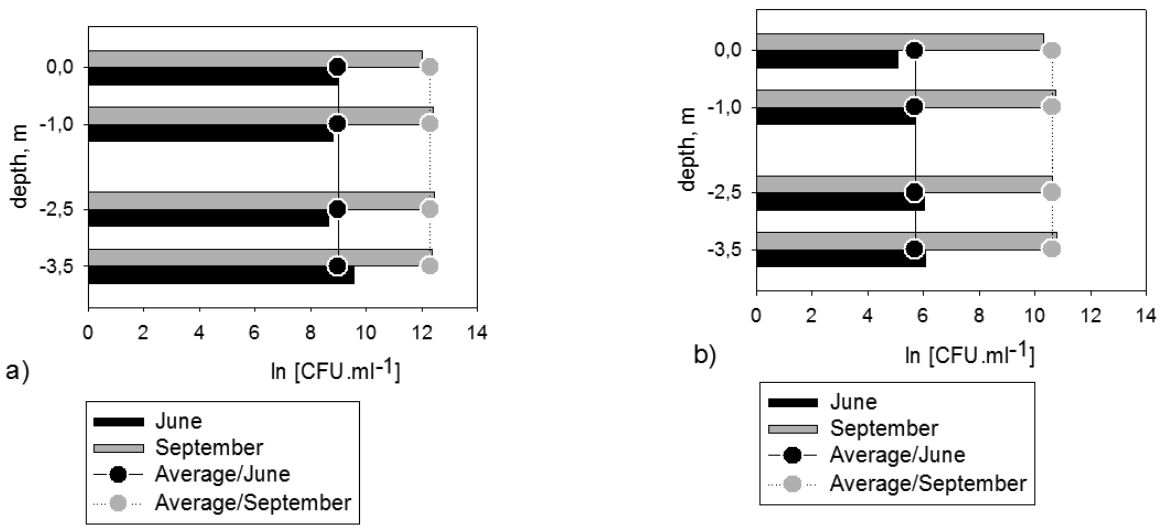

Fig. 2. Fluctuations of microbiological indicators in the waters of Lakatnik dam in June and September: *a*) aerobic heterotrophes; *b*) endo-bacteria

transformation processes. Thus, in future research of water bodies at HEPPs Cascade Middle Iskar the averaged water samples can be used in the practical monitoring programs. These conclusions have an important applied significance in the implementation of the ecological monitoring as well as in the environmental and social impact assessment of the cascade of small HEPPs "Middle Iskar".

Acknowledgements

This work was supported financially by HEPP "Svoge" EAD and Petrovilla Group as well as by the Scientific Research Fundat the Sofia University "St. Kliment Ohridski", Project №48 "Bioalgorithms for management of self-purification potential of sediments from "Middle Iskar" cascade". The authors express their gratitude to Mrs. Elmira Daskalova for the polite cooperation in processing the samples.

References

Dursun, B. and C. Gokcol, 2010. The role of hydroelectric power and contribution of small hydropower plantsfor sustainable development in Turkey. *Renewable Energy*, **36** (4): 1227–1235.

Kalchev, R., M. Beshkova, I. Botev, H. Kalcheva, D. Kozuharov and T. Trichkova, 2013. Effect of *Dreissenapolymorpha* on physicochemical characteristics of Zhrebchevo Reservoir (Central Bulgaria). *Comp. De l Acad. Bul. Des Sci.*, **66** (11): 1571–1578

Koldinga, J. and P. A. M. Zwietenb, 2012. Relative lake level fluctuations and their influence on productivity and resiliencein tropical lakes and reservoirs. *Fisheries Research,* **115–116**: 99–109.

Kozuharov, D., T. Trichkova, P. Borisova and M. Stanachkova, 2009. The zooplankton composition in two reservoirs in the North-West Bulgaria in relation to *Dreissena* spp. Occurrence. *Biotechnology and Biotechnological Equipment***, 23**: 271–275.

Lincheva, S., Y. Todorov, L. Kenderov and Y. Topalova, 2011. Assessment of the purification potential of the Iskar River in region of the "Middle Iskar" cascade during the high flow seasons of the year 2010/2011. *Ecological Engineering and Environment Protection,* **39:** 26–34.

Lincheva, S., L. Kenderov, I. Schneider, I. Yotinov and Y. Topalova, 2012. "Influence of Exploitation of Hydroelectric Power Plants Lakatnik and Svrazhen on Self-purification Potential of Iskar River in 2011 Year" (Proceeding of International Conference Ecology – Interdisciplinary Science and Practice), Sofia, pp. 454–460.

Madigan, M., J. Martinko, D. Stahl and D. Clark, 2010. Brock Biology of Microorganisms. (13th edition), Benjamin Cummings, p. 1152.

Yotinov, I., S. Lincheva, L. Kenderov, I. Schneider and Y. Topalova, 2013. 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". *Bulgarian Journal of Agricultural Science*, **19**, Supplement 2.