AN ASSESSMENT OF ECOLOGICAL POTENTIAL OF THE RADOINJA RESERVOIR (SERBIA)

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Introduction

The Serbian Environmental Protecion Agency (SEPA) was carried out an investigation of the Radoinja Reservoir during 2014. Based on following biological quality elemens (BQE): phytoplankton, phytobenthos and macroinvertebrates, supporting physico-chemical quality elements and specific non-priority substances, the assessment of ecological potential of the Radoinja Resevoir is given according to national legislation. This assessment is different from previous reservoir water quality assessments. Implementation of the Water Framework Directive (WFD/2000/60/EC) had changed the criteria of water body ecological status/potential assessement.

Materials and Methods

Sampling of phytobenthos and macroinvertebrates was conducted in August and October 2014. Sampling of phytobenthos (benthic diatoms) was done according to the SRPS EN 13946: 2008. The material was preserved using 4% formaldehyde. Removing of cell content and diatom slide preparation was done according to the SRPS EN 13946: 2008. The analysis of diatoms was carried out on inverted microscopes Nikon TE-2000U with the DS-5M camera and NIS-Elements D software and Zeiss Axiovert with AxioCam HRc camera and AxioVision 4.8 software. Identification and enumeration of the diatoms, as well as interpretation of the obtained results were performed according to the SRPS EN 14407: 2008. For calculation of diatom indices the Omnidia software was used. The assessment of ecological potential was based on the IPS diatom index (Coste and Cemagref, 1982).

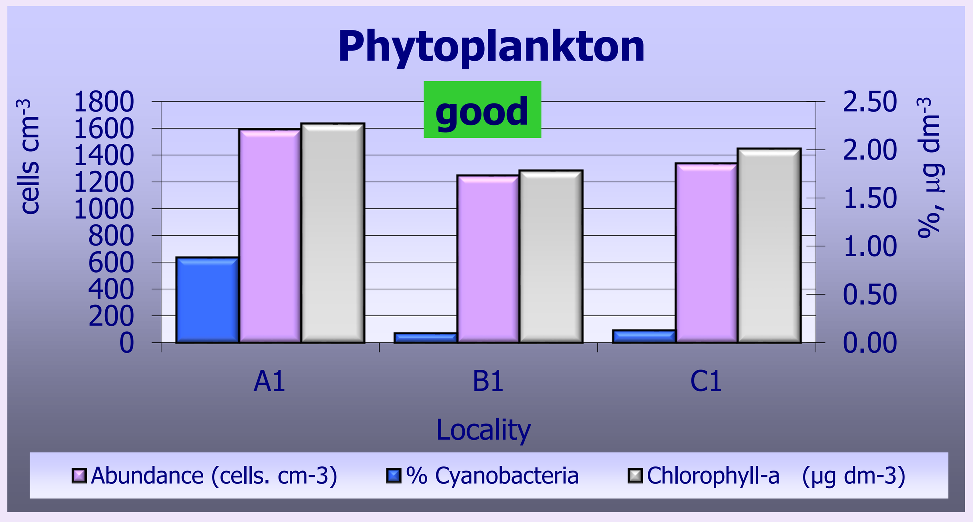
Aquatic macroinvertebrate samples were collected using hand nets (25x25 cm; 500 µm mesh size) according to the AQEM protocol. The multi-habitat sampling procedure was applied. The samples were preserved using 70% ethanol solution. Identification of organisms was done using the Leica MS 5 stereomicroscope. For the assessment of ecological potential, the following parameters of the ASTERICS software were used: Zelinka & Marvan Saprobic Index, BMWP Score, Shannon-Wiener Diversity Index, total number of taxa, percentage participation of Oligochaeta/Tubificidae in the total macroinvertebrate community and EPT Taxa.

Results and Discussion

Investigation of diatom community revealed poor diversity (22 taxa in August and 16 taxon in October 2014 respectively). The dominant species was *Staurosira venter* (Ehrenberg) Cleve & J.D.Möller (even 54% in Aug and 45% in Oct). Subdominant species were *Achnanthidium minutissimum* (Kützing) Czarnecki, *Achnanthidium catenatum* (Bily & Marvan) Lange-Bertalot and Lange-Bertalot & Genkal and *Cocconeis placentula* Ehrenberg.

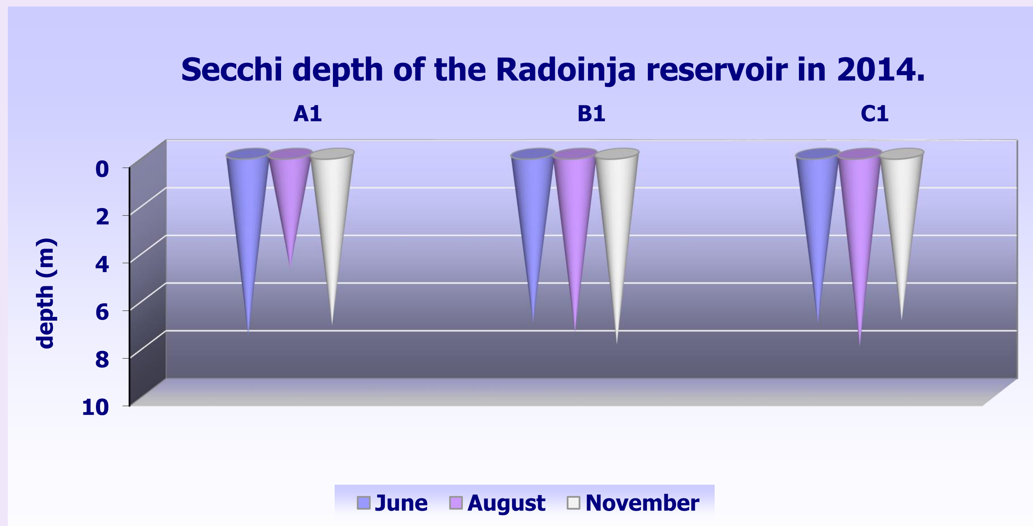
Considering aquatic macroinvertebrate community composition and structure, the total number of taxa was 13 in August and 12 in October 2014 respectively. In Aug 2014 Chironomidae and Tubificidae taxa were found to be principal components of the macroinvertebrate community, whlist in Oct 2014 the species *Dina lineata* (O.F.Müller, 1774) and the Chironomidae taxa. It is worth mentioning the finding of *Baetis lutheri* Müller-Liebenau, 1967 in Aug 2014.

The content of Dissolved Oxygen in water is the most important indicator of the ecological potential of the reservoir. In the Radoinja Reservoir there was not oxygen deficit in the hypolimnion. Physico-chemical quality elements that support BQE, as well as specific non-polluting substances indicate good ecological potential of the Radoinja Reservoir.



Supporting physico-chemical quality elements

Locality	pH	Dissolved oxygen (mg dm^{-3})	BOD_5 (mg dm^{-3})	TOC (mg dm^{-3})	Ammonium-ion (NH_4-N) (mg dm^{-3})	Nitrite (NO_2-N) (mg dm^{-3})	Nitrate (NO_3-N) (mg dm^{-3})	Total nitrogen (mg dm^{-3})	Orthophosphate (mg dm^{-3})	Total phosphorus (mg dm^{-3})	Chlorides (mg dm^{-3})	ecological potential assesment
A_1	7,98	7,62	1,3	4,4	0,09	0,006	0,40	0,75	0,016	0,037	3,2	good
B_1	8,02	7,65	1,5	4,4	0,08	0,005	0,47	0,75	0,019	0,043	3,1	good
C_1	7,95	7,39	1,4	4,4	0,06	0,005	0,51	0,79	0,012	0,037	3,1	good



Macroinvertebrates

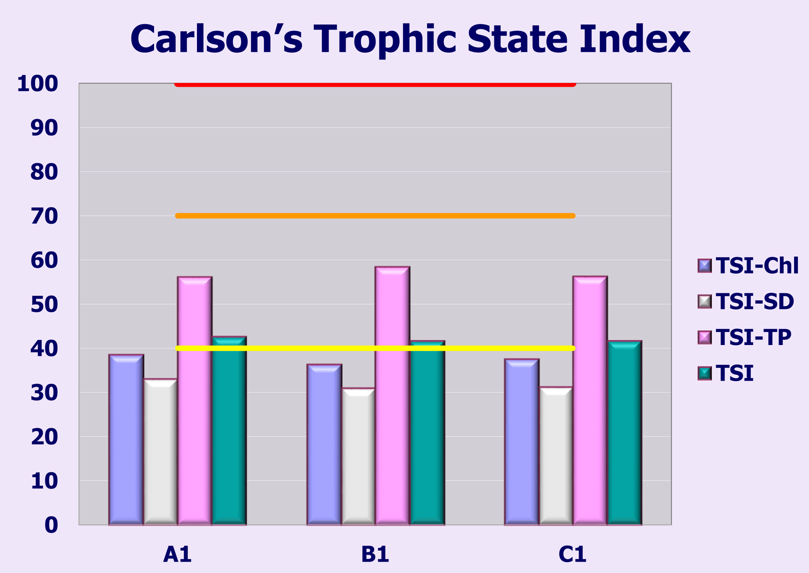
Locality	Zelinka & Marvan Saprobic Index	BMWP Score	EPT Taxa	Shannon-Wiener	Oligochaeta-Tubificide (%)	total number of taxa	ecological potential assessment
A i C	2,33	28	3	2,26	23,35	13	moderate

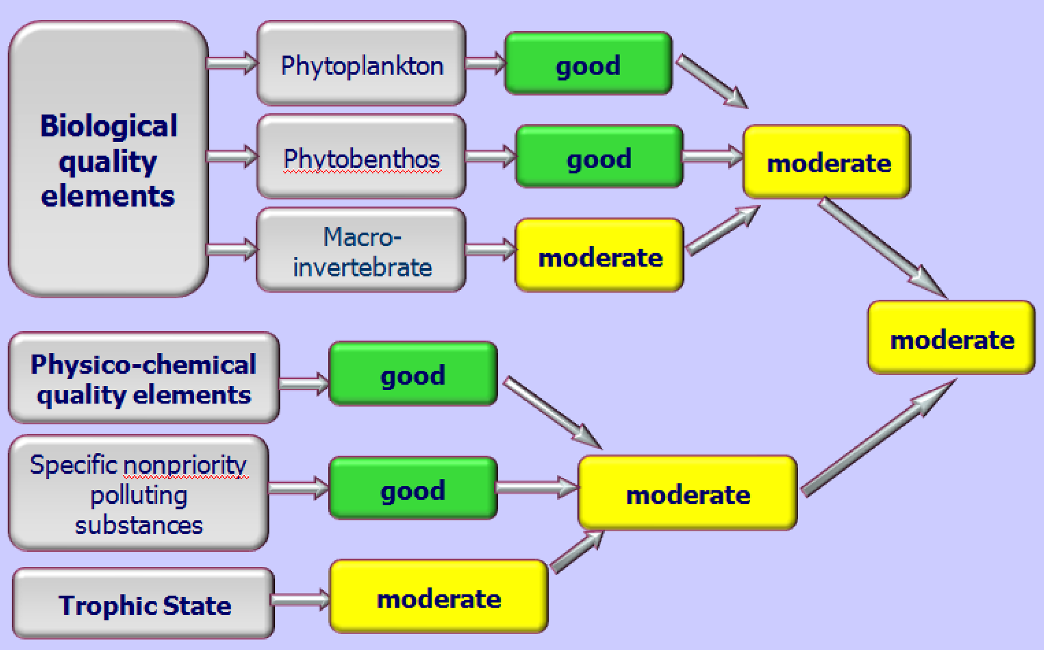
Phytobenthos

Locality	Diatom indices			ecological potential assessment
	EPI-D	IPS	CEE	
A	15,7	16,1	17,2	good
C	15,8	16,6	17,3	good

Carlson's Trophic State Index (TSI) pointed to moderate ecological potential. TSI is mostly affected by increased concentration of Total Phosphorus (TSI-TP).

Staurosira venter (Ehrenberg) Cleve & J.D.Möller





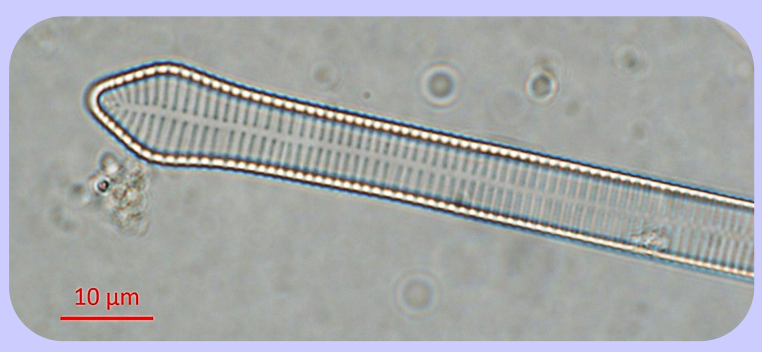
Conclusion

According to the WFD 2000/60/EC ecological potential is determined by the worst-assessed BQE. The Radoinja Reservoir had a **moderate ecological potential** in 2014 determined by the macroinvertebrates. According to national legislation, the reliability level of assessment is medium because not all BQE have been used and the frequency of biological monitoring and the monitoring of indicative physico-chemical parameters was lower than the minimally proposed for ecological status/potential assessment.

However, due to for this ecological potential assessment the parameters of those quality elements that are most sensitive to the pressures that the Radoinja Reservoir was actually exposed (nutrient and organic pollution) were used, characteristic for the operational monitoring programme by the WFD, we considered that the level of reliability of the ecological potential assessment of the Radoinja Reservoir was high.

Denticula tenuis Kützing

Achnanthidium minutissimum Kützing



Fragilaria dilatata (Bréb.) Lange-Bertalot

PHYTOPLANKTON COMMUNITY STRUCTURE, SEASONAL DYNAMICS AND PHYSICO-CHEMICAL CHARACTERISTICS OF THE RADOINJA RESERVOIR (SERBIA)

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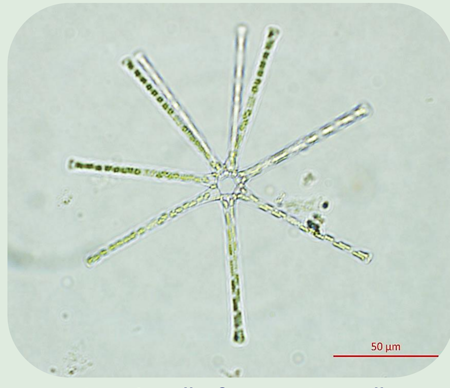
Introduction

The Radoinja Reservoir is situated in Southwestern Serbia. It represents a water filled canyon meandering between narrow and steep limestone shores and formed by constructing a dam across the Uvac River. The Radoinja Reservoir is 12 km long; it has a total volume of 7.6 x 10^6 m^3 and useful volume of 4.1 x 10^6 m^3. The mean altitude of the Radoinja Reservoir is 812 m a.s.l. The Radoinja Reservoir is a multi-purpose; it is used for electricity production and partially for water supply of the town of Priboj and its surrounding.

Cyclotella ocellata Pantocsek



Asterionella formosa Hassall

Materials and Methods

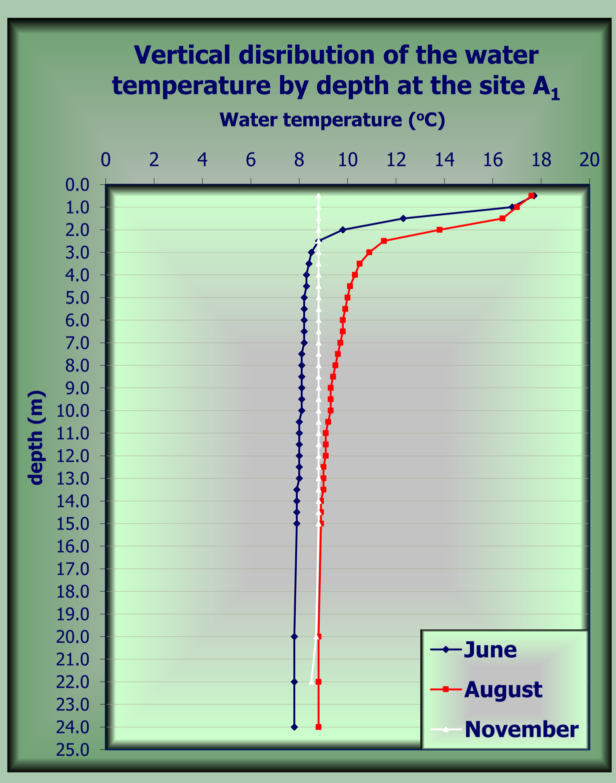
Field research of the Radoinja Reservoir was carried out in June, August and November 2014. The sampling was conducted at 3 sampling sites by depth (near the dam-A_1; central part of the reservoir-B_1 and at the entrance to the reservoir-C_1). By measuring water temperature at every 0.5 m depth, the layers of epilimnion, metalimnion (thermocline) and hypolimnion were determined.

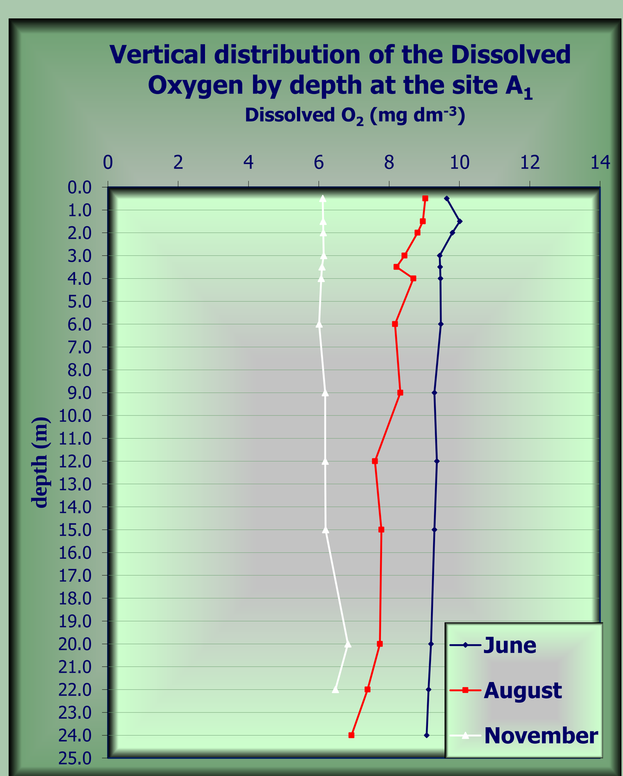
The samples for basic physico-chemical parameters, primary nutrients and chlorophyll *a* were taken at each 1.5 m in epilimnion, at each 0.5 m in metallimnion, and then at every 1.5 m in hypolimnion to the depth of 15 m, and then at each 5 m (including 10% of the depth of bottom of the reservoir). Analysis of physico-chemical parameters was conducted using standard analytical procedures according to appropriate SRPS ISO methods.

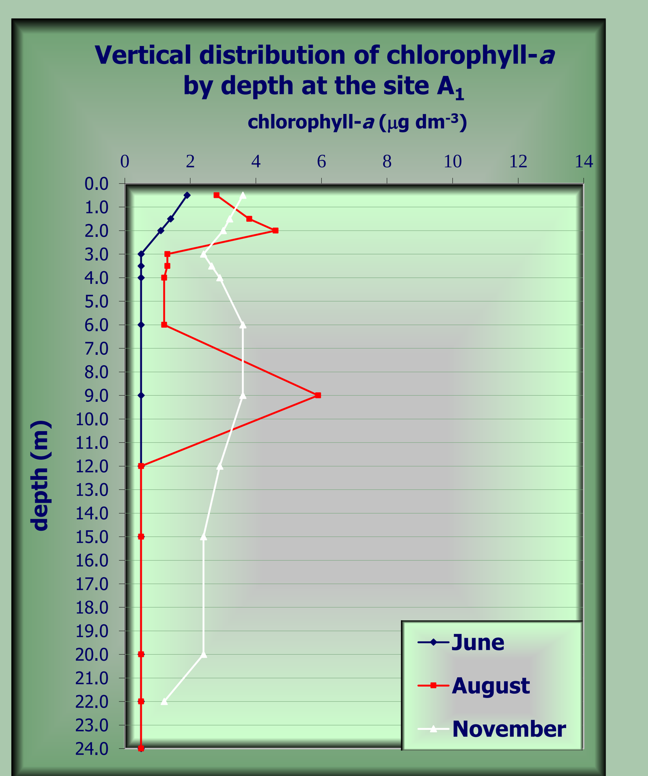
The algal material was collected using plankton nets (25 µm mesh size) and hydrobiological bottles. At three or four sampling sites by depth, two samples for quantitative analysis of phytoplankton were taken, and preserved with formaldehyde or Lugol's iodine. The phytoplankton analysis was done on inverted microscopes: Nikon TE-2000U with DS-5M camera and NIS-Elements D software and Zeiss Axiovert with AxioCam HRc camera and AxioVision 4.8 software. Quantitative analysis of phytoplankton was done using Utermöhl method (1958) according to the SRPS EN 15204: 2008.

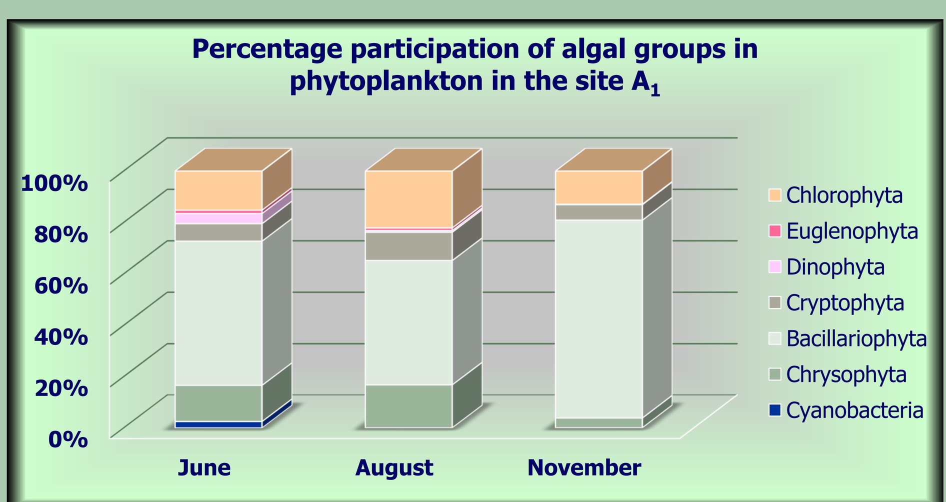
Results and Discussion

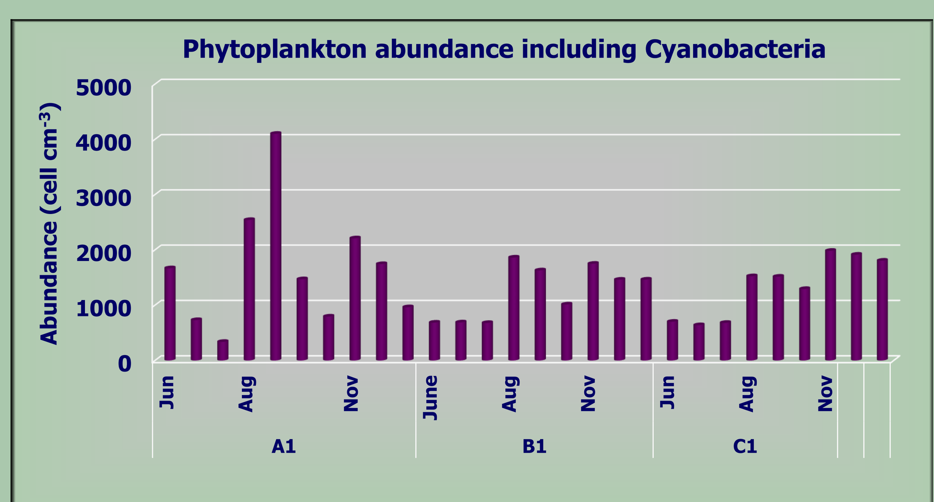
The first two field research is charaterised by thermal stratification whilst the third by total circulation of the reservoir. During all year the Dissolved Oxygen (DO) concentration was high in all water layers; there was not the DO deficit in the hypolimnion. The investigation showed that the phosphorus concentration is a limit factor for phytoplankton growth due to the TP:TN ratio > 17:1 and the Dissolved Inorganic Nitrogen (DIN):Soluble Reactive Phosphorus (SRP) mass ratio > 10:1. By qualitative phytoplankton analysis a total of 117 taxa were identified from 6 algal divisions: Chrysophyta (3 taxa), Bacillariophyta (52 taxa), Dinophyta (5 taxa), Cryptophyta (3 taxa), Euglenophyta (6 taxa), Chlorophyta (38 taxa) and Cyanobacteria (10 taxa). Quantitatively, the diatoms were dominant. Besides typical planktonic forms, the benthic diatoms were numerous. The highest phytoplankton abundance was recorded in August 2014, at the deepest sampling point, near the dam at 2.0 m depth, and it was 4100 cell cm^{-3} whilst the lowest phytoplankton abundance was in June 2014, near the dam, too, at the 24 m depth (336 cell cm^{-3}). The dominant species in phytoplankton community was *Cyclotella ocellata*. The Radoinja Reservoir belongs to oligo-mesotrophic reservoirs characterised by relatively uniform phytoplankton community composition and low productivity as well. In the summer period, a maximum of phytoplankton growth was observed, with poorly expressed peak below the thermocline (the highest chlorophyll *a* concentration was at 9.0 m depth and it was 5,9 µg dm^{-3}). Due to low phytoplankton productivity a water transparency was high (over 7 meters).



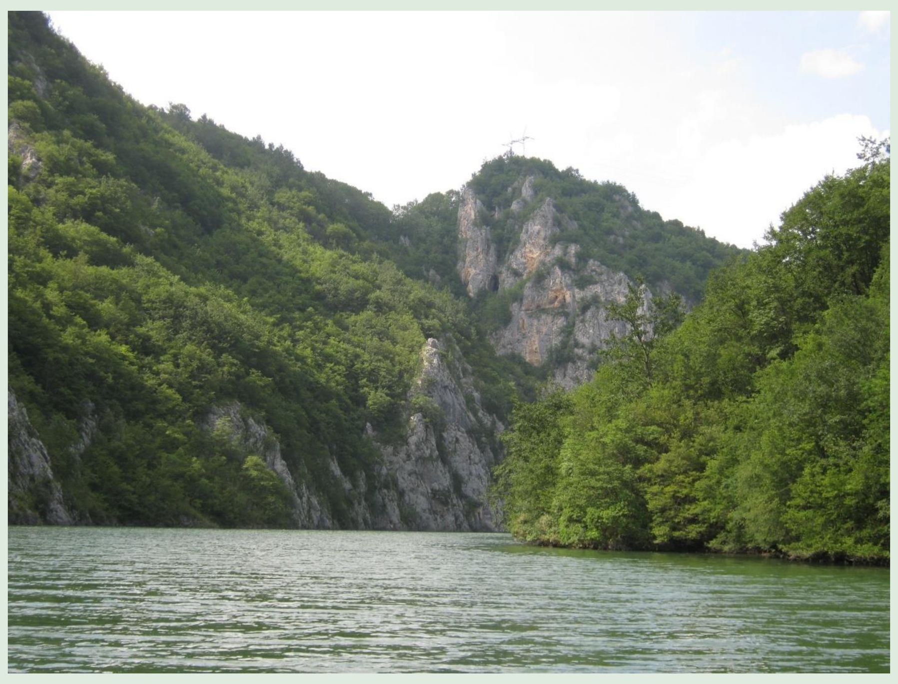


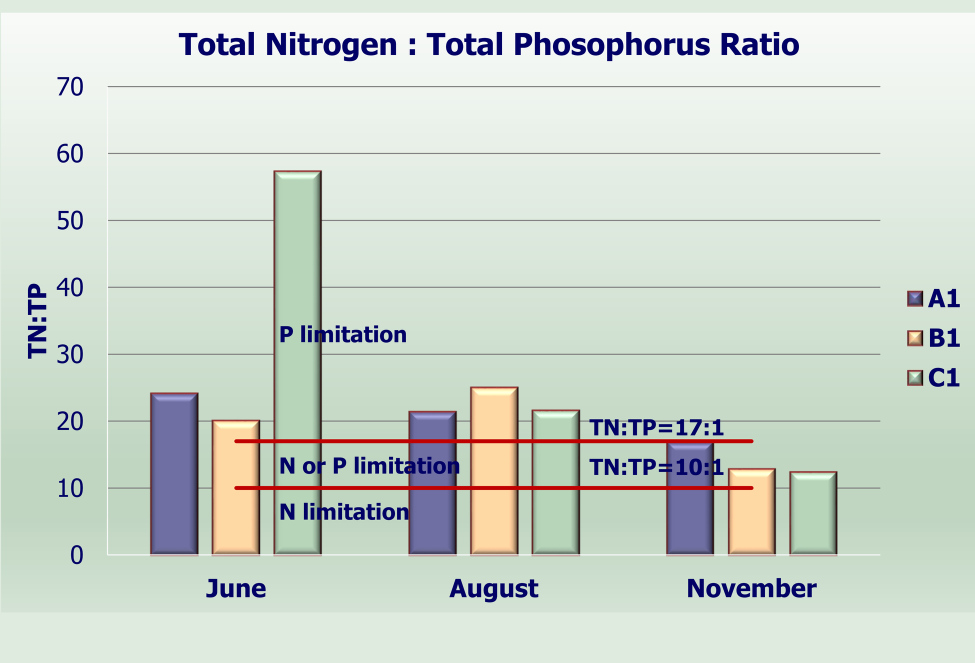






Phytoplankton taxa list of the Radoinja Reservoir in 2014	
Cyanobacteria	*Rhoicosphaenia abbreviata* (C. Agardh) Lange-Bertalot
Aphanocapsa incerta (Lemm.) Cronberg & Kom.	*Rhopalodia gibba* (Ehrenberg) Otto Müller
Cuspidothrix issatschenkoi (Usachev) P.Rajaniemi, Komárek, R.Willame, P. Hrouzek, K.Kastovská	*Staurosira construens* Ehrenberg
Gleotrichia echinullata P.G.Rihter	*Staurosira venter* (Ehrenberg) Cleve & J.D.Möller
Kamptonema formosum (Bory de Saint-Vincent ex Gomont) Strunecký, Komárek & J.Smarda	*Stephanodiscus minutulus* (Kützing) Cleve & Möller
Merismopedia elegans A. Braun in Kützing	*Surirella brebissonii* Krammer & Lange-Bertalot
Oscillatoria limosa Agardh ex Gomont	**Cryptophyta**
Phormidium terebriforme (Agard&Gom) Anagnostidis & Komarek	*Cryptomonas* Ehrenberg sp.
Planktothrix rubescens (DeCand. ex Gom.) Anagn.& Kom.	*Plagioselmis nannoplanctica* (H.Skuja) G.Novarino, I.A.N.Lucas & S.Morrall
Pseudoanabaena limnetica (Lemm.) Kom.	*Rhodomonas lacustris* Pascher & Ruttner
Snowella lacustris (Chodat) Kom. & Hindák	**Dinophyta**
Chrysophyta	*Ceratium hirundinella* (O.F.Müller) Dujardin
Chrysococcus biporus Skuja	*Gymnodinium* Stein sp.
Dinobryon divergens Imhof	*Parvodinium inconspicuum* (Lemmermann) S.Carty
Dinobryon sertularia Ehrenberg	*Peridinium* Ehrenberg sp.
Bacillaryophyta	*Peridinium cinctum* Ehrenberg
Achnanthidium catenatum Bily & Marvan	**Euglenophyta**
Achnanthidium minutissimum Kützing	*Euglena* Ehrenberg sp.
Amphora ovalis (Kützing) Kützing	*Lepocinclis acus* (O.F.Müller) Marin & Melkonian
Amphora pediculus (Kützing) Grunow	*Monomorphina pyrum* (Ehrenberg) Mereschkowsky
Asterionella formosa Hassall	*Strombomonas acuminata* (Schmarda) Deflandre
Campylodiscus hibernicus (Ehrenberg)	*Trachelomonas hispida* (Perty) Stein em. Deflandre
Caloneis silicula (Ehrenberg) Cleve	*Trachelomonas volvocina* Ehrenberg
Cocconeis placentula Ehrenberg	**Chlorophyta**
Cyclotella ocellata Pantocsek	*Acutodesmus acuminatus* (Lagerheim) Tsarenko
Cymatopleura solea (Brébisson) W. Smith	*Acutodesmus obliquus* (Turpin) Hegewald & Hanagata
Cyclotella radiosa (Ehrenberg) Kützing	*Trachelomonas volvocina* Ehrenberg
Cyclotella (Kützing) Brébisson sp.	*Chlamydomonas* Ehrenberg sp.
Cymbella cistula (Ehrenberg) Kirchner	*Chlorococcales* sp.
Cymbella affinis Kützing	*Closterium aciculare* West
Cymbella C.Agardh sp.	*Closterium acutum* Bréb. var. *variabile* (Lemm.) Krieg.
Cymbella helvetica Kützing	*Coelastrum astroideum* De Notaris
Denticula tenuis Kützing	*Coelastrum microporum* Nägeli
Diatoma ehrenbergii Kützing	*Cosmarium* Corda ex Ralfs sp.
Diatoma moniliformis Kützing	*Cosmarium depressum* (Nägeli) Lundell var. *planctonicum* Reverdin
Diatoma vulgaris Bory	*Crucigenia tetrapedia* (Kirch.) W. West & G. S. West
Diploneis elliptica (Kützing) Cleve	*Desmodesmus bicaudatus* (Dedusenko) P.M.Tsarenko
Encyonema minutum (Hilse) D.G.Mann	*Desmodesmus opoliensis* (P.G.Richter) E.Hegewald
Encyonema silesiacum (Bleisch) D.G.Mann	*Dictyosphaerium ehrenbergianum* Nägeli
Encyonopsis subminuta Krammer & E.Reichardt	*Golenkinia radiata* Chodat
Ellerbeckia arenaria (Moore & Ralfs) R.M.Crawford	*Hariotina reticulata* P.A.Dangeard
Fragilaria acus sensu Krammer&Lange-Bertalot	*Hindakia tetrachotoma* (Printz) C.Bock, Pröschold & Krienitz
Fragilaria dilatata (Brébisson) Lange-Bertalot	*Hyaloraphidium contortum* Pascher
Fragilaria capucina Desmazières	*Kirchneriella lunaris* (Kirchn.) Moeb.
Fragilaria crotonensis Kitton	*Koliella planctonica* Hindák
Fragilaria acus sensu Krammer&	*Lagerheimia ciliata* (Lagerh.) Chodat
Fragilaria ulna sensu Krammer&Lange-Bertalot	*Lagerheimia genevensis* (Chodat) Chodat
Gomphonema olivaceum (Hornemann) Kützing	*Monactinus simplex* (Meyen) Corda
Gomphonema parvulum (Kützing) Kützing	*Monactinus simplex* var. *echinulatum* (Wittrock) Pérez, Maidana & Comas
Gomphonema pumilum (Grunow) E.Reichardt & Lange-Bertalot	*Monoraphidium contortum* (Thurs.) Komarkova-Legn.
Gyrosigma acuminatum (Kützing) Rabenhorst	*Monoraphidium griffithii* (Berkeley) Komarkova-Legn.
Gyrosigma attenuatum (Kützing) Rabenhorst	*Monoraphidium komarkovae* Nygaard
Melosira varians Agardh	*Oocystis lacustris* Chodat
Navicula Bory de St. Vincent sp.	*Pandorina morum* (O.F.Müller) Bory
Navicula capitatoradiata Germain	*Pediastrum duplex* Meyen
Navicula cryptotenella Lange-Bertalot	*Pseudopediastrum boryanum* (Turpin) E.Hegewald
Navicula gregaria Donkin	*Scenedesmus grahneisii* (Heynig) Fott
Navicula lanceolata (Agardh) Ehrenberg	*Scenedesmus quadricauda* (Turp.) Brébisson
Navicula radiosa Kützing	*Staurastrum chaetoceros* (Schröder) G. M. Smith
Nitzschia Hassall sp.	*Staurastrum gracile* Ralfs ex Ralfs
Nitzschia denticula Grunow	*Tetraedron minimum* (A. Braun) Hansgirg
Pleurosira laevis (Ehrenberg)Kom.	*Tetrastrum staurogeniaeforme* (Schröder) Lemm.





Conclusion

In summer period in oligotrophic lakes the available primary nutrient content which controls productivity is suddenly decreased in surface water layer "suppressing" the phytoplankton populations to some kind of a refuge in the zone below thermocline. In surface water layer only a small amount of renewable primary nutrients remains enabling the survival of poor summer plankton community. Such conditions were noted in the Radoinja Reservoir, which belongs to oligo-mesotrophic type, and its phytoplankton community was characterised by uniform composition and low productivity.

PHYTOPLANKTON COMMUNITY COMPOSITION AND STRUCTURE OF THE BRESTOVAC RESERVOIR (SERBIA)

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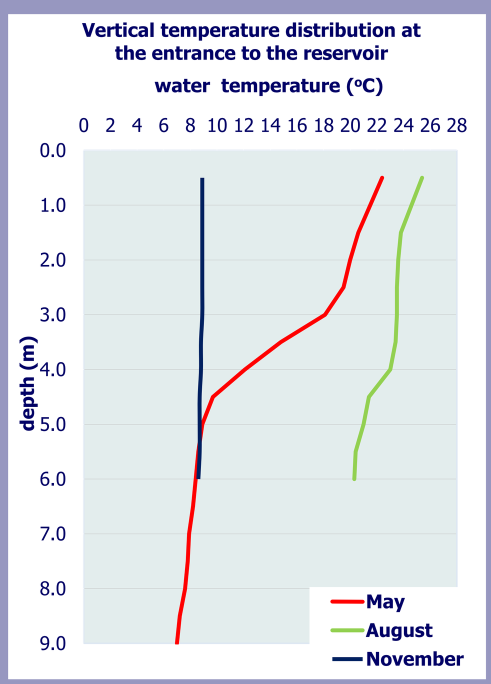
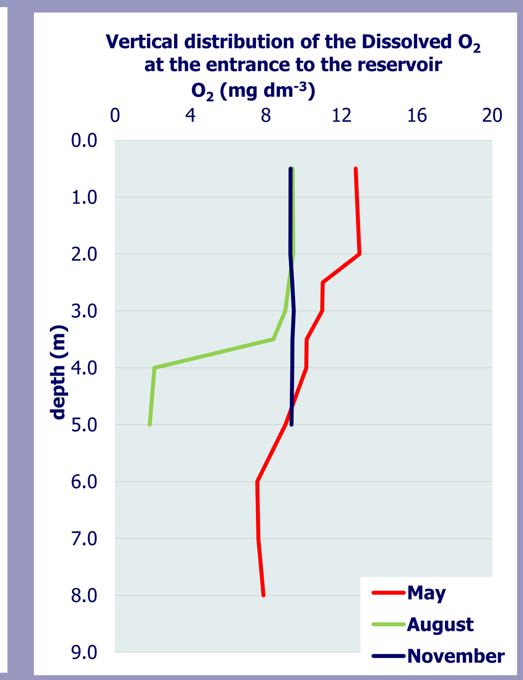
Introduction

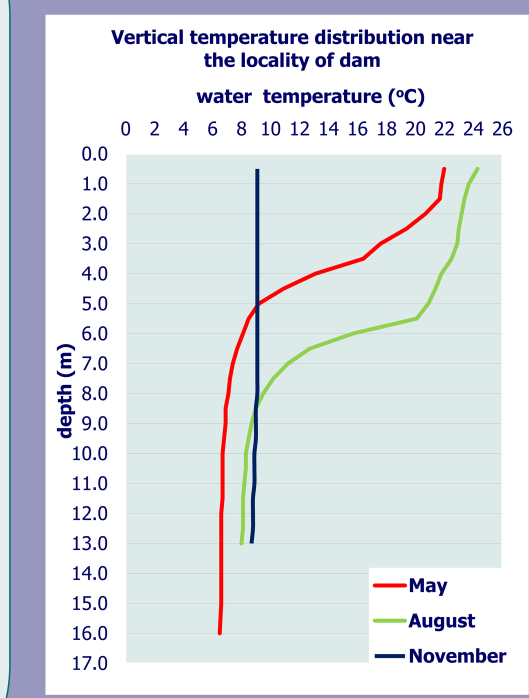
The Brestovac Reservoir is situated in Southern Serbia and it is primarily intented to provide a sufficient amount of drinking water for the population of its surrounding. The reservoir is 2.8 km long and 500 m wide with an average depth of about 12 m. The paper presents the seasonal and spatial variability of phytoplankton with supporting physico-chemical parameters: water temperature, Dissolved Oxygen (DO) and chlorophyll *a* concentration. The aim of the study is to determine structure and seasonal dynamics of phytoplankton in the Brestovac Reservoir as well as the influence of physico-chemical parameters on variability of phytoplankton community during the investigated period.

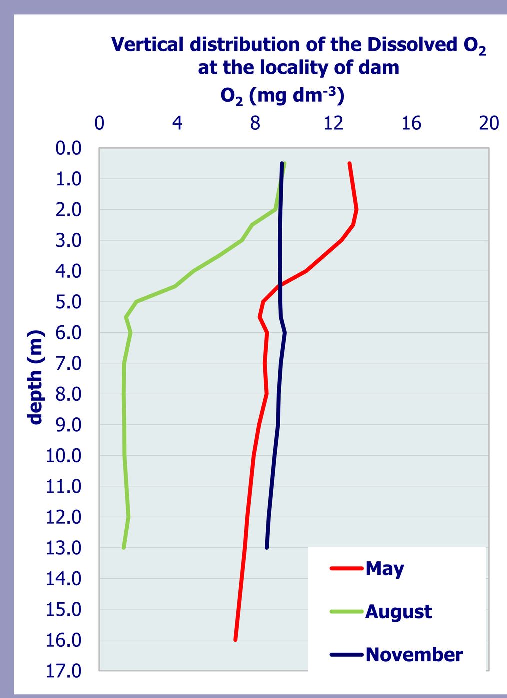


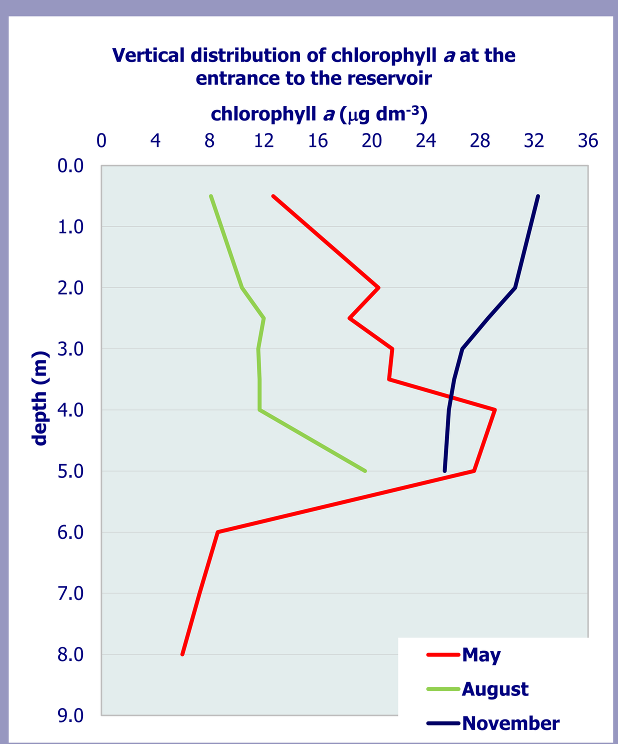


Materials and Methods

Water sampling was carried out in 2015 at two sampling sites: at the entrance to the reservoir and near the dam. The first two investigation was performed during the period of thermal stratification, in May and August, whilst the third in November, in the period of autumn circulation. The algal material was collected using plankton nets (25 µm mesh size) and hydrobiological bottles. At each sampling site, after measuring water temperature, at three to four points by depth, the samples were taken for quantitative and qualitative analysis of phytoplankton. The material was preserved with 4% formaldexyde. The phytoplankton analysis was done on inverted microscopes: Nikon TE-2000U with DS-5M camera and NIS-Elements D software and Zeiss Axiovert with AxioCam HRc camera and AxioVision 4.8 software. Quantitative analysis of phytoplankton was performed using Utermöhl method (1958), according to the SRPS EN 15204: 2008. For qualitative analysis of phytoplankton appropriate identification keys were used. The analysis of physico-chemical parameters was conducted according to proposed SRPS ISO standards.

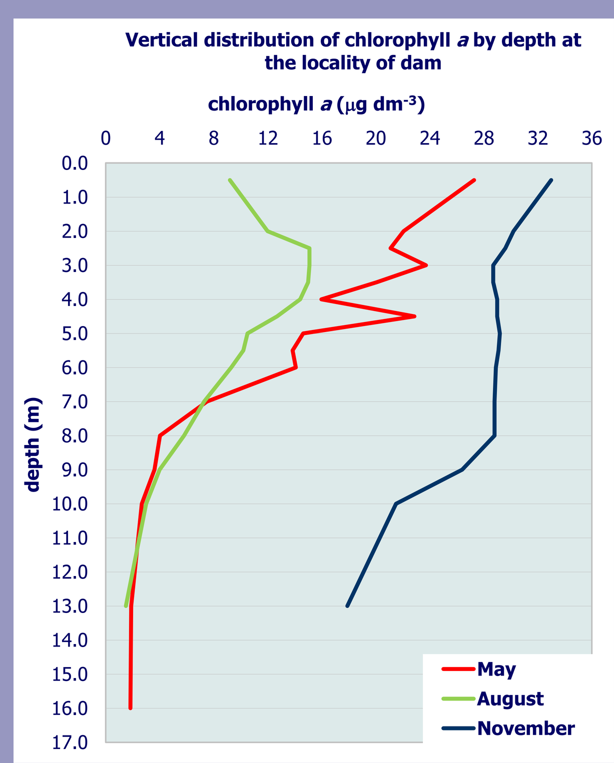


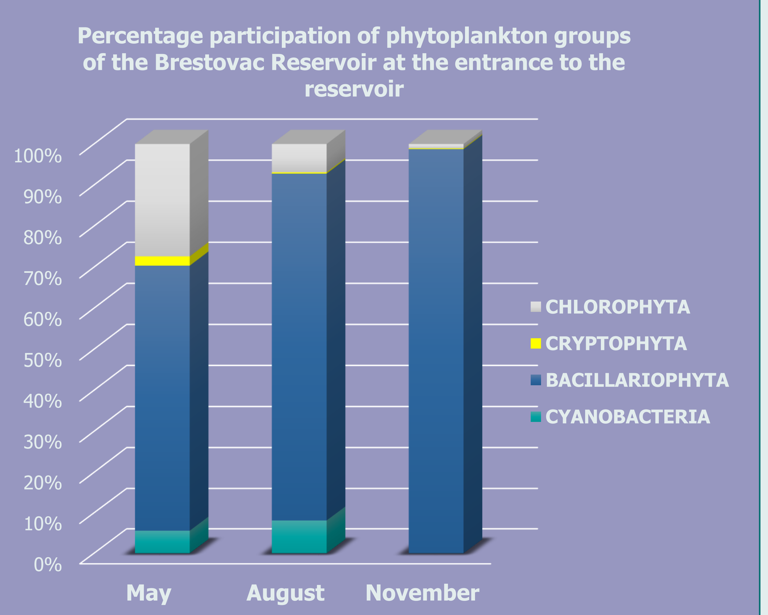


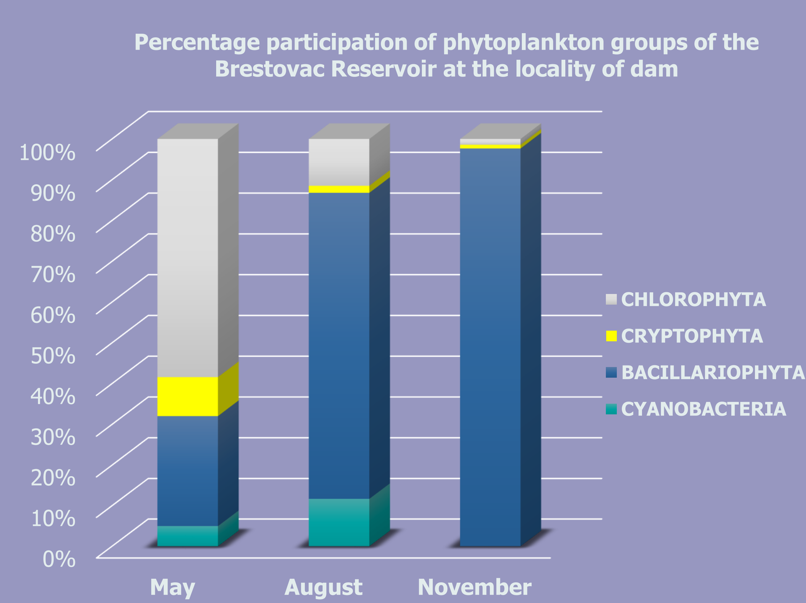


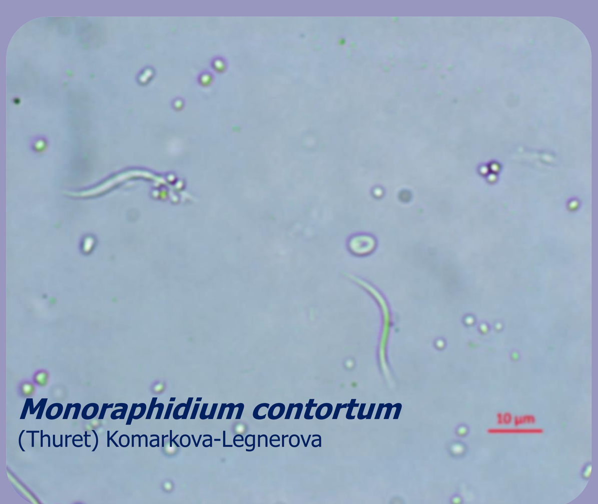
Results and Discussion

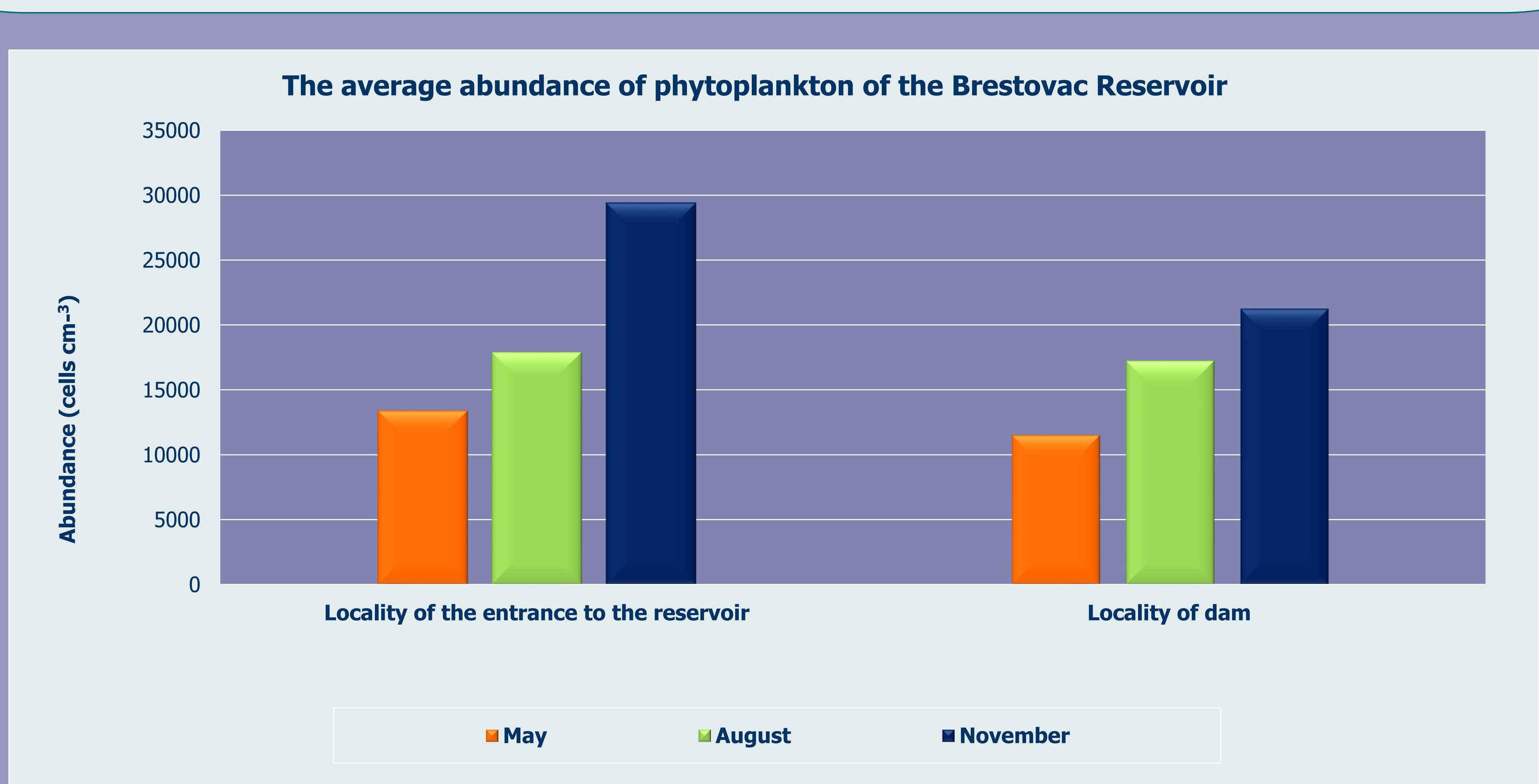
In the spring period, the heating of surface water layer was observed and growth of phytoplankton was intensified which caused the Dissolved Oxygen (DO) concentration in the surface layer of water to be higher compared to the deeper layer of water. The summer period of investigation was characterised by suddenly decreased the DO concentration (1.60 mg dm^{-3}) in the lower layer of metalimnion (thermocline) and hypolimnion (1.25 mg dm^{-3}), which was probably the consequence of oxygen consumption of the organic matter decomposition and plant and animal respiration as well. In August 2015, due to the low depth at the entrance to the reservoir, the thermal stratification was not established. The spring period of investigation is characterised by the high pH value in epilimnion (>9) at both sampling sites. By qualitative analysis of the phytoplankton community, a total of 64 taxa from 6 algal divisions were identified: Cyanobacteria (4 taxa), Bacillariophyta (19 taxa), Cryptophyta (2 taxa), Dinophyta (5 taxa), Euglenophyta (2 taxa) and Chlorophyta (32 taxa). In the spring period (May), at both sampling sites, the high floristic diversity and abundance as well had green algae with the dominance of ***Monoraphidium contortum*** (Thurs.) Komarkova-Legn., ***Kirchneriella dianae*** (Bohlin) Comas Gonzales and ***Monoraphidium arcuatum*** (Koršikov) Hindák. In the subsequent investigaton (August, November), the dominance of green algae was replaced by diatoms. The highest abundance had the species ***Aulacoseira granulata*** (Ehrenberg) Simonsen, ***Stephanodiscus minutulus*** (Kützing) Cleve & Möller and ***Ulnaria delicatissima var. angustissima*** (Grunow) Aboal & P.C. Silva. The percentage participation of *Aulacoseira granulata* (Ehrenberg) Simonsen in the total abundance in November 2015 was over 70%. In the spring and summer period, the presence of Cyanobacteria: ***Aphanocapsa holsatica*** (Lemmermann) Cronberg & J. Komárek, ***Leptolyngbya angustissima*** (West & G.S.West) Anagn. & Kom, ***Cuspidothrix issatschenkoi*** (Usachev) P.Rajaniemi, Komárek, R.Willame, P. Hrouzek, K.Kastovská, L.Hoffmann & K.Sivonen and ***Dolichospermum flosaquae*** (Brébisson ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek was also significant. This algal group was represented more than 34% in the total phytoplankton taxa abundance in August 2015, in the surface layer of water at the sampling site near the dam. The total number of phytoplankton was increased in the surface layer during whole period of investigation. Near the dam of the reservoir, at a depth of 3m, the maximum number of phytoplankton was measured and it was 36 879 cells cm^{-3}. The lowest number of algae was found at the maximum depth (16 m) at the sampling site near the dam (660 cells cm^{-3}). The obtained values of chlorophyll *a* concentration were highest in the surface water layer and these values ranged from 15.1 µg dm^{-3} to 33 µg dm^{-3}, whilst the lowest values of chlorophyll *a* were found only in the deepest layer of water near at the dam (1.83 µg dm^{-3}).











Conclusion

- *In the phytoplankton of the Brestovac Reservoir the highest floristic diversity and the highest abundance as well had algal taxa from Bacillarophyta and Chlorophyta division*
- *The highest total phytoplankton abundance and the highest chlorophyll a concentration were measured in the summer period in metalimnion*
- *During all three investigation of the Brestovac Reservoir in 2015 cyanobacterian taxa were found*

A VALORIZATION OF BENTHIC INVERTEBRATE FAUNA OF THE MLAVA RIVER (EASTERN SERBIA)

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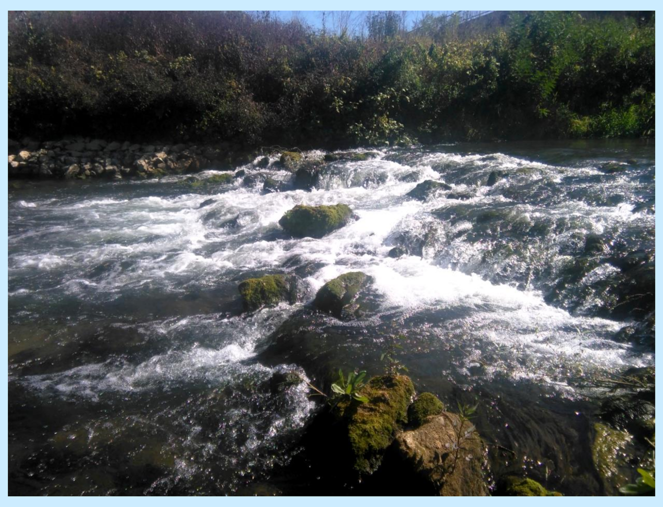
INTRODUCTION

The study provides a survey of benthic invertebrate community composition and structure of the Mlava River (Eastern Serbia). The Mlava River is one of the larger tributaries (122 km long) of the Danube River in Serbia.

Drainage area of the Mlava covers 1,830 km³ and belongs to the Black Sea drainage area. Average annual discharge at the mouth is 14 m³/s.

The Shannon-Wiener Diversity Index (Shannon, 1948) was used as a metric for valorization of the Mlava River benthic invertebrate fauna.



Mlava River - The Bratinac sampling site

MATERIAL AND METHODOLOGY

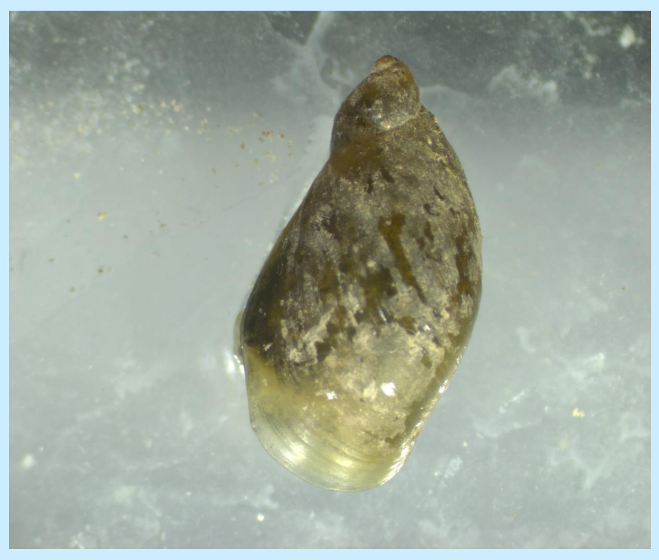
Sampling of aquatic macroinvertebrates was carried out in the 2009-2014 period at 8 sampling sites (data on sampling sites are provided in the table below).

Sampling site	Latitude, N	Longitude, E	Altitude (m a.s.l.)	River substrate
Vrelo Mlave	44°11'29.58"	21°47'0.72"	314	pebble 40%, sand 30%, cobble 20%, clay 10%
Žagubica 1	44°11'50.52"	21°46'30.96"	311	pebble 75%, sand 15%, boulder 10%
Žagubica 2	44°11'46.86"	21°46'9.48"	310	cobble 75%, sand 10% ,pebble 5%, clay 5%; boulder 5%
Belosavac	44°12'7.98"	21°45'7.86"	297	cobble 70%, pebble 10%, boulder 10%, sand 5%, clay 5%
Vukovac	44°13'29.28"	21°44'38.10"	296	cobble 75%, pebble: 10%, clay 10%, boulder 5%
Gornjak	44°16'55.80"	21°30'36.00"	156	boulder 40 %, cobble 40%, sand 10%, clay 10%
Veliko Selo	44°29'41.70"	21°17'58.60"	101	50% silt and clay, 20% sand, 10% pebble, 10% boulder
Bratinac	44°38'46.14"	21°13'12.35"	76	boulder 70%, cobble 20%, pebble 10%

Sampling was performed using Surber net (300 cm^2, 250 µm mesh size) and hand net (25x25 cm, 500 µm mesh size).
The multi-habitat sampling procedure (Hering, 2004) was used. Samples were preserved using 70% ethanol solution and further analysed in the laboratory using appropriate taxonomic keys.
A total of 44 invertebrate samples were processed.
According to the national surface water typology (Official Gazette of the Republic of Serbia 74/2011), the lower stretch of the Mlava River belongs to Type 2 (large rivers with medium grain-size mineral substrates, except for the Pannonian Plain rivers), while the middle as well as upper stretch of the river belongs to Type 3 of rivers (small and medium-sized streams, altitude up to 500 m with domination of large substrates).

RESULTS AND DISCUSSION

✓During the extensive field research of the Mlava River in the 2009-2014 period a total of 197 benthic invertebrate taxa were recorded.
✓Insecta were represented as principal component of the benthic invertebrate communities with 151 taxa, followed by Oligochaeta (18 taxa) and Mollusca (14 taxa).
✓Among Mollusca, Gastropoda were represented with 13 taxa and only one bivalvian taxon (*Pisidium* sp.) was recorded.
✓The most diverse insect orders were Diptera (56 taxa), Trichoptera (36 taxa) and Ephemeroptera (24), followed by Coleoptera (13 taxa), Plecoptera (10 taxa), Odonata (7 taxa) and Hemiptera (5 taxa). Diversity of other groups was significantly lower.



✓With regard to abundance/percentage participation Gammaridae, Chironomidae and Oligochaeta were recorded as principal components of the invertebrate community.
✓The Shannon-Wiener Diversity values ranged from 0.01 (the Mlava Well; April 2011) to 3.28 (the Gornjak Gorge; July 2011).
✓The Mlava Well is a typical limnocrene spring in submountain karst landscape. It is a pool-forming spring with slow water flow and relatively uniform water conditions as well. Thus the diversity is expected to be low.

CONCLUSION

Among recorded taxa, it is worth mentioning the first recent record of endemic amphipod *Gammarus dulensis* S. Karaman, 1929 in Serbia, especially abundant in upper course of the Mlava River, sometimes co-occured together with *Gammarus balcanicus* Schaferna, 1922.

The new data for 22 rare benthic invertebrate species in Serbia are provided: *Spirosperma ferox* Eisen, 1879, *Spirosperma velutinus* Grube, 1879, *Isoperla* cf. *buresi* Rauser, 1962, *Leuctra braueri* Kempny, 1898, *Ithytrichia lamellaris,* Eaton, 1873, *Micrasema longulum* McLachlan, 1876, *Stenelmis canaliculata* (Gyllenhal, 1808) etc.

The major influence on benthic invertebrate community structure in the middle and lower river catchment has discharge of wastewaters, industrial and sewage waters from settlements into the river as well as different types of anthropogenic pressures (activities related to agriculture, river engineering, hydromorphological alterations, gravel and sand exploitation, habitat deterioration, emission of polluting substances originated from thermal power plants and quarries as well as other types of environmental stress).

Based on our investigation it could be concluded that the Mlava River represents a refugium for rare benthic invertebrates.

ACKNOWLEDGEMENT

The authors would like to thank Academician Mr. Gordan Karaman (the Academy of Science and Arts of Montenegro, Podgorica) for identification of the Gammaridae species.

ECOLOGICAL POTENTIAL AND CHEMICAL STATUS ASSESSMENT: A PANNONIAN PLAIN CANAL SYSTEM CASE STUDY (SERBIA)

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Introduction

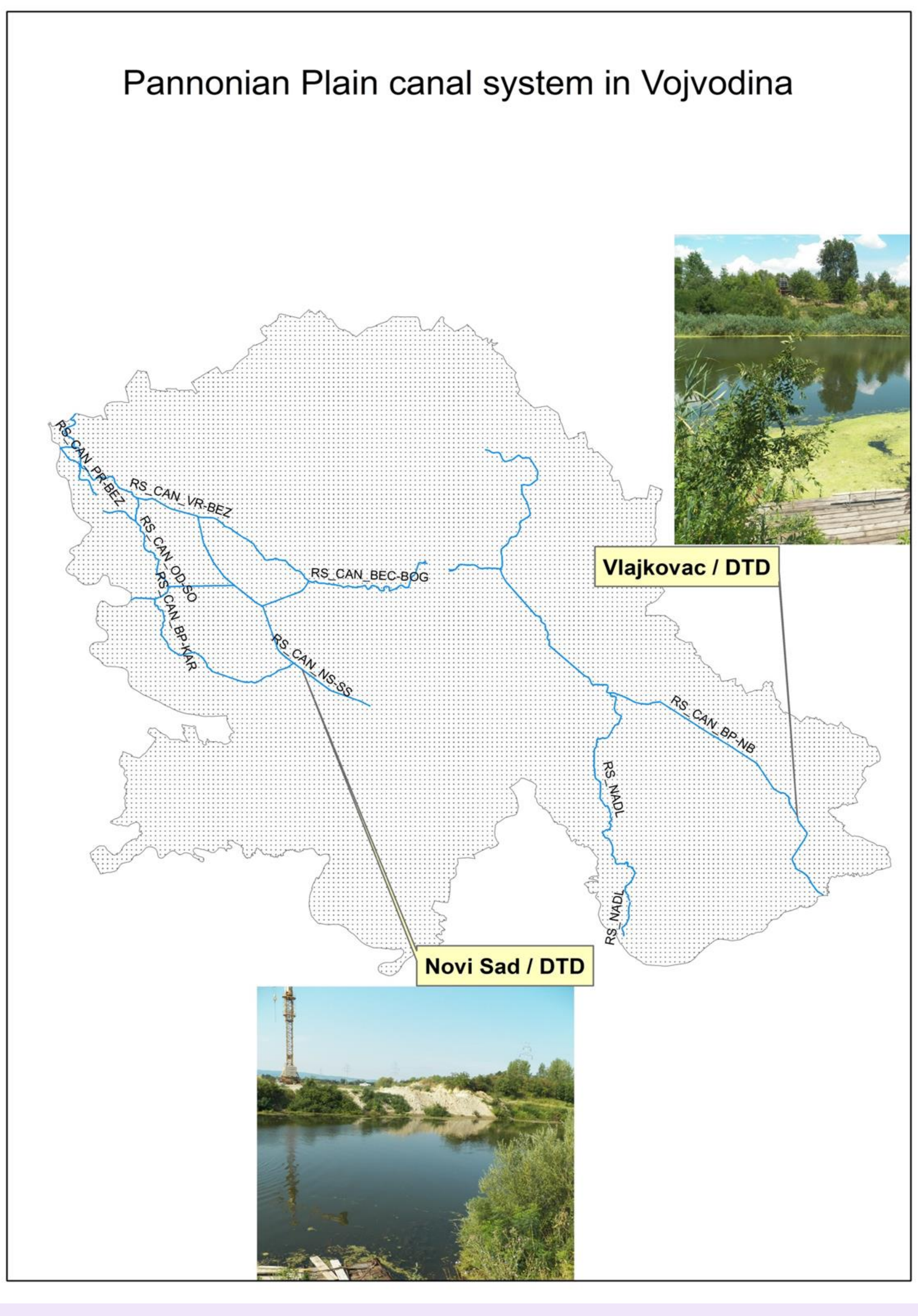
The Serbian Environmental Protection Agency (SEPA) provided a survey of ecological potential and chemical status assessment of the Pannonian Plain canal system in the territory of Vojvodina during 2012, 2013 and 2014. The sampling was carried out at total of 12 sampling sites. According to the national typology all investigated canals are classified as the artificial water body type.

The aim of the study is a comparison between the assessment of ecological potential and chemical status of the Pannonian Plain canal system as well as to provide more precise the degree of anthropogenic pressures on these water bodies.

Material and Methods

For ecological potential assessment the biological quality elements (BQE) (phytoplankton, phytobenthos and aquatic macroinvertebrates) along with physico-chemical quality elements (PCQE) (pH, Dissolved Oxygen, BOD_5, TOC, NH_4-N, NO_3-N, PO_4-P, Total Phosphorus and Cl^-; specific polluting substances-other substances) were used. The assessment of ecological potential and chemical status was done according to the national regulations. Data on investigated sampling sites are provided in the following table and map.

Waterbody code	Canal	Sampling site
RS_CAN_BAJ	DTD Baja-Bezdan	Bački Breg
RS_CAN_VR-BEZ	DTD Vrbas-Bezdan	Sombor
RS_CAN_KOS-MS	DTD Kosančić-Mali Stapar	Ruski Krstur
RS_CAN_BP-KAR	DTD Bački Petrovac-Karavukovo	Bač
RS_CAN_BEC-BOG	DTD Bečej-Bogojevo	Bačko Gradište
RS_CAN_OD-SO	DTD Odžaci-Sombor	Doroslovo
RS_CAN_NS-SS	DTD Novi Sad-Savino Selo	Novi Sad
RS_CAN_KIK	DTD Kikinda Canal	Novo Miloševo
RS_CAN_BP-NB	DTD Banatska Palanka-Novi Bečej	Melenci
		Vlajkovac
		Kajtasovo
RS_NADL	Nadel	Starčevo



Results and Discussion

Based on the selected parameters the majority of investigated water bodies was characterised by moderate ecological potential (Class III). In 2012/2013 poor ecological potential (Class IV) was assessed at 3 sampling sites: the Sombor/DTD Vrbas-Bezdan, the Novi Sad/DTD Novi Sad-Savino Selo and the Starčevo/Nadel, while bad ecological potential (Class V) was assessed at the Bačko Gradište/DTD Bečej-Bogojevo sampling site. In 2014 poor ecological potential (Class IV) was determined at 2 sampling sites: the Sombor/DTD Vrbas-Bezdan and the Srpski Miletić/DTD Bečej-Bogojevo.

Chemical status was assessed related to limit values of priority and priority hazardous substances according to the national regulations. In cases when each of the limit values had not been exceeded the chemical status could be regarded as „achievement of good status". The most of investigated water bodies did not achieve a good chemical status. The main cause of bad chemical status at all sampling sites was increased concentration of Dissolved Nickel.

Ecological potential assessment in 2012/2013

Canal	Sampling site	Biological Quality Elements (BQE)			Physico-chemical Quality Elements (PQE)	Specific polluting supstances	Ecological potencial assesment	Confidence level
		Phytoplankton	Phytobenthos	Aquatic macroinvertebrates				
DTD Vrbas-Bezdan	Sombor							high
DTD Bački Petrovac-Karavukovo	Bač							high
DTD Bečej-Bogojevo	Bačko Gradište							high
DTD Novi Sad-Savino selo	Novi Sad							high
DTD Kikinda Canal	Novo Miloševo	-	-					medium
DTD Banatska Palanka-Novi Bečej	Melenci							high
	Vlajkovac	-	-					medium
Nadel	Starčevo	-	-					medium
DTD Baja-Bezdan	Bački Breg							high

Ecological potential assessment in 2014

Canal	Sampling site	Biological Quality Elements (BQE)			Physico-chemical Quality Elements (PQE)	Specific polluting supstances	Ecological potencial assesment	Confidence level
		Phytoplankton	Phytobenthos	Aquatic macroinvertebrates				
DTD Kosančić-Mali Stapar	Ruski Krstur	-						medium
DTD Vrbas-Bezdan	Sombor	-						medium
DTD Bački Petrovac-Karavukovo	Bač	-						medium
DTD Bečej-Bogojevo	Bačko Gradište	-						medium
DTD Bečej-Bogojevo	Srpski Miletić	-						medium
DTD Odžaci-Sombor	Doroslovo	-						medium
DTD Novi Sad-Savino selo	Novi Sad	-						medium
DTD Kikinda Canal	Novo Miloševo							high
DTD Banatska Palanka-Novi Bečej	Melenci	-						medium
	Kajtasovo	-						medium
DTD Baja-Bezdan	Bački Breg							high

Chemical status assessment in 2012/2013

Canal	Sampling site	Chemical status assesment	Cause of bad chemical status	Sampling frequency per year	Mean annual concentracin	Max. measured concentracion	Confidence level
-	-	-	-	-	µg/l	µg/l	-
DTD Vrbas-Bezdan	Sombor		Dissolved Nickel	6	4.3		medium
DTD Bački Petrovac-Karavukovo	Bač						medium
DTD Bečej-Bogojevo	Bačko Gradište		Dissolved Nickel	6	10.1		medium
DTD Novi Sad-Savino selo	Novi Sad		Dissolved Nickel	6	4.3		medium
DTD Kikinda Canal	Novo Miloševo						medium
DTD Banatska Palanka-Novi Bečej	Melenci		Dissolved Nickel	6	4.1		medium
	Vlajkovac		Dissolved Nickel	6	5.3		medium
Nadel	Starčevo						medium
DTD Baja-Bezdan	Bački Breg		Dissolved Nickel	11	14.0	86.2	medium

Chemical status assessment in 2014

Canal	Sampling site	Chemical status assesment	Cause of bad chemical status	Sampling frequency per year	Mean annual concentracin	Max. measured concentracion	Confidence level
		-	-	-	µg/l	µg/l	
DTD Kosančić-Mali Stapar	Ruski Krstur		Dissolved Nickel	9	8.38		medium
DTD Vrbas-Bezdan	Sombor						medium
DTD Bački Petrovac-Karavukovo	Bač		Dissolved Nickel	6	15.88		medium
DTD Bečej-Bogojevo	Bačko Gradište		Dissolved Nickel	6	14.15	48.5	medium
DTD Bečej-Bogojevo	Srpski Miletić		Dissolved Nickel	8	16.54	56.9	medium
DTD Odžaci-Sombor	Doroslovo		Dissolved Nickel	9	4.42		medium
DTD Novi Sad-Savino selo	Novi Sad		Dissolved Nickel	8	9.20		medium
DTD Kikinda Canal	Novo Miloševo		Dissolved Nickel	6	19.05	69.2	medium
DTD Banatska Palanka-Novi Bečej	Melenci		Dissolved Nickel	6	8.27		medium
DTD Banatska Palanka-Novi Bečej	Kajtasovo		Dissolved Nickel	9	12.67	36.6	medium
DTD Baja-Bezdan	Bački Breg		Dissolved Nickel	10	5.47		medium

Conclusion

- It is important to note the influences of heavy rain and flood wave on water quality of the canals during 2014 in Serbia.
- According to national legislation, the reliability level of this assessment is high or medium depending on included quality elements as well as the frequency of biological monitoring and monitoring of indicative physico-chemical parameters.
- For this ecological potential assessment the parameters of those quality elements that are most sensitive to different anthropogenic impacts (eutrophication, nutrient enrichment and organic pollution) were used.
- Our experience showed that phytoplankton as BQE is the most important indicator in ecological potential assessment of artificial water bodies (canals).
- Some stretches of the canals could act as isolated lentic ecosystems (low water flow, low variability of physico-chemical parameters and homogenous water conditions).