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Original
Exploring spring behaviour in the Aosta Valley (Italy): integrated harmonic and isotopic analyses for hydrogeological assessment / Gizzi, M., Biamino, L., Bianco, F., Taddia, G.. - ELETTRONICO. - (2025), pp. 773-773. (Congresso SGI-SIMP 2025 Padova (Ita) 16-18 Settembre 2025) [10.3301/absgi.2025.03].

Availability:
This version is available at: 11583/3003128 since: 2025-09-18T10:00:44Z

Publisher:
Società Geologica Italiana ETS

Published
DOI:10.3301/absgi.2025.03

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11 November 2026

Exploring spring behaviour in the Aosta Valley (Italy): integrated harmonic and isotopic analyses for hydrogeological assessment

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Keywords: alpine hydrogeology, mountain springs, isotopic analysis.

Mountain springs represent a vital component of the drinking water supply system in northern Italy, playing an essential role in meeting the needs of local communities. In recent decades, however, numerous hydrogeological challenges have emerged across the Italian Alps and Apennines, including diminished spring flow and the transformation of perennial springs into seasonal ones. Gaining insight into the recharge processes of these springs is critical for informed and sustainable water resource management.

Since 2010, the Applied Geology Research Group at the Politecnico di Torino has been conducting detailed monitoring activities in the Aosta Valley Region (northwestern Italy) (Gizzi et al., 2022). This work involves the use of multiparameter sensors in several springs—Promise, Entrebin, Gabiet, and Promiod—each situated in distinct mountain catchments. These sensors collect hourly data on water level, temperature, and electrical conductivity. Meteorological data, including precipitation and air temperature, are also gathered from nearby weather stations. To investigate recharge dynamics, hydrograph signals were analysed using Fast Fourier Transform (FFT), which enabled the decomposition of time-series data to identify correlations between discharge patterns, temperature changes, and precipitation events. Isotopic analyses (based on the V-SMOW2 standards) further contributed to the understanding of groundwater recharge origins, employing $\delta^{18}O$ and $\delta^{2}H$ isotopes to estimate the altitudes at which rain and snow infiltrate.

By combining these investigative approaches, the study has provided a more comprehensive view of spring recharge processes. Furthermore, the findings reveal how climatic fluctuations in mountainous regions influence spring discharge, offering valuable information for the development of sustainable management strategies for alpine water resources.

Gizzi M. et al. (2022) - Aosta valley mountain springs: a preliminary analysis for understanding variations in water resource availability under climate change. Water, 14(7), 1004, https://doi.org/10.3390/w14071004.