Factsheet: Groundwater

What is Groundwater?

Groundwater is water found beneath the Earth's surface within the pores and fractures of soil, sand, and rock formations. This water accumulates in a saturated zone, where all available void spaces are filled with water; the upper boundary of this zone is known as the water table. Above the water table there is an unsaturated zone partly filled with water until the surface. Groundwater may be found at shallow depths or even above the surface (groundwater flooding) to depths of several kilometers, where it is usually more saturated with minerals (mineral waters/saline waters).

Contrary to common belief, groundwater does not typically flow in underground rivers but rather moves slowly, from few mm/year to several m/day, through these interconnected spaces, much like water saturating a sponge. Formations that can yield usable quantities of groundwater are called aquifers, which are essential for supplying wells and springs. Groundwater is a vital component of the Earth's hydrological cycle, replenished primarily by precipitation infiltrating into the ground[1–5]. Groundwater constitutes the world's largest accessible freshwater resource.

When the invisible becomes visible: groundwater plays a vital role in sustaining the lakes in the karst system of Plitvice Lakes National Park in Croatia.

Why is it important?

Groundwater is a hidden but critical resource that profoundly impacts our economy, environment, and society. Stored in aquifers beneath the Earth's surface, it. serves as a reliable source of water for many needs including society and industry. Having natural protection of overlying subsoil, it is usually of good quality, which makes it an important source for drinking water. It is the only natural resource that is renewable. It also serves an important environmental role in sustaining wetlands and river flows.

Groundwater is crucial for global economic stability, serving as a reliable source for **drinking water**, **agriculture**, and **industry**. Its role extends to providing a source for **geothermal energy**[4,6,7]

Groundwater **sustains various dependent ecosystems**, such as wetlands, rivers, forests, and even coastal waters which are vital for **maintaining biodiversity** and **ecological health**

Though groundwater is technically renewable, its **extremely slow recharge rate** makes it highly vulnerable to over-extraction and pollution

Groundwater and Society

How is Groundwater relevant to policy?

Groundwater is a vital resource, making its protection and management a high policy priority. Policies are in place in Europe to address key issues of quality and quantity to ensure the long-term sustainability of this hidden resource[8]. The EU's approach to groundwater is primarily governed by the Water Framework Directive[9,10] and the Groundwater Directive[8,10]. Recently, the European Commission adopted the European Water Resilience Strategy that recognises the essential role of groundwater for European water resilience[11]. The policy relevance stems from several critical factors:

- Two-thirds of Europe's drinking water comes from aquifers. Ensuring its quality is a matter of public health. The growing competition for this finite resource among agricultural, industrial, and municipal users highlights the need for a balanced approach to sustainable development.
- Groundwater is highly vulnerable to pollution from chemicals used in farming and industry, including mining. Once contaminated, it is extremely difficult and costly to clean. Excessive use can also lead to depleted aquifers and even land subsidence.
- Groundwater sustains many of our rivers, lakes, and wetlands. These ecosystems, and the wildlife they support, rely on a continuous and often invisible flow that can also emerge through springs, from a few litres to thousands of litres per second.
- Due to slow recharge, our actions today will impact groundwater availability for decades. The EU's focus on sustainable management is crucial for guaranteeing a secure water future.

Store Blåkilde ("Big blue spring"), where groundwater emerges from small limestone cracks to form a unique ecosystem in Himmerland, Denmark.

The role of EuroGeoSurveys

EuroGeoSurveys plays a key role in the sustainable management and protection of Europe's groundwater, through the Water Resources Expert Group (WREG) and the Geological Service for Europe (GSEU) project, building on initiatives such as GeoERA, a research programme that advanced the European Geological Data Infrastructure (EGDI), particularly for groundwater. EuroGeoSurveys harmonises data collection across Europe to enable consistent monitoring and forecasting groundwater levels and quality, providing a unified perspective that is vital for policymakers[12].

Beyond data collection, EuroGeoSurveys conducts research on the impacts of climate change and human activities on groundwater. This expertise supports the European Commission, particularly the development of effective management strategies. By improving understanding of these complex systems, the Geological Surveys help prevent pollution and over-extraction, protecting a resource that is difficult and costly to restore.

Towards long-term impact

Most activities within the green transition involve freshwater[13], and hence will increasingly affect freshwater quantity and quality, drinking water, and ecosystems in the future. Establishing a permanent **Geological Service for Europe**, with open access to groundwater data through EGDI, would strengthen ongoing efforts through improved real-time data[12] and forecasting to manage challenges such as droughts.

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