ENGLISH

Topic/Title

Analysis of the response of the karst aquifers of the Southern Apennines to climate variations, from the seasonal to multi-year scales

Proposer (Tutor)

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Research proposal

The karst aquifers of southern Italy represent the main supply for regional aqueduct systems as well as they maintain the fluvial ecosystems connected to them. The favourable hydrogeological conditions, such as the high permeability due to fracturing and karst and the high preciptitation across the Apennine Chain, make these aquifers very productive and of fundamental and irreplaceable importance for the supply and social and economic development of the large urban areas of Campania, Basilicata and Puglia regions. In this framework, the effects of climate change, which are currently shown by the progressive trend to air temperature rise and the increasingly occurrence of winters with low rainfall, is causing periods of low groundwater recharge and lower flow to tapped springs. These conditions appear, year by year, to be increasingly severe, risking compromising the supply of the main aqueduct systems.

Despite the considerable progresses in the knowledge of the hydrogeological characteristics of the southern Apennines, testified by the high number of scientific publications and designs for the construction of tapping works, the aforementioned effects of climate change are currently little known, especially in southern Italy, both in terms of scientific research and, subsequently, in terms of

both forecasting possibilities and the adoption of mitigation measures by the managing bodies.

In this framework, which appears particularly critical also due to the lack of awareness of this type of effect of climate change, whose consequences would have a high social and economic impact, the research program of the doctorate aims to lay the scientific foundations for the construction of forecasting models for the response of large karst aquifers to periods of lower rainfall, from the seasonal to the multi-year scales, with specific reference to the effects on the regime of the springs flow rates and water table levels.

The scientific and technical questions to which the program aims to give answers are (for example): 1) Observing the rainfall of the winter season, what will be the spring flow rates available at the end of summer-beginning of autumn? 2) What are the effects of the occurrence of several consecutive drought winters on spring flows? The reconstruction of forecasting models capable of giving answers to these questions are of fundamental relevance to prevent periods of water crisis, therefore also to mitigate the effects by drawing on supplementary water resources.

The basis of the research program is the conceptual model that large karst aquifers can be assimilated to in-series tanks, characterized by dynamics of recharge and simultaneous emptying. These very complex inflow-outflow relationships can be analyzed by empirical approaches, built on physically based numerical models and by models based on Artificial Intelligence.

The PhD activities will be focused on the collection and systemization of time series of spring flow rates, already monitored by managing bodies, on the collection of time series of precipitation and air temperature (detected by terrestrial monitoring networks and by satellite platforms), on the implementation of inflow-outflow models: empirical, numerical physically based (in-series

reservoirs and finite element models such as MODFLOW) and based on Artificial Intelligence (e.g. *machine learning*).

The PhD research program is grafted onto the long-term research activity of a group of DiSTAR researchers, of which the project proponent is a member. Among the activities of particular relevance and impact for the PhD project are those carried out within the framework of agreements stipulated with important managing bodies (GORI S.p.A.) for the study of the recharge of the large karst aquifers of Campania. Therefore, they will make use of all the databases and experimental installations already put in place as part of the aforementioned activities, as well as others to be carried out on purpose.

Research Plan

I° year

- Analysis and synthesis of the bibliographic knowledge on the karst aquifers of southern Italy.
- Identification of representative karst aquifers based on the availability of time series of spring flows.
- Collection and systematization of time series of spring flows, piezometric levels, precipitation and air temperature from terrestrial and satellite detection networks.
- Identification of sources whose collection works are prepared for the installation of sensors for monitoring flow rates.
- Installation of level sensors in the context of collection structures.

II° year

- Reconstruction of inflow-outflow models on an empirical basis.
- Definition of the supply basin of representative sources, reconstruction of physically based inflow-outflow numerical models (MODFLOW) .
- Reconstruction of inflow-outflow models based on Artificial Intelligence algorithms.

III° year

- Application to inflow-outflow models of climate change scenarios at different time scales, from seasonal to multi-year (Regional Climate Models), and evaluation of the effects.
- Visiting period in a research institute abroad for the development and application of models.
- Writing the Phd thesis.
- Scientific publications and participation in conferences.