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Modelling and forecasting of water resources availability in mountainous Mediterranean springs

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The amount of water available for the production of natural mineral water is affected by the variability of the flow regime in the springs from which the water is extracted. This variability occurs at different time scales (seasonal and inter-annual), being more pronounced in mountainous Mediterranean areas. Since water quality remains constant in the aquifers throughout the hydrological year, the main uncertainty in the plant's production lies in the springs flow regime. In snow dominated areas it is necessary to analyse both the influence of snow dynamics on the springs flow regime, and to establish the response time between the rainfall events and the increase in the subsurface flow regime.

A forecasting model has been developed for several springs within the Guadalfeo river basin (southern Spain), where a bottling plant is operated by an international company. The model combines two approaches: a conceptual model (MCAL); and a seasonal forecast model (MPEL).

MCAL is based on linear adjustments between measured monthly mean flow data at the different locations of the springs, and measured series of rainfall and snowfall from two meteorological stations in the area, as well as adjustments with the mean monthly flow in the antecedent months. The best results were obtained between mean monthly flow and the mean monthly flow of antecedent months, with low relative errors (0,2%-10%) in all the locations for twelve months ahead.

MPEL allows to forecast groundwater supplies six months ahead in the different locations, from two products generated by the European Centre for Medium-Range Weather Forecasts (ECMWF): Multi-model seasonal reforecasts of river discharge for Europe and Multi-model seasonal forecasts of river discharge for Europe from January 2021 to present. The hydrological model WiMMed (Watershed Integrated Model in Mediterranean Areas) has been implemented and calibrated, to generate historical simulations in periods when there are no flow measurements at the springs. Using the ECMWF products and performing a bias-adjustment, the forecasts of the groundwater supplies are obtained for several possible future scenarios.

The results obtained showed the lowest mean relative error values with the MCAL forecasts from May to October (0.8%-8%), whereas the mean monthly flow from November to January was better predicted with the MPEL forecasts (1.3%-12%). The relative errors were similar with both models between February and April (3%-20%).