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ORIGINAL ARTICLE

# Biogeochemical mechanisms controlling trophic state and micropollutant concentrations in a tropical artificial lake

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**Abstract** Lake Paranoá is a human-made water reservoir created in 1959 together with the new capital of Brazil (Brasilia). With the demands of urban development, population growth, and land use changes, the lake presented severe deterioration of water quality due to the disposal of wastewater with a high concentration of nutrients. To better elucidate the natural and anthropogenic sources controlling the water quality from Lake Paranoá, this study aimed to (1) investigate the main geochemical processes controlling water quality of the lake and its tributaries; (2) evaluate Lake Paranoá's trophic state; and (3) determine the occurrence and fate of organic micropollutants in Lake Paranoá waters and WWTPs effluents. The waters from Lake Paranoá tributaries are naturally acidic due to the nature of the extremely weathered ferralsols and the crustal material composition. The main processes linked with anthropogenic activities that affect the water quality from the tributaries are the input of untreated domestic wastewater and the dissolution of carbonate minerals arising from construction material residues. Generally, the waters of Lake Paranoá presented low nutrient and chlorophyll-a concentrations, indicating a low trophic state (oligo-mesotrophic). A significant increase in the trophic state (super-eutrophic) was observed at specific regions of the lake that have high nutrient input from tributaries, caused by the continuous disposal of untreated domestic sewage. In Lake Paranoá waters, the organic micropollutants that were identified and quantified (caffeine, bezafibrate, bisphenol A, diethyl phthalate, and nonylphenol) presented concentrations consistent with previous studies and within the threshold of toxicity, except bisphenol A.

**Keywords** Water quality · Geochemistry · Trophic state · Micropollutants · Wastewater

## Introduction

The water quality of lakes is naturally controlled by precipitation inputs, erosion, and weathering of crustal materials (Simeonov et al. 2003). However, anthropogenic diffuse and point source pollution can drastically change the chemical composition of surface waters (O'Shea 2002) due to agricultural, industrial, and domestic activities. In urban areas, one of the most frequent types of water pollution is linked to the discharge of sewage with excessive nutrient concentration (i.e., nitrogen and phosphorus, Jones and Lee 1982; Smith and Schindler 2009). This process usually leads to lake eutrophication, known to cause oxygen depletion in the water column and, therefore, mass mortality of benthic organisms and fish over large areas (Wu 1999). Other relevant pollutants are associated with the input of metal(loids), pharmaceutical products (antibiotics, anesthetics, anti-inflammatories and antilipemics),

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