

Anthropogenic impacts on water quality of the Pallikaranai catchment, Chennai, India

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Abstract

Water bodies of Chennai, India are facing deterioration of water quality due to the heavy anthropogenic impact. It is a great necessity to protect and restore them for the sake of the environment and to guarantee a reliable drinking water supply for the more than 10 million people living in the city. The present study assessed water quality in six lakes and a marshland within the Pallikaranai catchment in the city of Chennai (southeast of India). During the three sampling campaigns carried out between June and September 2019 impacts were easily visible, including the frequent intense green colour of the Chitlapakkam lake water and a massive death of fishes in the Sembakkam lake. In addition, the laboratory analysis proved high concentrations of pollutants, a high degree of eutrophication, quick change of water quality and great differences from lake to lake. pH in the lakes of the catchment reached 9.2 and chlorophyll a was frequently over 50 µg/l.

1. Introduction

Industrialization and economic growth in developing countries have put a lot of pressure on aquatic ecosystems (Dhamodharan et al., 2019; Rosado et al., 2015). The Pallikaranai catchment, located in Chennai, India, contains seven lakes and a marshland, including the Sembakkam lake, a proposed Ramsar site. In spite of the latter, the effects of anthropogenic activities are visible along the catchment in different ways, such as the reduction of birds and other animals, and the increase of the turbidity of waters. Sources of pollution include an uncontrolled dumpsite and a sewage treatment plant situated in the marshland.

This reduction in water quality is endangering the ecosystems and threatening the surrounding communities, which use the lakes for fishery and the groundwater for drinking. With all of this in mind, this study aims at evaluating the water quality in the lake and identify potential pollution sources as a key information for a future restoration.

2. Methods

Three monthly sampling campaigns were carried out between July and September 2019 in both i) the lakes of the Pallikaranai catchment, with the exception of Keelkatalai Lake that was dry, and ii) Okkiyam maduvu, the outlet of the Pallikaranai catchment, located in a marshland (Figure 1).

Samples were placed in a portable refrigerator (4°C) in the dark and transported to the laboratory of the Civil Engineering Department of the Indian Institute of Technology Madras and the following parameters were measured accordingly to the methods defined by APHA (2012): chemical oxygen demand (COD), chlorophyll A (Chl-A), sulfate and chloride.

At the same points and dates, in-situ measurements of pH, dissolved oxygen (DO), electrical conductivity (EC) and temperature were made with a Portable Multi-Parameter Meter HQ40d (Hach). The portable device was calibrated in situ with the standards provided by the manufacturer.

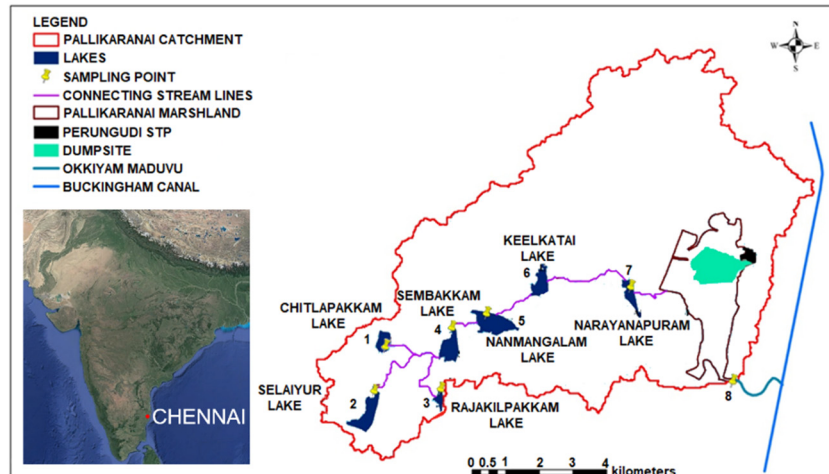


Figure 1. Sampling points in the seven lakes and the marshland of the Pallikaranai catchment (Chennai, India).

3. Results and discussion

During the sampling campaigns some problems were visible, as the intense green color of the Chitlapakkam lake water and a massive death of fishes in the Sembakkam lake (Figure 2). Also, it was observed that, as a result of the water scarcity, there was no water flow between the lakes until the end of the research period and therefore, they were not interconnected.



Figure 2. Pictures of the Chitlapakkam lake (left) and Sembakkam lake (right) part of the Pallikaranai catchment (Chennai, India).

As can be seen in Figure 3, the water quality parameters generally showed a bad condition and varied highly among months and lakes. pH and DO were out of the range of suitability for aquatic life defined by the USEPA in many samples (United States Environmental Protection Agency, 2019).

COD levels were especially high during August and September and reached values over two-thirds of the average of wastewater in developing countries reported by Henze et al. (2015). Levels of Chl-A suggested severe eutrophication, usually in the range of eutrophication and

hypereutrophication (Carlson and Simpson, 1996). R^2 between DO and Chl-A equaled 0.42, suggesting a certain degree of correlation. It was observed that sewage from nearby households was discharged directly into the lakes and together with urban runoff seems to be one of the main pollution sources explaining the levels of COD and Chl-A.

Sulfate values were usually well below 250 mg/L, the threshold defined by the EU for drinking water (European Council, 1998). On the other hand, chloride was over 230 mg/L in the lakes, and even above 860 mg/L in the marshland, the chronic and acute thresholds for preservation of freshwater aquatic life defined by the USEPA respectively (United States Environmental Protection Agency, 2019). An intrusion of seawater due to the low groundwater levels in the marshland might be a potential reason.

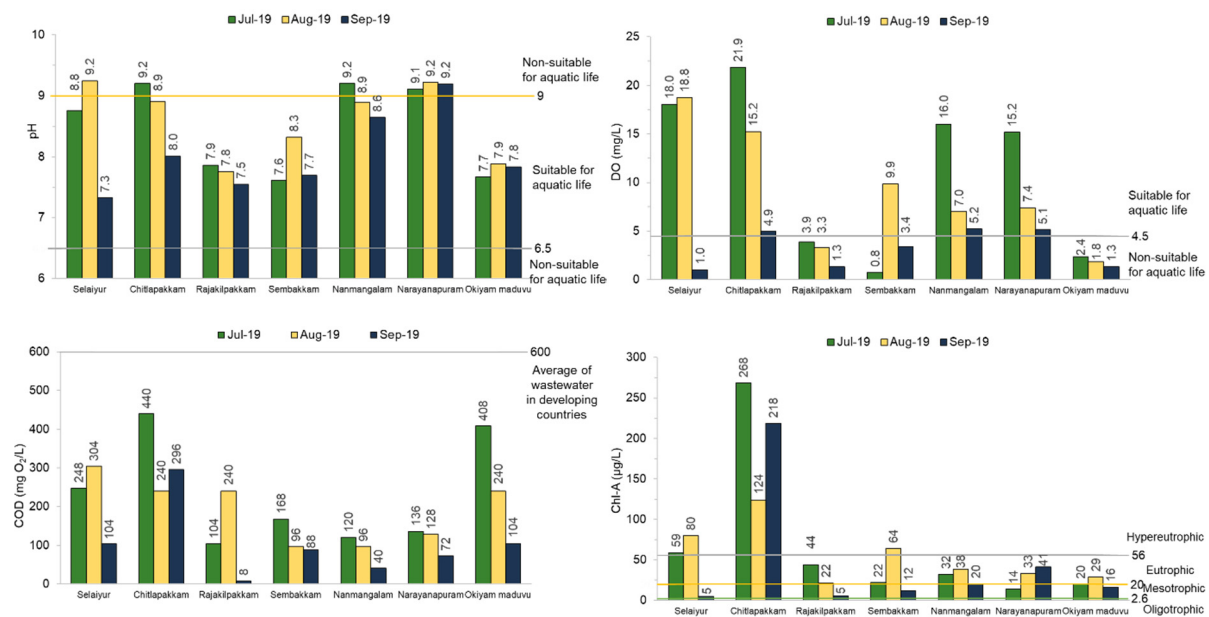


Figure 3. Results of pH, dissolved oxygen (DO), chemical oxygen demand (COD) and chlorophyll a (Chl-A) in the six lakes and the marshland (Okkiyam Maduvu) of the Pallikaranai catchment (Chennai, India). Threshold values sources: pH and DO (United States Environmental Protection Agency, 2019), COD (Henze et al., 2015) and Chl-A (Carlson and Simpson, 1996).

These results might be partially explained due to the severe drought that took place in Chennai at the beginning of the sampling, followed by an increase in rainfall events. However, droughts are common in Chennai during this season and, thus, these values are likely to be reached every year.

4. Conclusions

The water quality in the lakes and the marshland of the Pallikaranai catchment is not always suitable for aquatic life and it is also deteriorated by high eutrophication.

Sewage and urban runoff coming from nearby households was identified as a relevant source of pollution considering the chemical oxygen demand and chlorophyll a levels.

Intrusion of seawater due to the low groundwater levels in the marshland is likely to be happening.

Further research is needed to more precisely estimate the impact of the mentioned pollution sources and to identify other relevant pollution sources that allow a successful proposal for restoration.

5. Acknowledgements

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