WE-NEED

WatEr NEEDs, availability, quality and sustainability

Groundwater (GW) is a major source of water supply in Europe. This natural resource is endangered by several factors, such as improper water management policies, including over-exploitation, and contamination by anthropogenic activities. Ignoring the profound consequences of GW depletion and quality deterioration is the foundation on which unsustainable water policies are built. The goal of this project is to develop new management strategies to assist in the sustainable use of two key components of the GW resource: pumping wells, used to obtain water for drinking purposes, and natural springs, typically employed for crop irrigation as well as for recreational use. We ground our activities on observations linked to two field sites in Italy. These sites are archetypal of two distinct realities and can be considered representative of diverse environmental settings and conditions of Europe-wide interest. As such, key features of our approach and techniques are resilience and adaptability, so that the approach can be readily adapted and employed in other European aquifer systems. We will (i) build conceptual models to describe groundwater system functioning under the influence of uncertain parameters and processes defined at diverse spatial-temporal scales; (ii) characterize the fate of emerging contaminants (ECs) such as pharmaceuticals, personal care products and engineered nanomaterials, as well as agricultural and industrial chemicals, in aquifers and the way they may threaten the quality of GW; and (iii) quantify the effect of multiple sources of uncertainty on sustainable management and protection of groundwater, here including hydrogeological settings, well abstraction rates, sources of contamination, anthropogenic actions, EC loads, natural attenuation processes, spatial and temporal distribution of redox conditions and ecotoxicological concerns. Because geological media are heterogeneous and exhibit spatial variations on many scales, prediction of subsurface flow and transport are formidable challenges. These tasks can only be rigorously tackled within a probabilistic framework. We apply and extend a recently developed scaling framework able to explain a wide range of observations about the way main statistics and probability distributions of environmental variables change with (space-time) scale. We adopt a Probabilistic Risk Assessment (PRA) approach aimed at increasing confidence in decision making through quantification of risk. Our approach to PRA involves considering information of various origins and synthesizing them in a descriptive and simplified set of indicators, easily transferable to decision makers. Casting the work in a Bayesian framework will enable updating risk indices by conditioning on data obtained in the experimentallyoriented parts of the project. Risk analysis will be based on assessing exposure of a given organism to concentrations of ECs, combined with ecotoxicological studies, as well as consideration of social implications. Ecotoxicity tools (bioassays) will allow quantitative assessment of potential deleterious effects to the environment of the ECs that may be present in the system. Relevant and application-oriented pilot scenarios jointly identified with the stakeholders involved in the project will be analyzed. This will lead to (i) assessment of the contaminant-specific vulnerability of the aquifer systems, and (ii) improved, physically-based risk assessment and water management protocols. As such, PRA provides an umbrella under which knowledge of diverse nature can be blended so that a comprehensive decision can be taken by properly considering risk (Decision Making Under Risk). As a concrete and applicable product, we will provide a decision-making procedure and associated decision matrix for the sustainable use and management of groundwater for civil, agricultural and industrial activities and ecosystem preservation in the pilot scenarios.