A Holistic Perspective on Tropical Hyporheic Zones: Integrating Natural Tracers and Bioindicators for Comprehensive Characterization

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Abstract: River-aquifer exchange studies in tropical regions have been limited, primarily due to the complexity and multidisciplinary nature of such investigations. In this study, we present an initial attempt to characterize the hyporheic zone (HZ) within an outcrop area of the Guarani Aquifer System (GAS) in the Onça creek basin in São Paulo state, Brazil, employing a multidisciplinary approach. Points of high river-aquifer exchange were identified using fiber optics coupled with a distributed temperature sensing device (FO-DTS). Macroinvertebrates were employed as bioindicators to assess the ecological response in the HZ. Water quality parameters, including pH, conductivity, total dissolved solids, and dissolved oxygen, were measured using multiparameter quality probe. Furthermore, a comprehensive analysis of key nutrients such as nitrate, nitrite, ammonium, total nitrogen, soluble reactive phosphorus, total dissolved phosphorus, and total phosphorus was conducted. In this preliminary analysis, we observed limited variation in water quality parameters and main nutrients between points of high and low interaction with the aquifer. However, there was a notable impact on the abundance of macroinvertebrates, indicating the influence of aquifer-river interaction on the ecological dynamics within the HZ. It is worth noting that further studies are required under different hydraulic and meteorological conditions to fully characterize the HZ in tropical regions. By conducting investigations in varied environmental settings, we can better understand the temporal and spatial variations in river-aquifer interactions and their implications for ecosystem functioning.

Keywords: SW-GW interaction, hyporheic zone (HZ), Guarani Aquifer System (GAS), FO-DTS, macroinvertebrates.

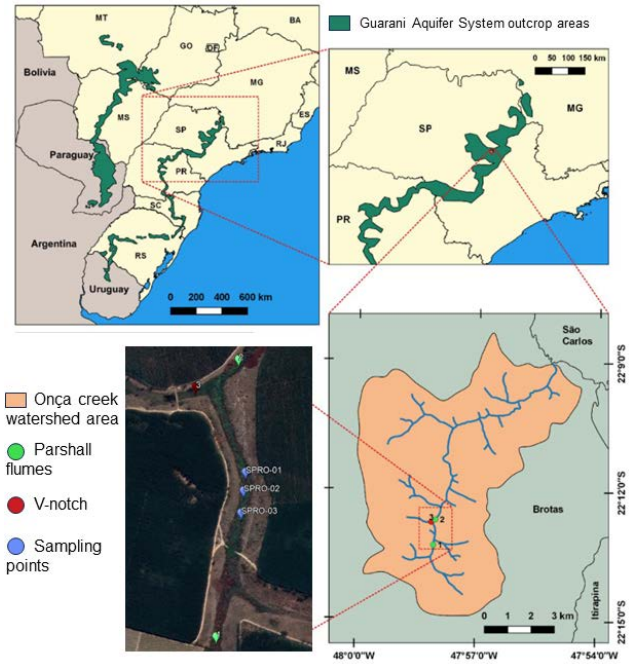
INTRODUCTION

Understanding the spatial and temporal variability of river-aquifer exchange is of great relevance in the field of ecohydrology, especially concerning the impact on invertebrate communities and the processing of organic matter (Krause et al., 2011). In this study, we adopt a comprehensive approach to examine the HZ in an outcrop area of the GAS using temperature as a natural tracer and macroinvertebrates as a bioindicator.

METHODS AND STUDY AREA

Fiber optics coupled with a distributed temperature sensing device (FO-DTS) was employed to analyze river-aquifer interactions in Onça creek basin (Reis, 2023). In the initial assessment, we selected points 1 and 3, that presented low interaction, and point 2, that presented high interaction. The collection of macroinvertebrates was carried out using a D-frame aquatic net (250 µm). Water quality parameters were analyzed using a multimeter probe and an extensive analysis of the main nutrients present in the water was conducted.

Figure 1 – Sampling points and its regional context. Adapted from Wendland et al. (2022).



RESULTS AND DISCUSSION

The findings of the study demonstrated a limited variation in water quality parameters and main nutrients between points of high and low interaction. However, the abundance of macroinvertebrates was notable impact, indicating a potential increase in ecological activity and biodiversity within the HZ with high interaction zones. To further investigate and characterize the HZ in tropical areas, we plan to conduct these analyses under different hydraulic and meteorological conditions.

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