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title: **Use of factorial correspondence data analysis to evaluate groundwater chemistry and pollution of a shallow aquifer (Loures Valley, Lisbon, Portugal)**

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A significant industrial development, associated with a demographic expansion, occurred during the last decades of the XX century, in Loures valley, a region located in the vicinities of Lisbon. This was accompanied with an important modification of land use and occupation patterns, mainly the decrease of the agricultural land.

One of the main consequences was the augmentation of domestic sewage, which, combined with the low levels of wastewater treatment and the reduced dilution power of the watercourses, contributes to the deterioration of the water quality of Trancão River and associated shallow alluvium aquifer. This one is continuous unconfined aquifer and mainly exploited for irrigation by several dug wells.

In order to characterize the magnitude of anthropogenic impact in the groundwater, the results of physic-chemical analyses of waters of 36 shallow wells and soils were sampled during three campaigns (Silva, 2003). The first campaign refers to data collected in a wet year during the summer season; the second campaign refers to data collected in the same year, during the winter season and the third campaign refers to data collected in the next year, a dry year, during the summer season. The list of monitored parameters are EC (electrical conductivity), pH, major anions (HCO_3, SO_4, Cl, F), major cations (Na, K, Ca, Mg) and trace elements (Al, Cr, Mn, Fe, Ni, Cu, As, Se, Br, Sb, Hg, Pb). Spatial and temporal correlation between variables and time horizons were carried out by using a multivariate statistical approach based on the principle of correspondence factor analysis (CFA).

Developed by Benzécri in the early sixties (Benzécri, 1977, 1982), CFA belongs to a group of factor extraction methods whose main objective is to discover the underlying pattern of relationships within a data set. This is basically done by rearranging the data into a small number of uncorrelated "components" or "factors" that are extracted from the data by statistical transformations. Such transformations involve the diagonalisation of the some sort of similarity matrix of the variables, such as a correlation or variance-covariance matrix. Each factor describes a certain amount of the statistical variance of the analysed data and is interpreted according to the intercorrelated variables. The main advantage of CFA is that symmetry is conferred to the data matrix thus permitting the simultaneous study of correlations within and between variables and samples (Stigter et al., 2006).

With this type of statistical treatment, a similarity/dissimilarity hydrochemical interpretation model is inferred between classes of quantitative variables (build with threshold concentration values) and of qualitative variables (e.g. build with type of soils) for various time horizons.

With this interpretation it was possible to attribute a meaning to the factorial indices (e.g. geogenic vs. anthropogenic or diffuse vs. punctual pollution) and to map the magnitude of each sample in the area under study. Analysis of these maps can be very useful for decision risk management.

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