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Groundwater quality impacts by urbanization

Rafael Terada[1], Ricardo Hirata[1], Carlos Marques[1], Paulo Galvão[2]; M. Cathryn Ryan[3]

1 - University of São Paulo

2 - Federal University of Minas Gerais

3- Geoscience, University of Calgary

Summary

Urbanization is a current global phenomenon that can modify water cycles regionally and can have adverse environmental impacts that lead to economic, ecological and social consequences. In the context of sustainable cities, urban groundwater quality stands as one of the important emerging areas in the earth sciences. This is particularly true in Brazil, where: 1) groundwater is the source of 42% of public water supplies (and 80% of municipal water supply in the state of São Paulo); 2) the impacts of urbanization are poorly studied; 3) aquifer contamination vulnerability mapping for appropriate water management requires improvement; and 4) global climate change is also altering water availability, which can exacerbate water consumption patterns, requiring changes to human land occupation.

This research aims to understand decadal scale changes in groundwater geochemistry (particularly nitrate) in the Adamantina Aquifer which is an important water supply to the City of Urânia (located about 600 northwest of São Paulo, Brazil). In addition to contributing to groundwater science, this project seeks to provide the first integrated study of urban groundwater geochemistry in Brazil, and advance appropriate policy and social approaches to improve urban groundwater management. The City of Urania was selected for this research since significant geological and historical groundwater geochemistry data were available that indicated long term groundwater nitrate pollution with clear temporal and spatial variations.

Urban recharge to the unconfined aquifer is assumed to include municipal water supply leakage and onsite wastewater treatment system effluent. It is being estimated using the water table fluctuation and soil water balance methods. A multi-level monitoring well installed in the unconfined aquifer in the northwest (oldest) sector of Urânia complement existing multi-levels in the northeastern and southern (youngest) sectors. A 70 m core was recovered for stratigraphic and hydraulic conductivity analyses. Rainwater is being sampled to determine volume-weighted δO^{18} and δD composition for comparison with groundwater, surface water, municipal tap water, and sewage sampled in both rainy and dry seasons. Geochemical analyses include field parameters, major ions, and δN^{15} and δO^{18} in nitrate.

Observed nitrate and chloride concentrations in the aquifer are as high as 150 mg NO_3/L and 70 mg Cl^-/L, concentrated at northeast sector, near the stream. The multi-level monitoring well leads to more accurate assessment for the old part of the city, where the groundwater nitrate plume extends as deep as 50 to 70 m below ground surface/water table. The isotopic composition of water suggests significant evaporation occurs in dug, but not drilled, wells.