Assessing Natural vs Anthropogenic Origins of Water Resource Degradation in Coastal Regions Using Environmental Isotopes

A case study under **IAEA TC Project RER7013** – Evaluating Groundwater Resources and Groundwater – Surface Water Interactions in the Context of Adapting to Climate Change

Bulgaria, Cyprus, Georgia, Montenegro, Portugal, Russian Federation and Türkiye

Case Study Focus

Degradation of major aquifers and vulnerability of water resources systems in seven coastal countries

The opportunity

Freshwater availability is under increasing pressure due to human activities, including unsustainable water abstraction and contaminating activities, such as the use of fertilizer and livestock production. These activities threaten water resources for both drinking and irrigation.

Groundwater systems constitute an important and sometimes unique source of drinking water supply in many parts of the world, but they can be threatened by pollution from the surface and upper aquifer. In coastal regions, groundwater resources are often vulnerable to seawater intrusion. The rapidly increasing demand for good water quality intensifies salinization processes and limits the further exploitation of coastal water resources. Salinization can be related to both seawater intrusion and water–rock interaction mechanisms. Furthermore, the expansion of agricultural areas and the excessive use of fertilizers also lead to groundwater salinization, thereby increasing the pressure on water resources.

The proposal

The origin of groundwater salinization in coastal regions has been investigated using a variety of different approaches, from physical-geochemical data and environmental isotopes to traditional hydrogeological tools and statistical approaches. One of the main goals of this case study is to identify: (i) the key mechanisms responsible for groundwater salinization and the main sources of nitrate pollution; and (ii) the main pollutant sources responsible for increasing nitrate contamination levels.

Combining measurements of tritium and carbon-14 with hydrochemical parameters can be used for a better understanding of: (i) seawater and groundwater mixing patterns; (ii) recent seawater intrusion; (iii) the legacy of groundwater salinization and (iv) the contribution of natural and anthropogenic sources to groundwater salinization.

Natural processes of water-rock interaction are the main mechanisms responsible for water mineralization,

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although this trend can be disturbed by anthropogenic activities. Groundwater recharge results from the direct infiltration of precipitation, or in some cases, from the infiltration of surface waters (rivers and lakes). Thus, groundwater samples reflect the mean isotopic composition of regional precipitation. To investigate this, the establishment of four Global Network of Isotopes in Precipitation (GNIP) stations is planned.

In groundwater salinization studies, it is common to examine groundwater evolution along the flow path. For example, the stable isotope values of the water may remain the same, while the water salinity may increase as a consequence of mineral dissolution. A different trend is observed when seawater intrusion occurs, with isotopic composition and mineralization being increased in parallel. Based upon this difference, the main hydro-chemical processes can be identified through the analysis of isotopic and geochemical data.

In addition to stable isotopes, tritium will be used as a global transient tracer to study the dynamics of the hydrological cycle and as a qualitative tracer in the identification of active recharge and mixing between different hydrogeological units.

Country	Location
Bulgaria	Sarmatian Aquifer (Shabla region)
Cyprus	Kiti-Pervolia Aquifer
Georgia	Kintrishi and Dekhva river basins
Montenegro	Risanska Spila Aquifer (Gulf of Risan region)
Portugal	Algarve Basin (Quarteira-Faro area)
Russian Federation	Middle Paleogene Aquifer (Sambia Peninsula of the South-Eastern Baltic)
Türkiye	Küçükçekmece Basin (Küçükçekmece Lagoon)

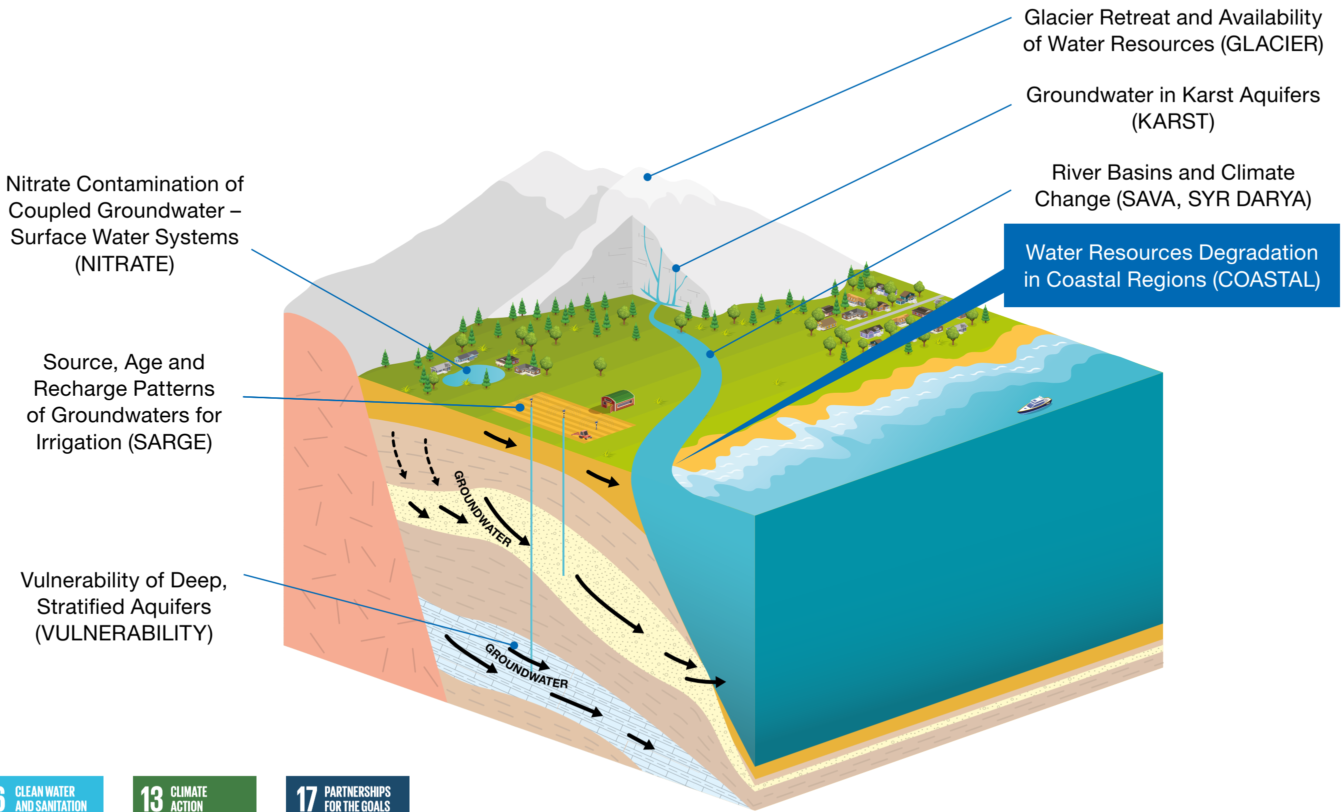
Overview of site names included in the case study.

The benefits

Seven countries from the European Atlantic Coast to the Black Sea region are involved in this research project. These countries have different water resource systems, varying from superficial water systems to groundwater bodies. Moreover, the study areas are very heterogeneous in terms of geographic location, geology and climate, which is useful for understanding and comparing the isotopic and chemical data.

Nuclear techniques provide a faster and easier way to determine the isotopic composition of nitrate in water. In coastal aquifers this can significantly improve the understanding of coastal marine environments where nitrogen pollution can lead to eutrophication.

This knowledge is essential for the management of coastal aquifers. It supports the identification of preventive measures that contribute to a good understanding of the quantitative and qualitative status of coastal groundwater resources.



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