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title: **Using GIS mapping to assess groundwater studies in urban areas (Porto, NW Portugal): combined potential contamination sources and radon susceptibility**

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Urban aquifers are particularly important but extremely fragile, easily damaged, and slow to restore. Groundwater conditions are also of primary significance in the construction and maintenance of the subsurface engineering structures (e.g., tunnels, sewers, underground storage facilities and building foundation) and more generally in urban drainage. The aquifer vulnerability assessment is an important basis in order to fulfil demands of the EU Water Framework Directive 2000/60/EC and EU Groundwater Directive 2006/118/EC. These legislations demand that all groundwater must be protected and state that pollutant concentration in groundwater should be used in the risk assessment for groundwater bodies (Robins et al., 2007). Radionuclides are one of the sources of contamination in groundwater, occurring often in concentrations above the limits defined in the legislation; thus, the consumption of waters naturally enriched in radionuclides can be considered an environmental health hazard. The U isotopes (^{235}U and ^{234}U), ^{226}Ra and ^{222}Rn are the main radionuclides generally observed in natural waters, occurring in highly variable concentrations constrained mainly by geological factors (Desideri et al., 2007). In general, aquifers composed by rocks enriched in uranium also have higher concentrations of its daughter isotopes dissolved in the circulating water.

This integrated study presents the preliminary results of the hydrogeological and natural radioactivity studies of granitic rock masses. Hydrogeological methods were used to assess the nature and suitability for use of groundwater from spring galleries located in Porto urban area (NW Portugal, Iberian Peninsula), the so-called *Arca D'Água* underground catchworks (*c.* 3,3 km extension and ≈ −20 m of depth). These springs represented one of the main ancient water supplies of Porto city, for more than six centuries. The water supply of Porto City was secured through fountains fed by numerous springs. Several underground galleries were excavated on granite throughout the centuries to conduct the water of these springs. An inventory of surface potential contamination sources around *Arca D'Água* spring galleries was also performed. These sources are, dominantly, point sources in character, according to the proposal of Zaporozec (2004) with a moderate to high potential contamination load. Almost two-thirds of these sources correspond to garages and spring galleries' entrances and ventilation shafts (Afonso et al., 2007, 2010). Groundwater samples were collected from several sampling sites for hydrogeochemical studies. Most of the groundwater are enriched in sulphate and nitrate and are classified in two groups: SO_4–Ca and HCO_3–Ca types. However, these groundwater may be suitable for irrigation purposes (Afonso et al., 2007, 2009).

In addition, several radiological parameters were investigated, namely radionuclides ^{238}U, ^{234}U, ^{226}Ra and radon gas on the basis of liquid scintillation counting techniques. The uranium isotopes have activities, predominantly, below 0.2 BqL^{-1}, and even below the detection limit. The ^{226}Ra activities vary between 0.13 and 0.45 BqL^{-1}. On the other hand, ^{222}Rn shows a large variation, ranging between 2 and 799 BqL^{-1}.

All parameters show a wide range of variation which is correlated with the geology of the area. The results of this study will contribute to a better water management of an urban geo-space. It also demonstrates that the applied multidisciplinary approach is realistically adequated to understand urban hydrogeological processes and their dynamics.

REFERENCES

Afonso M.J., Marques J.M., Guimarães L., Costa I., Teixeira J., Seabra C., Rocha F.T., Guilhermino L., Chaminé H.I., 2007: *Urban hydrogeology of the Paranhos sector, Porto city (NW Portugal): a*

geoenvironmental perspective. In: Chery L., Marsily G. (eds). Aquifer Systems Management: Darcy's Legacy in a World of Impending Water Shortage. Selected Papers on Hydrogeology, IAH/Taylor & Francis CRC Press, London, SP10: 391–406.

Afonso M.J., Chaminé H.I., Marques J.M., Carreira P.M., Guimarães L., Guilhermino L., Gomes A., Fonseca P.E., Pires A., Rocha F., 2009: *Environmental issues in urban groundwater systems: a multidisciplinary study of the Paranhos and Salgueiros spring waters, Porto (NW Portugal)*. Environ Earth Sci, DOI 10.1007/s12665-009-0351-7.

Afonso M.J., Pires A., Chaminé H.I., Marques J.M., Guimarães L., Guilhermino L., Rocha F.T., 2010: *Aquifer vulnerability assessment of urban areas using a GIS-based cartography: Paranhos groundwater pilot site, Porto, NW Portugal*. In: Paliwal B.S. (ed.) Global Groundwater Resources and Management. Selected Papers from the 33rd International Geological Congress, General Symposium: Hydrogeology, Oslo (Norway) Aug. 6–14, 2008, Scientific Publishers (India), Jodhpur, pp. 259–278.

Desideri D., Meli M.A., Feduzi L., Roselli C., Rongoni A., Saetta D., 2007*: ^{238}U, ^{234}U, ^{226}Ra, ^{210}Po concentrations of bottled mineral waters in Italy and their dose contribution*. Journal of Environmental Radioactivity, 94 (2): 86–97.

Robins N.S., MacDonald A.M., Allen D.J., 2007: *The vulnerability paradox for hard fractured Lower Palaeozoic and Precambrian rocks*. In: Witkowski A.J., Kowalczyk A., Vrba J. (eds.): Groundwater Vulnerability Assessment and Mapping. International Association of Hydrogeologists Selected Papers. Taylor & Francis Group, London, 11:13–19.

Zaporozec A. [ed.] 2004: *Groundwater contamination inventory: a methodological guide with a model legend for groundwater contamination inventory and risk maps*. IHP-VI, series on groundwater, 2. UNESCO, Paris, 160 p.

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