

KARST SPRING MONITORING AND RESPONSE TO EXTREME RAIN EVENTS: THE JOÃO RODRIGUES CAVE SYSTEM IN SÃO DESIDÉRIO, BAHIA, BRAZIL

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Key-words: Karst spring; groundwater flow monitoring; extreme precipitation.

INTRODUCTION

One of the major challenges concerning the study of karst aquifers reside in their heterogeneity and anisotropy. To characterize flow dynamics and the catchment area of a karst groundwater basin, conventional hydrogeology investigation methods alone are sometimes insufficient, and specific techniques more suitable to karst research must be applied, like dye tracing tests, spring hydrographs, cave survey, among others. Karst springs are typically the most important monitoring points in a karst aquifer system because they can provide information of all processes influencing surface or subsurface flow dynamics and signal transformations from recharge to discharge points (Larocque et al., 1998; White, 2002; Groves, 2007; Ford and Williams, 2007).

In Brazil, many karst springs are important water supplies to small communities and big cities, but few of them have ever been studied and none present long-term monitoring hydrographs. This scenario reveals a problem for groundwater management, especially considering population growth in a climate changing world. This study concerns the groundwater monitoring of the João Rodrigues cave system (Figure 1) at the São Desidério municipality (state of Bahia), where expressive groundwater lakes exert a major control in groundwater flow patterns. Besides this rare hydrologic scenario, an environmental conservancy area is being implemented at São Desidério to protect some of the largest caves in Brazil that face potential threats due to land use (agriculture and highway building).



Figure 1. A: Surubim karst spring, the major discharge point for the João Rodrigues cave system. Average flow rate is 0.95 m³/s (Hidrovia, 2012). B: Banquisa underground lake in the Bacupari cave. The yellow ellipse indicates a speleologist for scale. Thin calcite rafts cover the surface of the lake.

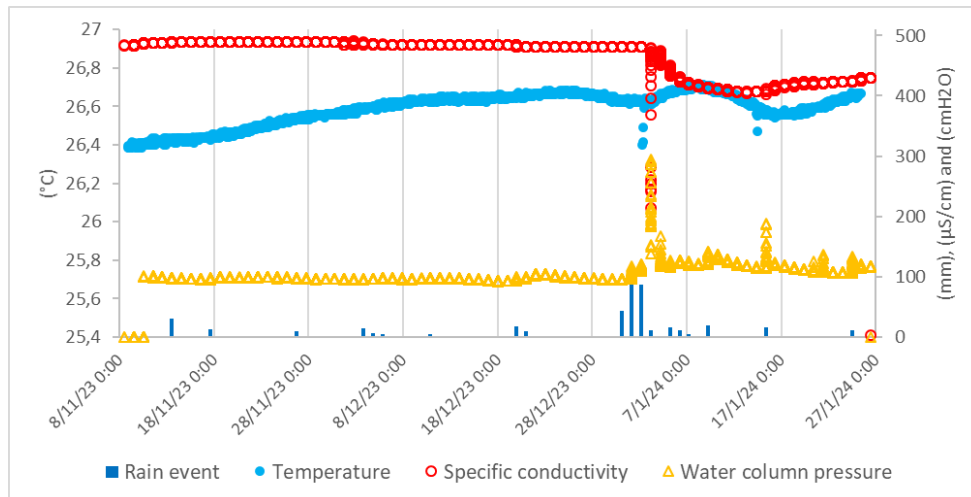


Figure 2. Hydrograph for the Surubim karst spring, from 2023, November 8 to 2024, January 25.

For data acquisition, water level, specific conductivity, temperature, and precipitation were monitored in the study area, starting from November 2023, by using auto level loggers and a weather station. The Surubim spring hydrograph and the precipitation curve for the catchment area (Figure 2) show two extreme rain events of 99,3 mm in 2023, December 31 and 87,3 mm in 2024, January 01. The response to this intense recharge pulse at the spring was a 1.8 m rise in water level 7 hours after the rain event. The linear distance between the sinking stream and the spring is approximately 9.8 km. Water level rise is inversely proportional to specific conductivity and temperature. While the storm water level rapidly decreases, temperature and specific conductivity tend to follow a slower recovery trend. This suggests that the cave system is composed of two major flow zones: the fast zone, represented by the underground river with quick response to input signals, and the slow zone, probably represented by lateral ponding of the river system in the form of underground lakes. The slow zone would be responsible for an important component of water storage in the system and the delayed recovery of monitored parameters at the spring.

CONCLUSION

These are preliminary results of hydrograph monitoring that will continue until January 2025. The time response at the spring to two extreme rain events were measured and a delay effect from underground lakes was identified. Besides the Surubim spring, 13 other points along the João Rodrigues cave system are currently being monitored for water level, water flow rate, temperature, hydrochemistry, and stable isotopes.

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