From snowpack to runoff: setting up an integrated monitoring scheme for water balance assessment in a glacierised Alpine basin

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High-altitude Alpine basins are controlled by snowpack, glacier melt, and liquid precipitation, which regulate the timing and magnitude of downstream water inputs. Climate change is shifting precipitation from snow to rain, altering snowmelt dynamics and glacier mass balance, and consequently modifying runoff seasonality and water storage.

This study investigates a small glacierised catchment (8.5 km^2; 2600–3300 m a.s.l.) in the Ortles-Cevedale Group (Italian Alps), including the Careser Glacier (0.665 km^2 in 2022) and a regulated reservoir used for hydropower production. The aim is to quantify water balance components using an integrated approach combining field measurements, isotopic analyses, and remote sensing.

An integrated monitoring network supports the study, including automatic weather stations for reconstructing climatic forcing and hydrological measurements at the catchment outlet (Careser Baia), where water level is recorded using a pressure sensor. Discharge is estimated from velocity measurements and rating curve development. Additional datasets include daily discharge (capturing flood events), reservoir volumes and snow depth and density measurements provided by the hydropower operator.

In parallel, a dedicated snow monitoring dataset was developed within this study. Snow water equivalent (SWE) is estimated from snow depth and density measurements collected along a transect of 10 sampling points selected based on elevation, slope and aspect. Snow depth (HS) and sampling for stable isotope analysis ($\delta^{18}O$, $\delta^{2}H$) are performed every ~15 days. Satellite data are used to derive snow cover area (SCA), which is combined with interpolated field measurements to estimate catchment-scale snow water storage.

Preliminary results show a seasonal increase in snow density from approximately 200–250 kg m^{-3} (early February) to 300–350 kg m^{-3} (late April). During the 2025–2026 winter season, snow depth ranged between ~1.2 and 1.7 m (2600–3100 m a.s.l.), corresponding to SWE values of about 0.45 m w.e., indicating limited accumulation compared to typical conditions. Consistently, no liquid discharge was observed between November and mid-March during the current season, with flow resuming at the onset of melt. During the previous summer, discharge at Careser Baia reached maximum values of 0.5 m^3 s^{-1}.

A distributed modelling framework (e.g. Alpine3D) will be implemented in future work to integrate the collected datasets and further investigate melt processes and runoff generation.

This monitoring framework provides a robust basis for quantifying water balance components in glacierised Alpine basins and for assessing climate change impacts on water availability and management.

Commentato [CC1]: deve venir fuori che non sono quelle che prendi tu. Ho provato a renderlo con l'aggiunta sotto.