IWA 17th SWWS AND 9th ROS
10th–14th November, 2024
Curitiba-Brazil

Assessment of water quality parameters associated to eutrophication and water level changes in the Santa Maria Reservoir, Distrito Federal, Brazil

Rodrigues, K.B.*, Generoso, T.N.*, Salerno, C.C.F.*, Gurgel, L.S.V.* and Arruda, E.M.F.*

*Companhia de Saneamento Ambiental do Distrito Federal (CAESB), Brasília, Brazil

Highlights:

- Chlorophyll a development can be associated to low water levels.
- Nutrient concentrations can increase at low water levels and lead to phytoplankton growth.
- Santa Maria Reservoir maintained good water quality despite nutrient concentration and water level variations.

Keywords: phytoplankton growth; water quality; Santa Maria Reservoir

INTRODUCTION

In urban basins, one of the biggest water quality problems is eutrophication and nutrient loading, mainly nitrogen and phosphorus. Increased nutrient concentration can lead to phytoplankton growth, which can impact aquatic life. Cyanobacteria are a group of phytoplankton and these conditions favor them. These organisms can release toxic substances. Phytoplankton growth can also change organoleptic properties of water and increase water treatment costs (MEDEIROS *et al.*, 2015).

To analyze phytoplankton development, chlorophyll a concentration can be used since it's a compound found in these organisms, therefore, it's an indirect indicator of phytoplankton in water.

Santa Maria Reservoir is an artificial lake located in the Brasília National Park, in Distrito Federal (DF). It supplies water to approximately 13% of the population (Plano de Exploração, 2021). Since the lake is a lentic environment, nutrient accumulation can promote phytoplankton growth.

From 2015 to 2017, DF experienced a prolonged period of drought, which caused significant decrease in the water level of Santa Maria reservoir. This circumstance motivated the current study, which aims to analyze chlorophyll a behavior in response to fluctuations in water level and nutrient concentration. The goal is to determine the lake's sensitivity to phytoplankton growth during periods of water stress.

METHODOLOGY

This study consisted of historic data analysis of Santa Maria reservoir from January 2011 to March 2024. Parameters used were: water levels acquired from a linimetric station (code 60477100), chlorophyll a concentration (*chla*), ammoniacal nitrogen concentration ($N\text{-}NH_3$) and total phosphorus concentration (P_t) obtained from five monitoring points from CAESB (Companhia de Saneamento Ambiental do Distrito Federal) located in the same place, but at different depths, as shown in Figure 1.

Lake Santa Maria is a water body classified as special class by the Conama Resolution nº 357/2005, since the lake and all its tributaries are located within a National Park, which is an integral protection

area. The resolution sets concentration limits for water quality parameters according to the water body classification, which depends on its intended uses. However, for special classes, it does not establish maximum values; therefore, the limits considered for the analysis are those specified for Class 1 freshwater.

Aligned dots on the graphs, especially for N-NH_3, mean that the result was below the detection limit.

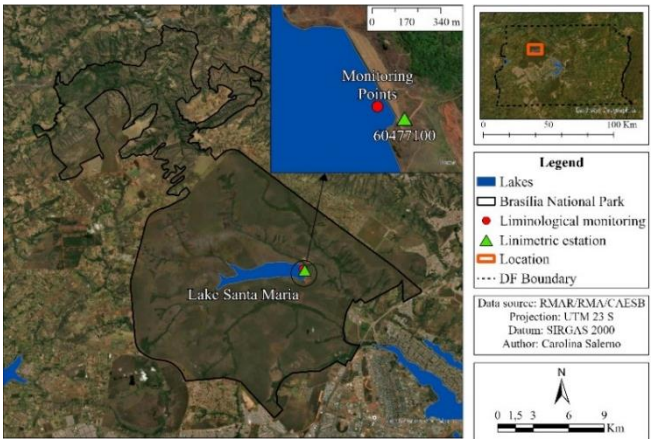


Figure 1: Lake Santa Maria and its monitoring points.

RESULTS AND CONCLUSIONS

Figures 2 to 6 show the parameter results from 2011 to 2024 for each monitoring point and the water level variations in this period. The maximum water reservoir level is approximately 1,072.13 m and the lowest water level (1,064 m) was recorded in 2017 due to the water crisis. Water level decreased in 2023 due to low precipitation, but it has been increasing since December. The variables behaved similarly in all the monitoring points.

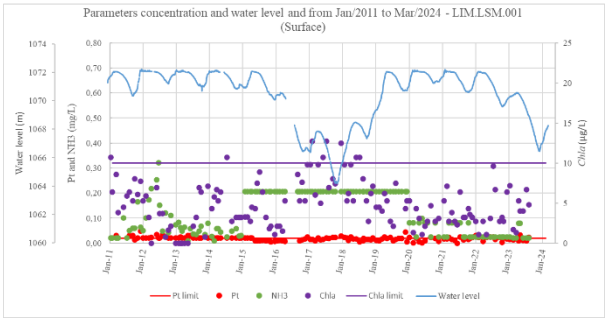


Figure 2: Water quality results for point LIM.LSM.001 – surface.

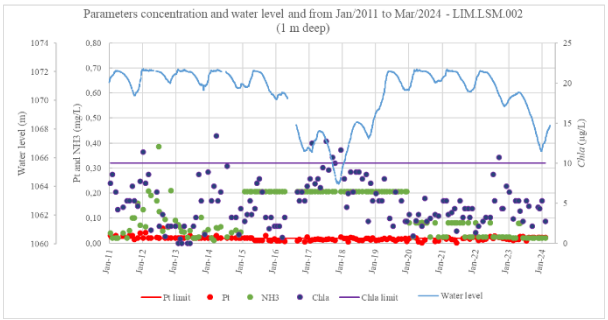


Figure 3: Water quality results for point LIM.LSM.002 – 1 m deep.

Chlorophyll a concentration at all points increased during the drought. It's also evident that *chla* does not consistently increase as water level decreases. For example, in 2023, when water level reached 1,066 m and *chla* didn't reach the 10 µg/L limit for class 1 water bodies. However, for lower water levels, like in 2017, *chla* increased and surpassed the limit value. It's important to note that in 2011 and 2012, the water level didn't deviate from usual values, but *chla* increased. This could be caused by nutrient increase when water level decreases, as pointed by Cruz *et al.* (2018).

In the most superficial layers in 2011 and 2012, N-NH_3 was detected at low concentrations, and in 2014 remained below the equipment's detection limit making it difficult to assess its effects on *chla* values.

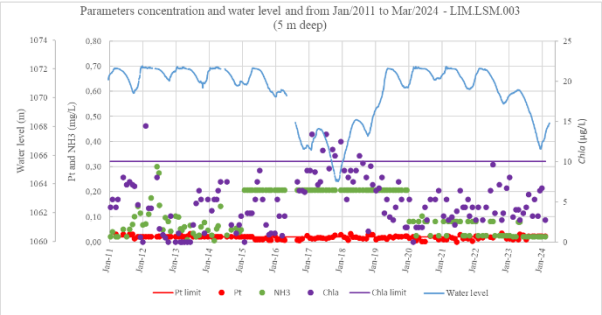


Figure 4: Water quality results for point LIM.LSM.003 – 5 m deep.

However, at the bottom of the reservoir it was possible to observe that in the driest years (and after them) the N-NH_3 concentration was higher.

Total phosphorus concentration increased in 2011 and 2012 and was above the limit in some samples, indicating that the *chla* increase in this period could be associated to this nutrient. In 2017, P_t was lower than in 2011/2012 in most samples, but it still surpassed the limit and could have favored *chla* development. Therefore, further studies are needed to more accurately assess the factors that may influence reservoir behavior during dry periods including statistical analysis.

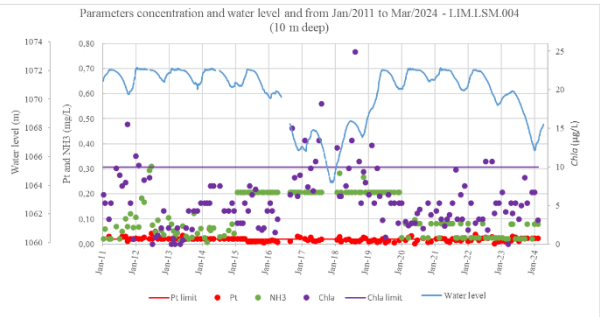


Figure 5: Water quality results for point LIM.LSM.004 – 10 m deep.

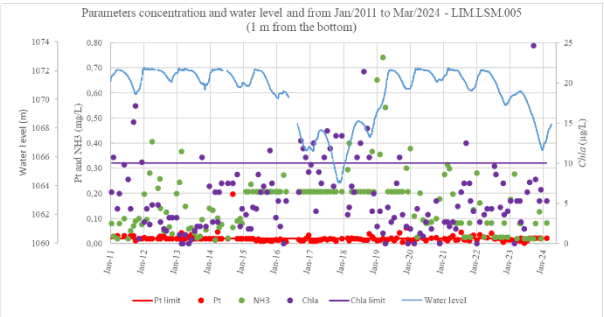
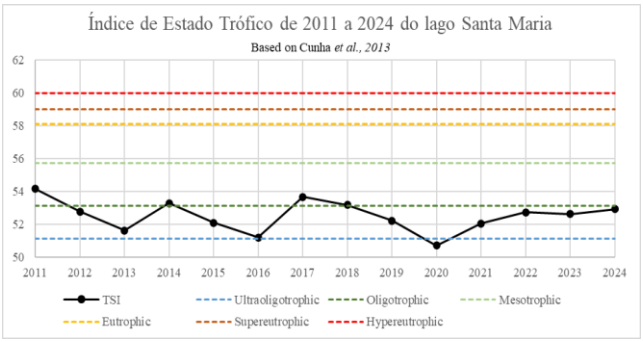


Figure 6: Water quality results for point LIM.LSM.005 – 1 m from the bottom.

The trophic state index (TSI), shown in Figure 7, was calculated using *chla* and P_t. Typically categorized as oligotrophic, the lake was classified as mesotrophic in 2011 and 2017, indicating higher concentrations of chlorophyll a and phosphorus, as previously noted. The reservoir was able to recover a low trophic state, even being constructed without a bottom outlet to the downstream area, indicating its resilience against the changes previously mentioned. Santa Maria Reservoir is located in an integral protection area with low anthropic influence, so limiting nutrients that favor phytoplankton growth aren't present in high concentrations, which assures the water quality despite parameters fluctuations through the years.



With this preliminar study, it was possible to see that lake Santa Maria has low sensitivity to chlorophyll a variation when it's associated with low water levels that can increase nutrient concentration. Further studies are being carried out to evaluate the factors that most influence the behavior of this reservoir.

REFERENCES

BRASIL, Resolução Conama n°357, de 17 de março de 2005. Classificação de águas, doces, salobras e salinas do Território Nacional.

Companhia de Saneamento Ambiental do Distrito Federal (Caesb), 2021. *Plano de Exploração*: Diagnóstico e Caracterização. Brasília, Distrito Federal, p. 139. Available on: <https://www.adasa.df.gov.br/legislacao/resolucoes-adasa>. Accessed 14 May 2024.

Cunha, D. G. F., Calijuri. M. C., Lamparelli, M. C. *A trophic state index for tropical/subtropical reservoirs (TSItsr).* Ecological Engineering, Volume 60, 2013, pages 126-134. Doi: https://doi.org/10.1016/j.ecoleng.2013.07.058.

Cruz, P. S., Silva, R. D. dos S., Oliveira, D. A. de., Viana, L. G., Silva, D. de L. e Barbosa, J. E. de L. 2018. *Fitoplâncton dynamics and tropical reservoir evolution in brazilian semi-arid*. Revista Verde de Agorecologia e Desenvolvimento Sustentável. Pombal-PB, v.13, n°. 4, p. 495-500. Doi: http://dx.doi.org/10.18378/rvads.v13i4.5629.

Medeiros, L.C., Mattos, A., Lürling, M. *et al. Is the future blue-green or brown? The effects of extreme events on phytoplankton dynamics in a semi-arid man-made lake*. Aquat Ecol 49, 293–307 (2015). https://doi.org/10.1007/s10452-015-9524-5.