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Anthropogenic sources and hydrogeochemical characteristics of groundwater in Mediterranean regions

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Introduction

In Mediterranean countries, groundwater (GW) is an almost ubiquitous source of fresh water and covers about 60% of the water demand. Indisputably, preserving GW reserves is of utmost importance to support economic activities (food production, tourism, industry, energy), as well as to ensure the health of humans and ecosystems. Due to its importance, the phenomenon of GW depletion needs to be further studied, adopting innovative methods and integrated approaches. Three areas in which GW depletion has been documented to have influenced GW quality have been studied. Two areas are located in Greece (Anthemountas and Mouriki basins) and one in Italy (Volturno basin). Different hydrogeological regimes including porous/unconsolidated, fractured rock, and karst aquifers are determined in the three basins. The current work is part of a thorough hydrogeological research on GW quality and quantity variations in the areas under investigation.

Materials and methods

Land use: Agricultural activities occupy most of the study areas (Figure 1) affecting the quality of GW. Agricultural, livestock, and industrial water demands are met by GW resources in the Anthemountas basin (Kazakis and Voudouris, 2015; Busico et al. 2021). In the Mouriki basin, the main crops are corn, cereals, fruit trees, vegetables, and legumes (Patrikaki et al. 2012; Busico et al. 2021). In the Italian region, agricultural, livestock activities, and mixed forests and pastures constitute the land cover of the area, while the main crop types are vineyards, cereals, vegetables, and orchards (Cuoco et al. 2016).

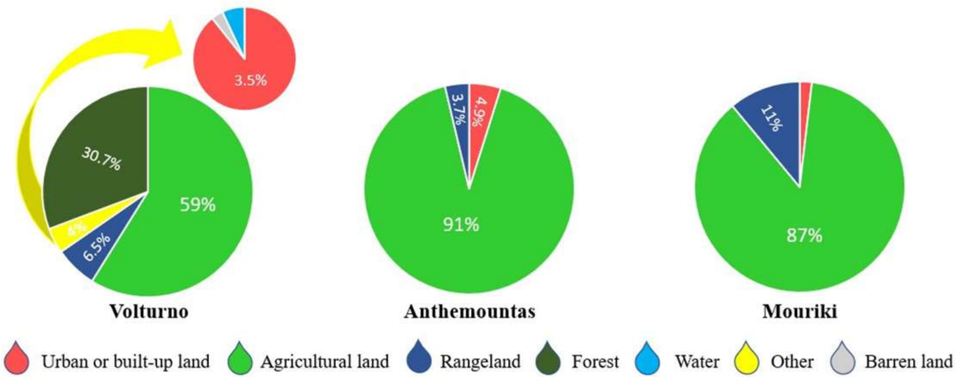

Figure 1. Pie diagrams of land use in the study areas (from Corine Land Cover 2018).

Samples collection: GW samples were collected during the dry period of 2022 (month of June) from agricultural wells in the three study areas. To give good spatial coverage over the entire studied areas, the sampling wells covered all the extent of the catchments, where it was possible. The main ions were determined according to the respective Standard Methods for the Examination of Water and Wastewater (Rice et al. 1999).

Results and concluding remarks

The obtained analytical values of the GW samples were plotted on the Piper diagram (Figure 2). The results showed that the GW samples in Volturno and Mouriki mainly have the following cations $Ca^{2+} > Mg^{2+} > Na^{+}+K^{+}$, while $HCO_3^{-} > Cl^{-} > SO_4^{2-}$ are the main anions. On the other hand, the samples from the Anthemountas basin show lower concentrations of Ca^{2+} and Mg^{2+}. Moreover, NO_3^{-} concentrations in the areas vary from 1 to 128 mg/L and depict the extensive use of fertilizers in the study areas, where the higher values belong to samples from the Volturno basin. Obviously, the formation of the hydrochemical facies/water types is a result of the geochemistry of the GW, which is further controlled by the geological structure and mineralogy of the aquifers, while external factors such as anthropogenic activities also affect the water quality. Thus, the hydrochemical analysis will be analyzed in spatial and temporal steps in all the basins. A multi-analysis of the provided data can help enhance the findings' validity and reliability. In this aspect, the current research data could be combined in various ways with other indexes and simulation processes. Different methods of GW protection have to be applied in the study areas taking into account the hydrogeological regime, artificial aspects, and climate variability.

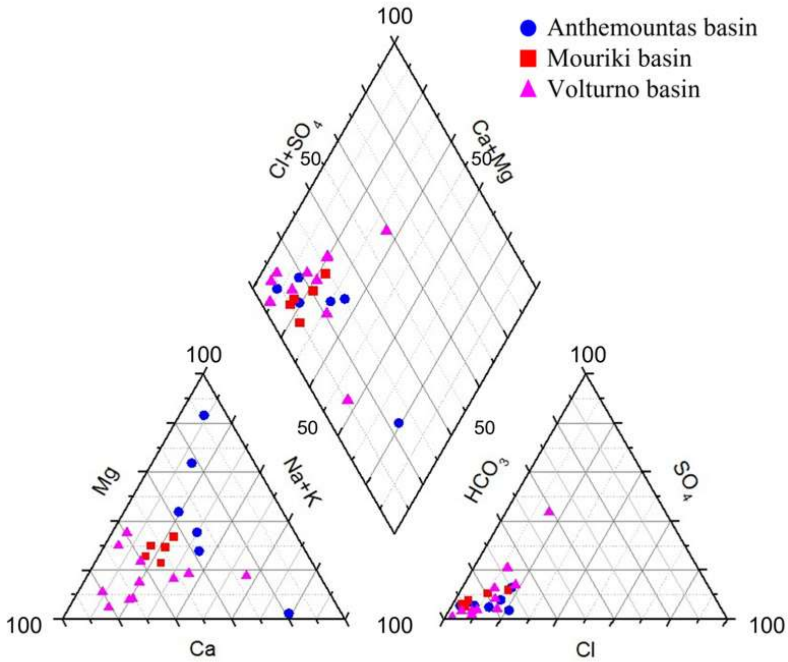

Figure 2. Classification of the GW samples in a Piper diagram.

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