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Evaluation of risks of groundwater quality alteration in Recife urban area (Pernambuco, Brazil) using a multi-isotopic approach.

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The Recife Metropolitan Region (RMR) is a heavily urbanized area located in a estuary zone and over a multi-layered sedimentary system on the Brazilian Atlantic coast. In a context of increasing land use pressures, involving aquifer overexploitation and surface water contamination, and repeated droughts, the identification of groundwater quality risks in RMR is a necessary management requirement. In this perspective, this work focused on the two shallow aquifer systems, named Boa Viagem and Barreiras aquifers, located at the interface between the city (the consumers) and the deeper semi-confined Cretaceous Cabo and Beberibe aquifers. The Holocenic Boa Viagem and Tertiary Barreiras formations conform unconfined sedimentary aquifers, with no more than 80 m of thickness. Cabo is the most important groundwater body for Recife private complementary water supply and it has experienced an intense exploitation in the last three decades. In contrast, Boa Viagem and Barreiras aquifers are more restrictively used, but it is important to understand their water quality degradation,because of hydraulic connections with deeper aquifers, mainly in the littoral part of Recife, where hydraulic potentiometric head of the Cabo aquifer is 60 m below sea water level in some places, with conditions for recharge from shallower aquifers. Through a multi-isotopic characterization ($^{87}Sr/^{86}Sr$, $\delta^{11}B$, $\delta^{18}O\text{-}SO_4$, $\delta^{34}S\text{-}SO_4$) of sampling of 19 wells and 3 surface waters, carried out during two field campaigns with additional geochemical parameters (major ions, noble and major gases, CFC´s and SF_6), the spatio-temporal variability of groundwater quality was investigated. The detection of CFC´s, implying a modern recharge component, highlighted the vulnerability of Boa Viagem and Barreiras to surface contaminations. The increasing mineralization and decreasing $^{87}Sr/^{86}Sr$ from the inland sector wells to the wells located close to the coast or estuary, with higher well and population densities, were attributed to water-rock interactions along the natural or human-induced potentiometric gradients. Along with this trend appeared an environmental pressure gradient, highlighted by $\delta^{11}B$ related to sewage or surface channel networks. These sources are purveyors of chloride, nitrate and sulfate, which are found in varying amounts (13,6< [Cl]<2826,8 mg/L; 0<[NO_3]<103,9 mg/L; 1,7< [SO_4]<375,4 mg/L). Nitrate and sulfate are also potentially produced or consumed within the system, featured by varying sediment texture and organic contents and therefore apparent to a patchwork of biogeochemical reactors, as demonstrated by $\delta^{18}O\text{-}SO_4$, $\delta^{34}S\text{-}SO_4$ and dissolved major gases. Further, on the cost line high well-density area, intensive pumping, through intrusion andhydraulic lift, probably explains temporary salinization in some wells.