Application of Multivariate Statistical Analysis for the Delineation of Groundwater Bodies: A Case Study in Campania Region (Southern Italy)

Stefania Stevenazzi1, Konstantinos Voudouris2, Daniela Ducci1

[1]*Università degli Studi di Napoli Federico II*

[2]*Aristotle University of Thessaloniki*

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The European Guidelines for the identification and delineation of groundwater bodies require the identification of hydrogeological boundaries and the assessment of the quantitative and chemical status of groundwater. These criteria must ensure that i) a precise estimation of the water budget for each groundwater body, and ii) an accurate quantitative and qualitative description of groundwater status can be reliably assessed.

In this context, this study attempts to verify the current delineation of groundwater bodies (GWBs) through the application of multicriteria statistical analysis. The areas of interest are represented by three GWBs located in the northern part of Campania Region (Southern Italy): the Volturno Plain (P-VLTR), a coastal plain of about 1340 km² constituted of fluvial, pyroclastic and marine sediments; the Phlegrean Fields (FLE), an active volcanic area constitued of a series of monogenic volcanic edifices; and the Plain of Naples (P-NAP), an inner plain constituted of fluvial and pyroclastic sediments. The identification and delineation of GWBs in Campania Region was developed by the regional public authorities in 2007 (49 GWBs) and updated in 2021 (81 GWBs), in compliance with the European Directives.

A multivariate statistical analysis (i.e., factor analysis, FA) was performed to differentiate among the main hydrochemical processes occurring in the area. FA allowed the handling of many geochemical and physical parameters (variables) measured in groundwater samples collected at about 200 sampling points during 2013-2017. Results reveal five hydrogeochemical processes variably influencing the hydrochemical characteristics of the three GWBs: salinization, carbonate rocks dissolution, natural or anthropogenic inputs (nitrate, sulphate), redox conditions (Fe, Mn), volcanic products contribution (As). FA allows identifying the areas characterised by one or more hydrogeochemical processes, mostly reflecting known processes (water-rock interaction, chemical reaction, natural/anthropogenic phenomena), but also highlighting the influence of groundwater flowpaths on water chemistry.

The application of multivariate statistical analysis allowed to: i) evaluate the consistency and reliability of public datasets to assess groundwater quality; ii) identify the hydrogeochemical processes

characterising each GWB; iii) highlight the necessity and usefulness of large chemical database for an appropriate delineation of GWBs.