

Linear Discriminant Analysis for groundwater's geochemical fingerprinting in Santiago Island (Cape Verde, Western Africa)

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Difficulties of managing water resources in developing countries are enhanced by pressures related with population growth and uncontrolled anthropic activities. In semi-arid and arid climates these problems are even more conditioning due to water scarcity and prolonged dry period. This is the case of Cape Verde, where surface water is seasonal or non-existent and groundwater becomes the regular source of water supply. This work is focused on the water resources properties in the most populous island of the country, Santiago Island. Based on an inventory of water points covering diverse geological and anthropogenic conditions, the present work aims to evaluate spatial variability and the major control factors on the groundwater quality in this island.

Linear Discriminant Analysis (LDA) was used as a supervised pattern recognition technique to access and evaluate groundwater spatial variations in Santiago Island. This approach starts with the allocation of all the individuals (samples) to a spatial or temporal pre-known support, designated as a group. In this survey, LDA was used to evaluate the variation in water quality with depth as there is geological evidence for the existence of a multi-layered aquifer system. Therefore, aiming the identification of the similarities or dissimilarities between the sampled gauging points and to identify the most significant groundwater quality variables responsible for the 3D spatial variations in the multi-layered aquifer system. Two groups were considered, the first concerning water levels up to 100 m and the second to water levels over 100 m. Seven samples were pre-classified as belonging to group 1 and nine samples as belonging to group 2.

Different patterns associated with depth variations were identified. The first group (shallow water) mainly explained by SO_4^{2-} content and the second group (deep water) explained by the content in Ba, Mg, Ca, Na, Sr, Cl^- , Br^- and electrical conductivity. Four samples were reclassified: three from group 1 to group 2. These samples were gathered at water levels between 52-97 m, which lead to conclude that the shallow aquifer system is up to 50 m (and not 100 m, as previously assumed) and the deep aquifer system concerning water levels above 50 m. The only sample reclassified from group 2 to group 1 (120 m depth) is situated in an area of intensive agricultural activities and most certainly under anthropogenic contamination.

The results of this study allowed enlighten the aquifer's nature in the study survey, Santiago Island, pointing out to the existence of a multi-layered aquifer system with specific geochemical fingerprinting considering the water points inventory as spatial support. The achieved results may be very useful to the local authorities for the management of pollution and decision-making for better protection of an important source of freshwater.

PALAVRAS-CHAVE

Multi-layered Aquifers; Geochemical fingerprinting; Linear Discriminant Analysis; Cape Verde.

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