Environmental Tracers for the Assessment of Nitrate Contamination of Coupled Groundwater – Surface Water System

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

Czech Republic, Georgia, Poland, Romania, Russia, Ukraine

Case Study Focus

Understanding the key factors behind nitrate contamination of surface and groundwaters

The opportunity

Nitrate (NO_3) has emerged as a widespread and highly discussed groundwater contaminant across Europe, while drinking water sources exceeding permissible limits of nitrate concentrations are a frequently reported and alarming phenomenon. Intensified agricultural practices and fertilizer applications, along with other anthropogenic activities, are assumed to be the primary sources that have produced these high accumulations of nitrate in surface and groundwater reservoirs.

Sampling for the Nitrate Case Study in the Czech Republic (Photo: T. Meador).

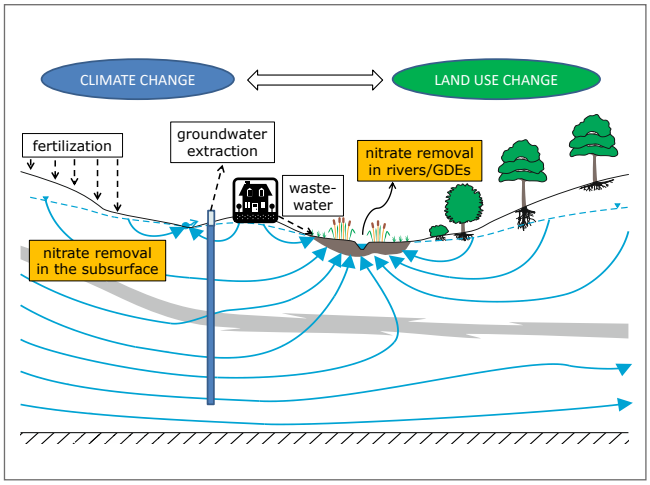

Figure 1 Schematic presentation of sources and pathways of nitrate contamination through the soil-groundwater-surface water continuum (Source: T. Meador)

Nitrate contamination of in-land waters presents a health risk to humans, especially newborns and infants, and disturbs the balance of nutrient storage and fluxes throughout soil and aquatic ecosystems. Increased nitrate concentrations can have adverse effects on various ecosystems—such as algal blooms and eutrophication—thereby creating uninhabitable conditions, causing the rapid collapse of food webs and resulting in the severe loss of ecosystem functions. The prolonged consequences remain unknown, due to large pools of nitrogen stored in soil and groundwater.

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Drivers and timescales of nitrate pollution therefore need to be determined to inform policymakers, stakeholders and the general public, allowing evidence-based measures to be implemented to reduce, or eliminate, the potential hazards.

Both the comprehensive risk assessment and efficient management of nitrate contamination require a thorough understanding of the sources, pathways and transformations of nitrate in various water bodies and associated ecosystems. The quantification of water travel-times through the unsaturated and saturated zones, achievable with the help of environmental tracers, is a crucial factor in assessing the vulnerability of water resources.

The proposal

One primary indicator of sources, fate, and cycling of nitrate in natural systems is its dual stable nitrogen and oxygen isotopic composition. By determining the spatial and temporal coupling of hydrogeological conditions, chemical profiles, and isotopic composition of nitrate, this case-study aims to identify the key factors that govern nitrate inputs, cycling as well as denitrification processes. The case study will investigate eleven affected areas in six countries, including transboundary coastal zones, aquifers and watersheds.

This study aims to identify the role of surface and groundwater processes in their contribution to the nitrogen cycle, the variability and timescale of nitrate fluxes in the affected areas, as well as to provide a scientific basis for the mitigation of nitrate pollution.

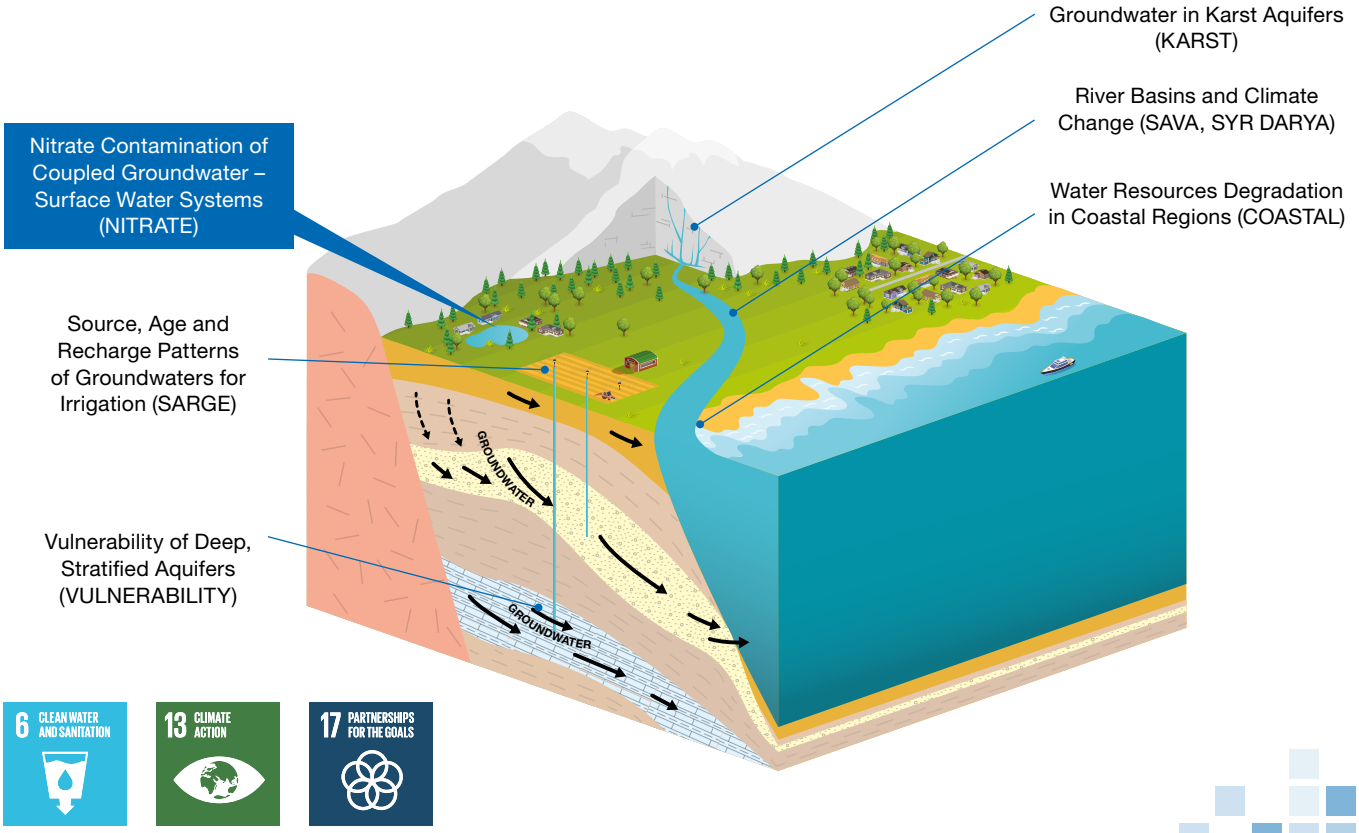
Therefore, this project will inform decision-makers and stakeholders on the most important factors controlling nitrate pollution, leading to recommendations for land-use and water-treatment practices that would help reduce contaminations.

Country	Location
Czech Republic	Plešné lake
Georgia	Rioni River
Poland	Kocinka
Poland/Russian Federation	Mamonovka basin
Romania	Apuseni Mountains
Ukraine	Desna River basin

The participants will first conduct site-screening to develop a conceptual model for each site. Then, relevant samples for nitrate isotope analyses will be selected and measured during coordinated training exercises, which simultaneously aim to disseminate expertise in isotope methodologies. Finally, the analytical results will be interpreted for the different study sites.

The benefits

This case study will improve knowledge of the sources and timescales of nitrate contamination in groundwater and river catchments. By identifying the inputs and transformations of nitrate in these areas, the results are expected to elucidate and understand natural processes and inform best management practices to effectively protect these vulnerable water resources.



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