ABSTRACT

Gravimetry as a groundwater monitoring solution:
combining hydrological and gravimetric measurements to understand a pre-alpine alluvial aquifer

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RADMOGG Resilience and Dynamics of Mountain Groundwater using Gravimetry

Introduction

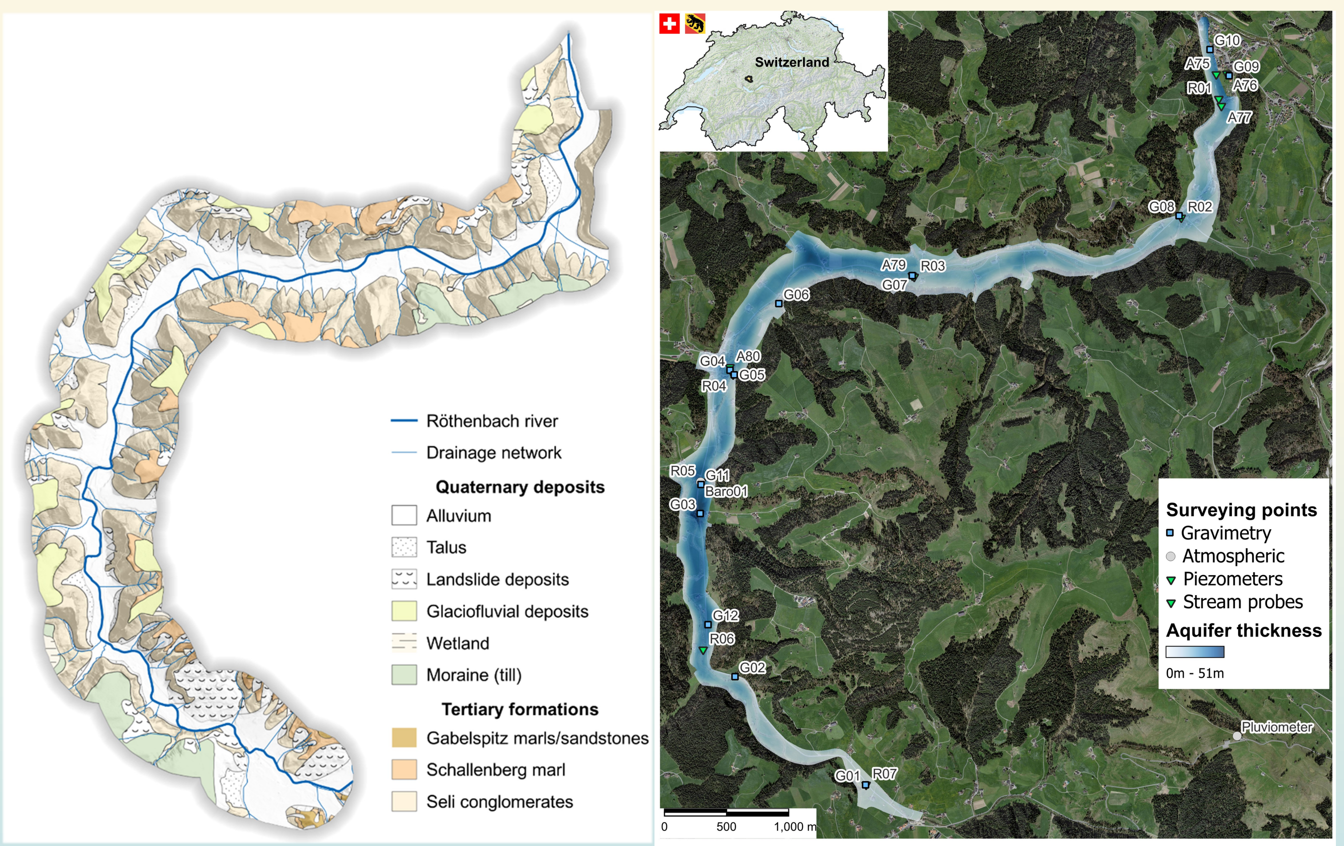
Groundwater resources are increasingly affected by **climate change**, in which rising temperatures and altered precipitation patterns lead to shifts in recharge rates, thereby impacting **water availability**.

While traditional hydrological measurements—like stream discharge and groundwater levels—offer valuable point-based data, they often fail to capture the spatial complexity of groundwater storage change. This is especially true in mountain systems, where seasonal storage changes and spatial heterogeneity demand more **integrative monitoring approaches**.

Study area and context

The study is conducted in the **Röthenbach catchment** (Bern canton, CH), a pre-alpine alluvial aquifer system, characterized by strong seasonal hydrological variability.

The aquifer is composed of quaternary unconsolidated deposits, mainly undifferentiated alluvium, laying over an impermeable marl and conglomerates layers extending to the valley sides forming steep slopes.



Materials and methods

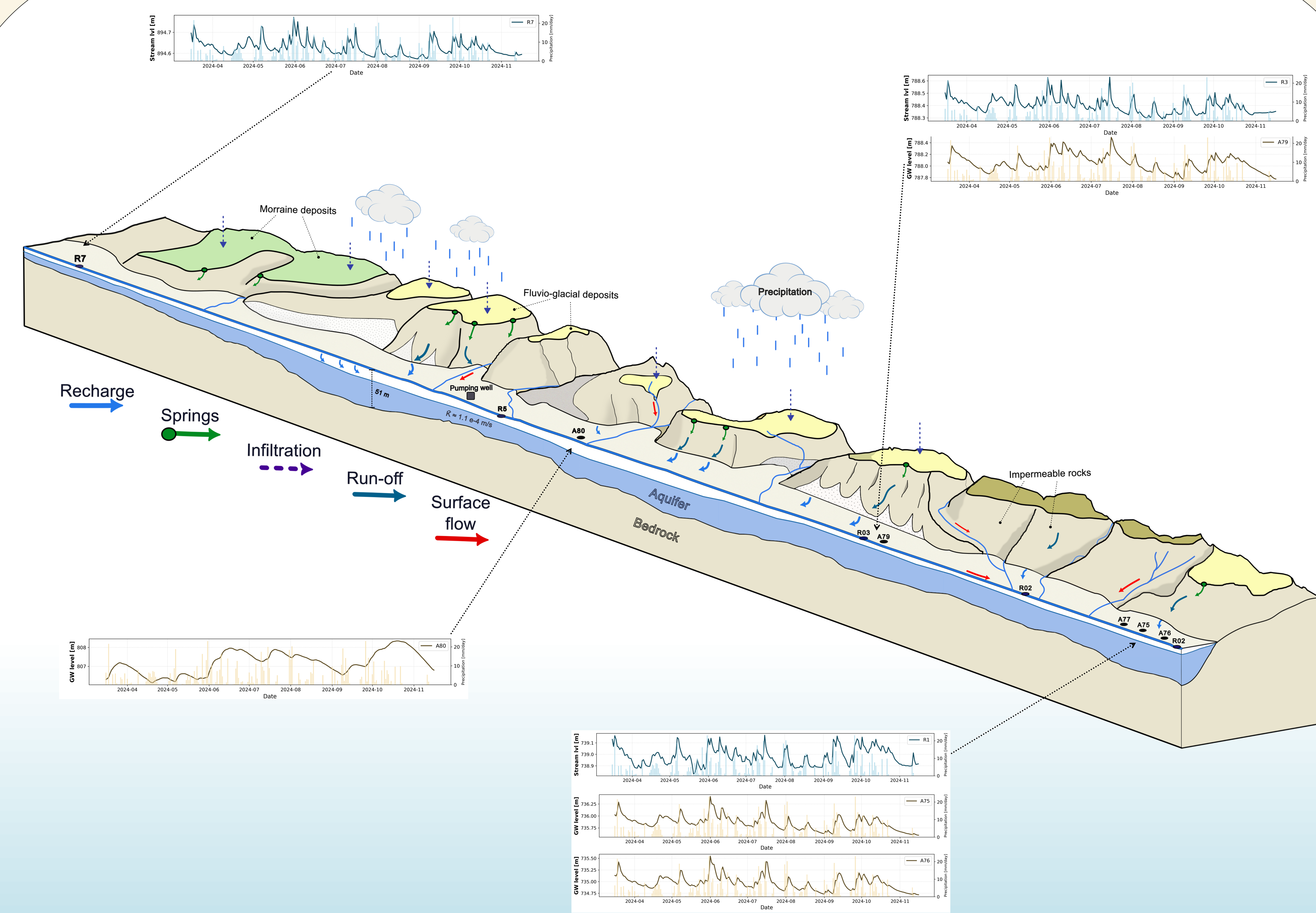
The study collects monthly repeated gravimetric data relative to an absolute gravity station, corrected for tidal effects, instrumental drift and height, and compares them to time-series of groundwater head, river discharge, groundwater levels and recharge.

Mapping with QGIS with geospatial products from the Swiss Federal Office of Topography

Hydrological time series reading with Keller DCX-22 automatic data loggers

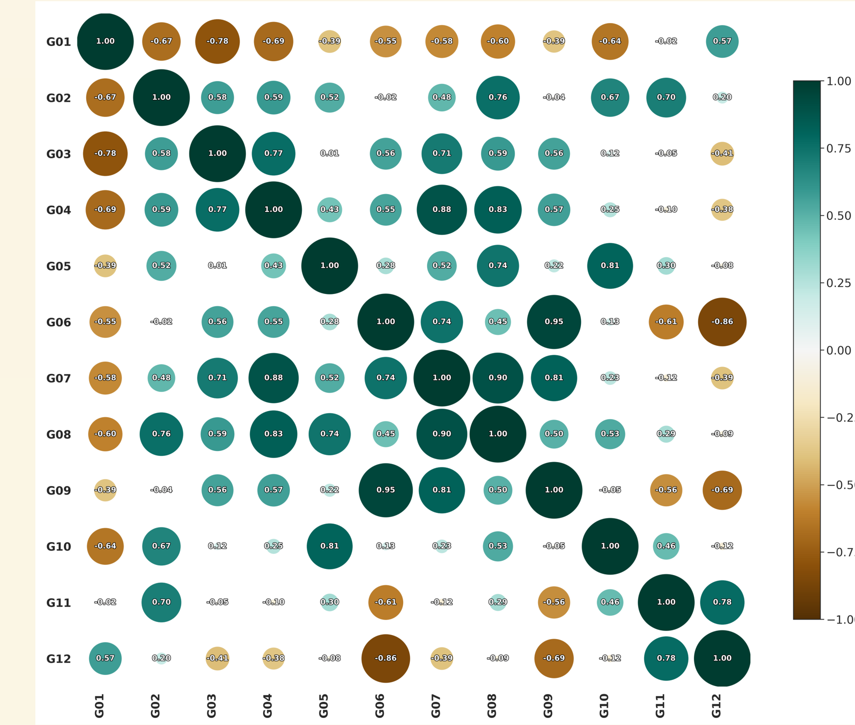
Gravimetric surveying with Scintrex CG-6 Autograv™

Data correction and processing with Microsoft Excel and Python scripts



Time-lapse gravimetry provides a solid tool to spatially integrate **groundwater storage changes**, especially when combined with detailed hydrogeological data. The study highlights **strong spatial and temporal variability** in water storage responses across the catchment.

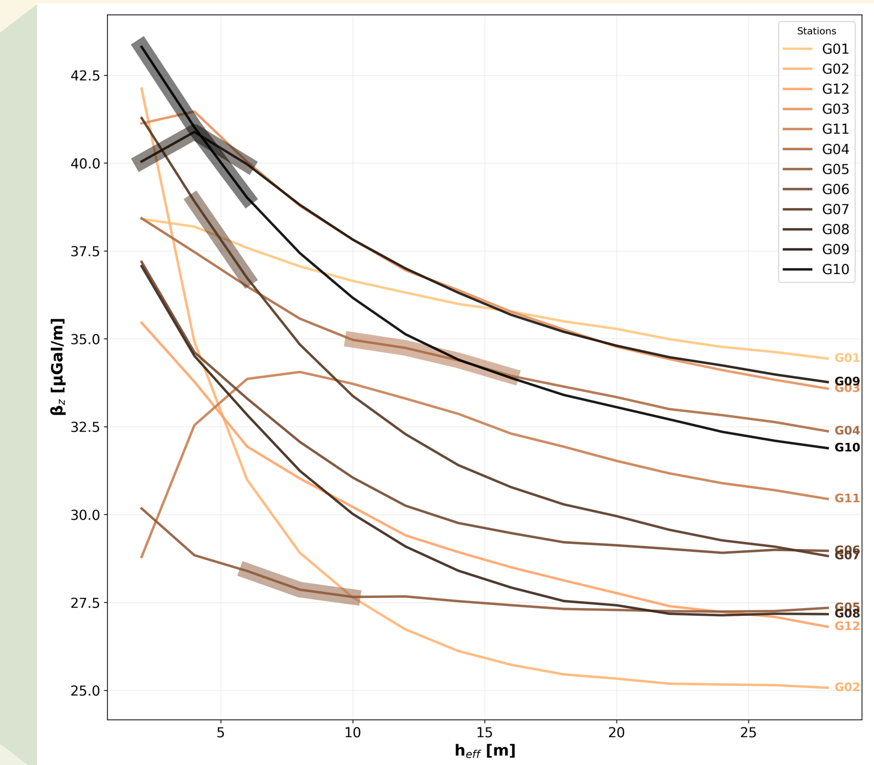
Results



The matrix shows the correlation of **processed monthly Δg [mGal]** results from each gravity measuring station. Stronger positive correlations can be observed from stations in the middle section of the valley.

β_z [μGal/m] is the conversion factor for the vertical component of gravity changes per unit of equivalent free water column.

Its variability is shown as a function of assumed effective depth to to the water table, with highlighted ranges shown for locations with known depth.



Accumulated and monthly groundwater storage change is approximated here by the change of meters of groundwater equivalent, using the **βz** and **Δg** results for each measuring station.