

TROPHIC STATUS ASSESSMENT OF OČAGA RESERVOIR (LAZAREVAC, SRBIJA) BY CARLSON'S INDEX

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PROCENA TROFIČKOG STATUSA AKUMULACIJE OČAGA (LAZAREVAC, SRBIJA) POSREDSTVOM CARLSON-OVOG INDEKSA

Apstrakt

Trofički status se može definisati kao ukupna težina živog biološkog materijala (biomase) u nekom vodenom telu na određenom lokalitetu i u određeno vreme. Trofički status nekog vodenog tela može se proceniti na osnovu merenja specifičnih parametara i predstavlja biološki odgovor na spoljašnje faktore, kao što su količina nutrijenata, sezonske promene, ispaša, mešanje vode itd. Procena trofičkog statusa jezera ili akumulacije je od velikog značaja. Postoje različiti kriterijumi za procenu trofičkog stanja jezera, kao što su: koncentracija nutrijenata, produktivnost, kvantitativni i kvalitativni sastav flore i faune, dostupnost kiseonika i morfometrija jezera. Međutim, imajući u vidu da je multiparametarski indeks nepraktičan, Carlson je predložio indekse trofičkog stanja (TSIs) koji su znatno jednostavniji za upotrebu od multiparametarskog indeksa. Ovi indeksi kao bazu za klasifikaciju trofičkih stanja koriste algalnu biomasu. U tom smislu koriste se tri parametra za izračunavanje ovih indeksa: koncentracija hlorofila a, ukupni fosfor i providnost izmerena Secchi diskom. Svaka od ove tri promenljive se može koristiti za klasifikaciju statusa vodenog tela, ali je hlorofila a najznačajniji parametar s obzirom da je direktni pokazatelj algalne biomase. Opseg Carlson-ovog trofičnog indeksa obuhvata vrednosti od 0 do 100. Vrednosti ispod 40 odgovaraju oligotrofnim, od 40 do 50 mezotrofnim, od 50 do 70 eutrofnim, a preko 70 hipereutrofnim jezerima i akumulacijama. Glavna prednost ovog indeksa je što odnos između tri parametra može ukazati na određene uslove koji vladaju u datom jezeru ili akumulaciji, a tiču se faktora koji limitiraju algalnu biomasu ili utiču na izmerene parametre. Iako određivanje trofičkog statusa vode nekog vodenog tela ne treba poistovećivati sa samim kvalitetom vode, ono, svakako, predstavlja značajan aspekt istog.

Cilj ovog istraživanja bio je određivanje trofičkog statusa jezera Očaga na osnovu Carlson-ovog trofičkog indeksa i ispitivanje veze između izračunatih indeksa za hlorofil a (TSI(CHL)), ukupni fosfor (TSI(TP)) i providnost merenu Secchi diskom (TSI(SD)).

Veštačko jezero Očaga nalazi se u blizini Lazarevca i isključivo se koristi za rekreaciju. Ispitivanje vode rađeno je jednom nedeljno tokom jula i avgusta, od 2012. do 2014. godine. Sve analize urađene su u Zavodu za javno zdravlje iz Beograda.

Vrednosti dobijenih indeksa (TSIs) varirale su od 41 do 86.25, u ispitanom periodu, a jezero je menjalo status od mezotrofnog, preko eutrofnog do hipereutrofnog, pri čemu su eutrofni uslovi preovladavali. Hipereutrofnija je zabeležena tokom avgusta 2013. Godine, kada su bile izmerene i najveće vrednosti sva tri parametra, što je, verovatno, rezultat organskog opterećenja vodenog ekosistema i vremenskih uslova. Prema podacima RHMZ-a, 2013. godina je bila jedna od najtoplijih i najsušnijih godina još od 1951. godine. Nasuprot tome, u avgustu 2014. godine izmerene su najmanje vrednosti svih parametara, što ukazuje na mezotrofne uslove u jezeru te godine. Mezotrofni status jezera je, verovatno, posledica velike količine padavina u prvoj polovini te godine, ali i pražnjenja i ponovnog punjenja jezera nakon majskih poplava.

Ključne reči: jezero Očaga, Carlson-ov trofički indeks

Keywords: Očaga reservoir, Carlson's trophic index

INTRODUCTION

Trophic state can be defined as the total weight of living biological material (biomass) in a waterbody at a specific location and time, and it is understood to be the biological response to forcing factors such as nutrient additions, where the effect of nutrients can be modified by factors such as season, grazing, mixing depth, etc. (Carlson & Simpson 1996).

Carlson (1977) suggested the trophic state indices (TSIs) that use algal biomass as the basis for trophic state classification. TSIs are calculated using only three parameters: log-transformed Secchi disk transparency (SD), concentration of chlorophyll a (CHL) and the total phosphorus (TP). In practice, the index range is from 0 to 100. Generally, the TSIs value below 40 corresponds to oligotrophy, between 40 and 50 – mesotrophy, from 50 to 70 – eutrophy, and above 70 – hypereutrophy of the lake or reservoir (Carlson & Simpson 1996).

When more than one of the three variables are measured, it is possible that different index values will be obtained. Nevertheless, the interrelationships between variables can be used to identify certain conditions in the lake or reservoir that are related to the factors that limit algal biomass or affect the measured variables (Carlson & Simpson 1996).

Trophic state determination is an important aspect of every reservoir survey. On the other hand, trophic state is not the same thing as water quality, but the trophic state certainly is one aspect of the water quality (Carlson & Simpson 1996).

The objective of this study was to determine the trophic status of Očaga reservoir based on TSIs and to examine the relationship between the three calculated trophic state indices: TSI (SD), TSI (CHL) and TSI (TP).

MATERIALS AND METHODS

Sampling site

Očaga artificial lake (44°23'24.9"N, 20°14'14.88"E) was formed at the old open pit of lignite mining basin „Kolubara” for the purpose of remediation after exploitation. The bottom of the reservoir is concreted, while the coasts were made of stone. The surface area of the reservoir is 0.12 km². The reservoir is fed by groundwater as well as precipitation. The last regular cleaning was carried out at the end of 2013, however, after the floods in May 2014 the whole procedure was repeated. Očaga reservoir is primarily used for recreational purposes.

Methods

Sampling was conducted weekly for two summer months during the period of the three years (2012-2014), each time at the same sampling site (middle of the reservoir, from the depth of 0.5 m). The sampling procedure for Chl a and TP was carried out following a standard sampling technique described in SRPS ISO 5667-4:1997 standard. The transparency (m) of the reservoir was measured *in situ* using Secchi disc. In the laboratory, TP (µg/L) concentration was measured using SRPS EN ISO 6878:2008 standard, while Chl a (µg/L) concentration was determined using spectrophotometric method according to standard procedure ISO 10260:1992. All measurements were conducted by the National Institute of Public Health, Belgrade.

The trophic state of the Očaga reservoir was determined by Carlson's TSI. Three equations were used for the index calculation: Secchi disk TSI (SD), chlorophyll a TSI (CHL) and total phosphorus TSI (TP), (Carlson & Simpson 1996).

Statistical analyses were done using CANOCO for Windows Version 5.0 (Ter Braak & Šmilauer 2012).

RESULTS AND DISCUSSION

The average values for SD, Chl a and TP are presented in Figure 1. The lowest documented SD value in Očaga reservoir was 0.4 m, in August 2013, while the highest value was in August 2014 (3.1 m). The highest values for TP (207 µg/L) and Chl a (73.04 µg/L) were observed in August 2013, while the lowest values were recorded in August 2014, 6 µg/L for TP and 2.07 µg/L for Chl a. This is in accordance with the obtained SD values during the mentioned periods.

Carlson's TSI values were calculated using monthly average values for Chl a, TP and SD obtained on the basis of weekly measurements in July and August. The values of TSIs obtained during studied period ranged from 41 to 86.25 (Figure 2).

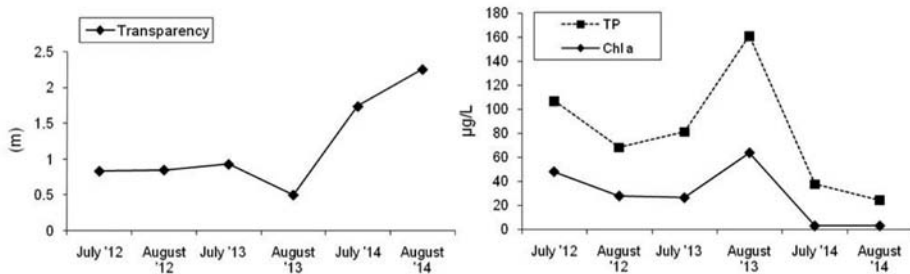


Figure 1. Average values for transparency (left), chlorophyll and total phosphorus (right).

The values of individual indices are more evenly distributed than the measured values of TP, Chl a and SD, but still the highest values of TSI (CHL) and TSI (TP) were observed in August 2013, and the lowest during 2014, and *vice versa* for TSI (SD), (Figure 2).

In general, Carlson's TSI values for all three parameters are high to very high, ranging from mesotrophy to hypereutrophy, but most often correspond to eutrophic model. High values of Carlson's TSI and the high concentration of Chl a and TP in the mentioned periods indicate to a very poor ecological condition. The sudden increase of TP in August 2013 is most probably due to anthropogenic impact and lack of rainfall, as this year was considered the hottest and the most arid since 1951 (RHMZ of Serbia 2014). Lower TSI values recorded during 2014 are probably a consequence of a heavy rainfall that was frequent during the first half of this year (RHMZ of Serbia 2015), as well as of the cleaning of the reservoir.

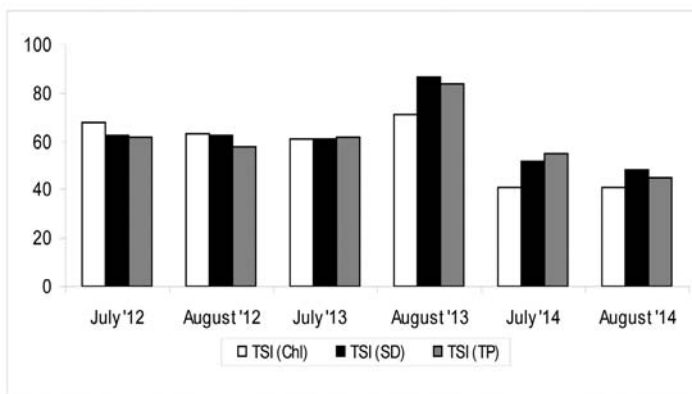


Figure 2. Carlson's TSI values for Chl a, SD and TP during the studied period.

Regarding to monthly average values (Figure 2), all TSI's were close together indicating the same trophic status, except in July 2014, where TSI(CHL) indicated mesotrophic status, while the other two pointed to eutrophy. During the whole study period the eutrophic conditions prevailed in July, while in August ecosystem was characterized as eutrophic in 2012, as hypereutrophic in 2013 and as mesotrophic in 2014.

According to Carlson & Simpson (1996) lake classification regarding trophic condition range, the reservoir in 2012 was eutrophic, in 2013 eu/hypereutrophic, while in 2014 meso/

eutrophic (Figure 3). Interrelationships between TSI's based on main annual values follow TSI (CHL) = TSI (TP) = TSI (SD) pattern in 2012.

According to Carlson & Simpson (1996) this means that algae dominate light attenuation, where phosphorus is limiting factor. In 2013 and 2014 the ratio is TSI (TP) = TSI (SD) > TSI (CHL), and this pattern shows that non-algal particulates or color dominate light attenuation.

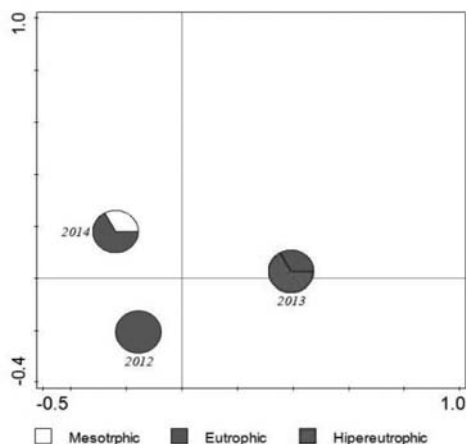


Figure 3. Trophic state based on the main annual values of Očaga reservoir

CONCLUSION

In Očaga reservoir, eutrophic conditions in general prevail, except in August 2013 and 2014. Hypereutrophic state that was observed during August 2013, when high values of all parameters (TP, Chl a and SD) have been measured, probably occurred as a result of organic load on ecosystems and weather conditions. The lowest measured values of all parameters and the state of mesotrophy in August 2014 are probably the consequence of strong rainfall that were frequent during this year and, consequently, emptying of the reservoir. It is worth mentioning that, for all parameters, Carlson's trophic state indices were uniform during these two months.

ACKNOWLEDGEMENTS

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