

Editorial

Groundwater Quality in the Mediterranean Region

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In recent decades, the percentage increase in water use on a global scale has exceeded twice that of population growth. This has led to more, and larger, regions in the world being subject to water stress where the current restricted rates of water use and consumption, let alone the desired rates, are unsustainable [1, 2]. In the Mediterranean area, water availability is a main economic and social target for most countries since most of them share several features including, for instance, similar water and land resources, agricultural development, demographic pressure coupled with tourism increase and, last but not least, a climate change evolving toward semiarid to arid conditions [3–5]. This precious resource, widely exploited, is not distributed, at a regional level and within each country, in a homogeneous fashion. The increase in groundwater exploitation poses a severe risk for the availability of water resources, and the resulting resource scarcity is a major concern in most countries of the Mediterranean region. Groundwater paucity often occurs in combination with poor groundwater quality, not only in areas heavily conditioned by human activities [6] or in the often highly saline coastal aquifers [7–9] but also in zones characterized by geogenic contamination sources. In such areas, although human pressure is absent, water-rock interaction processes, as those promoting, for instance, geogenic

Cr(VI) water contamination [10], may cause pollution with critical effects on the public health.

More in detail, overuse of fertilizers and pesticides in agriculture, overexploitation of groundwater causing sea water intrusion, increases in the discharge of untreated or poorly treated domestic and industrial water, injection of brine and hydrocarbon by-products from oil production, and refinery operation into aquifers, and naturally occurring contaminants are among the principal causes of groundwater pollution. Thus, in the last two decades, many Mediterranean countries planned policies devoted to the assessment of the groundwater quality and trends [11, 12]. This special issue is aimed at delivering contributions presenting a wide range of aspects related to groundwater quality in the Mediterranean countries such as contaminants' input and origin, salinization effects, and protection and remediation approaches. Within this frame, we encouraged submissions of paper dealing with a wide range of groundwater-related topics including the following:

- (i) Elemental and isotope hydrogeochemistry
- (ii) Hydrology and hydrogeology
- (iii) Groundwater geophysics

- (iv) Groundwater modeling
- (v) Groundwater contamination and toxicology
- (vi) Groundwater protection and remediation
- (vii) Water resources management

From March 2018 to November 2018, a total of 14 papers have been submitted to be considered for publication in the special issue. After rigorous editorial check and peer-review processes which involved external and independent experts, 4 manuscripts were rejected, 2 have been withdrawn, and 8 papers have been accepted, with an acceptance rate of 57%. Twenty-four authors from Mediterranean European countries and northern Africa contributed to the special issue. In the following paragraphs, a short presentation of each is given.

In the article titled “Inferred Industrial and Agricultural Activities Impact on Groundwater Quality of Skhira Coastal Phreatic Aquifer in Southeast of Tunisia (Mediterranean Region),” S. Melki et al., using a geochemical approach coupled with statistical procedures through principal component analysis, assessed the processes affecting water quality and showed that the industrial activities, especially those related to phosphate treatment in an area close to a phosphogypsum storage site, may seriously influence a part of the aquifer where the water is acidic and very charged in SO_4^{2-} , H_2PO_4^- , F^- , and Zn^{2+} . As for nitrates, their distribution is controlled, in addition to the excessive use of fertilizers, by physical and chemical factors. Overall, most analysed samples do not meet the World Health Organization Norms and therefore are not suitable as drinking waters, and the study sheds light on the increasing deterioration risk of the aquifer suggesting the need for urgent solutions by decision makers.

In the article titled “A Modelling Approach for Assessing the Hydrogeological Equilibrium of the Karst, Coastal Aquifer of the Salento Peninsula (Southeastern Italy): Evaluating the Effects of a MAR Facility for Wastewater Reuse,” G. De Filippis et al. focused on the characterization of the deep aquifer of the Adriatic portion of the Salento peninsula from a quantitative point of view by means of modelling tools for the simulation of groundwater dynamics. The implementation of a density-dependent flow model, the lateral extent of such phenomenon, and the vertical depth of the transition zone between freshwater and saltwater were inferred, highlighting also the role of major faults which characterize the hydraulic behaviour of the karst system. The model was also applied to design a Managed Aquifer Recharge (MAR) facility for the management and protection of the hydrogeological equilibrium of the deep aquifer. Model results allowed also identifying areas where the lack of data prevents a proper comprehension of the hydrogeological processes investigated, thus representing supporting tools for planning further monitoring campaigns.

In the article titled “Hydrogeology and Hydrogeochemistry of the Lauria Mountains Northern Sector Groundwater Resources (Basilicata, Italy),” F. Canora et al. presented the hydrogeological characterization of a carbonate hydrostruc-

ture in the southern Apennines, in an area including springs having high annual mean discharges. The results elucidate that the main hydrogeochemical processes controlling the chemical content of the groundwater composition are strongly affected by the lithology, especially limestones and dolomitic limestones. The analysis, in all studied groundwater samples, shows that facies groundwater type is Ca-HCO₃; bicarbonate is the dominant anion, and calcium is the dominant cation with appreciable magnesium contents. Further, $\delta^{18}\text{O}$ and δD signatures for the groundwater of the major springs allow identifying the recharge area of these occurrences at elevations ranging from 900 m to 1000 m (a.s.l.), pointing out the presence of deeper flow regime feeding of these springs. The groundwater isotopic feature record suggests that most of the groundwater recharged directly by infiltration in high permeable media.

In the article titled “Geochemical Modeling of Water-Rock Interaction in the Granulite Rocks of Lower Crust in the Serre Massif (Southern Calabria, Italy),” C. Apollaro highlighted the irreversible water-rock mass exchanges occurring in a shallow hydrogeological metamorphic complex through a reaction path modelling in a kinetic mode. The secondary solid phases that were allowed to precipitate are kaolinite, vermiculite solid mixture, and hydroxide solid mixture. The reaction path modelling shows that the release of major dissolved constituents is mainly controlled by plagioclase weathering. Computed contents of key dissolved components are comparable with analytical data, although not all the details are reproduced, probably due to insertion in the model of average composition of primary minerals, in spite of their nonnegligible chemical variations and to the fact that some elements, such as Na and K, are controlled by varying contributions of atmospheric marine salts. Due to the worldwide occurrence of granulite rocks, the results can be transferred to other sites where the lithology occurs.

In the article titled “Groundwater Quality Assessment in a Karst Coastal Region of the West Aurunci Mountains (Central Italy),” G. Sappa et al. presented the groundwater quality assessment in the karst coastal region of the West Aurunci Mountains (central Italy). A large chemical dataset of springs and well water, collected from 2016 to 2018, is discussed in order to unroof the processes controlling the groundwater hydrogeochemical evolution. The groundwater is mostly characterized by a Ca-HCO₃ facies, indicating its evolution is mainly controlled by the carbonate mineral dissolution/precipitation. Well water samples show, over the time, an increasing mineralization compared to spring water, and their Ca^{2+} , Na^+ , and Cl^- enrichment is mainly due to the dissolution of calcite, dolomite, and halite and subordinately to a probable ion exchange related to seawater intrusion. Results suggest that carbonate weathering, ion exchange, and seawater intrusion in this karst coastal region are the major factors controlling groundwater geochemistry.

In the article titled “Boron Isotopes in the Mount Vulture Groundwaters (Southern Italy): Constraints for the Assessment of Natural and Anthropogenic Contaminant Sources,” M. Paternoster discussed the application of boron contents and isotopes (¹¹B) as tools for assessing water quality in one

of the most significant aquifer systems of Southern Italy. In the area, two different hydrofacies are observed. The first one (BAW) has bicarbonate alkaline and alkaline-earth composition whereas the second one (HSW) has bicarbonate-sulphate alkaline composition. The HSW is enriched in boron and has low $\delta^{11}\text{B}$ values similar to those measured in the local magmas suggesting B contents in these waters are affected by the interaction with volcanic rocks. As to BAW, a wide variability in B concentrations and B isotope composition is observed, likely due to anthropogenic input. Water samples with high B concentrations and negative $\delta^{11}\text{B}$ values are probably influenced by agricultural activities; for water samples characterized by positive $\delta^{11}\text{B}$ values and low B contents, a slight contamination by sewage effluents cannot be excluded. This study highlights the relevance of B isotopes coupled with the B/Cl ratio as a tool for the assessment of natural and anthropogenic contaminant sources.

In the article titled “Deep Electrical Resistivity Tomography for the Hydrogeological Setting of Muro Lucano Mounts Aquifer (Basilicata, Southern Italy),” E. Rizzo et al. presented the application of a deep geoelectrical survey to a carbonate aquifer in order to define the best location for exploitation well drilling for increasing water supply. The work summarizes the hydrogeological knowledge at west of the Basilicata Region (Southern Italy). The investigated area is characterized by the presence of a karst aquifer which is made up by a carbonate ridge that tectonically dips southward. The assessment of the complex hydrogeological framework of the area was detailed by the use of a new multichannel deep geoelectrical technique (DERT). The proposed technique was able to successfully locate a less-resistive zone connected to more fractured limestone resulting suitable for the localization of a groundwater exploitation well.

In the article titled “Groundwater Quality on the Adriatic Karst Island of Mljet (Croatia) and Its Implications on Water Supply,” S. Borović et al. focused on the peculiar source of water supply in the Island of Mljet, Croatia: desalination of water from brackish lakes is fed by groundwater and connected to the sea by karst conduits. All waters sampled from the lakes are of Na-Cl type. Daily monitoring of total dissolved solids in the feed water was recently introduced: maximum concentrations were observed during September and interpreted to be caused by a combination of natural and anthropogenic pressures during the summer tourist season. According to the presented data on groundwater quality, climate change predictions, the connection of water supply system to the mainland, and problems with the effluent treatment, the main future issue will be the creation of an island-wide sustainable water management plan followed by continuous monitoring and research, in a global scenario where water supply of the islands is a relevant challenge.

Conflicts of Interest

The guest editors declare that they have no conflicts of interest or private agreements with companies.

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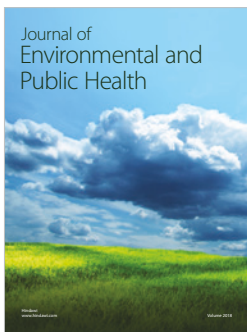
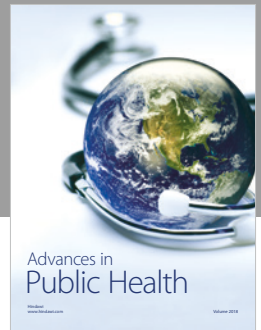
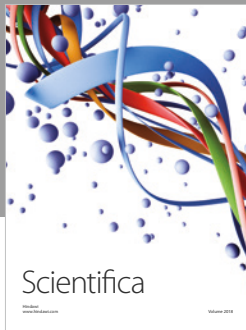
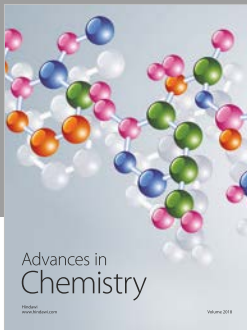
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