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Cutting-edge tools for spring monitoring and groundwater system characterization in mountain environments

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Mountain aquifers represent one of the largest and most valuable water sources, necessary to meet the population's water needs. Over time, they have been threatened by huge anthropogenic exploitation activities, which are currently leading to the depletion of aquifers in many regions worldwide. Furthermore, the vulnerability of groundwater resources is rapidly increasing due to climate change, urbanization, massive industry production, intensive agriculture, and breeding.

Knowledge and forecasting about groundwater flow systems are required to guarantee proper management and territorial planning strategies, according to the mountain environmental evolution taking place. Besides, examining how groundwater storage mechanisms in different regions have changed in response to both climate-driven and anthropogenic effects is becoming increasingly crucial.

In remote alpine areas, continuous monitoring and data collection of springs' hydrogeological parameters is still often hampered by technical and logistical problems. In these contexts, new automated techniques and tools need to be applied to monitor springs' hydrogeological parameters, punctually understanding the dynamics of exhausting of the available groundwater resources.

The instrumentation and sensors complex, installed in correspondence with the Mascognaz spring basin (Aosta Valley, Italy) allows detailed analyses of the surface and underground groundwater system, recording continuously hydrogeological variables entering and leaving the spring recharge system. A cutting-edge weather station was here combined with a spring monitoring system through snowpack-hydrometeorological sensors installation. This setup, composed of a snow scale, ultrasonic and laser sensors for snow weight and snow depth reading, provides the possibility of a detailed study of the snow layer evolution during each season. Besides, a multiparametric probe allows water discharge, temperature and electric conductivity values detection.

The high quality of the data provided and the small-size basin features have permitted highlighting the variables affecting the system and standing out those are evolving in time. Besides, the relationship between changes in weather conditions and water availability can be defined by performing correlations between different hydrogeological and meteorological available data

series.

The Mascognaz spring's pilot site could be helpful as an example for other researchers and authorities who need to identify suitable instruments, sensors and methods to reconstruct the groundwater flow system and hydrogeological structure of a mountain basin.