



Supplement of

Impacts of Mediterranean snow droughts on mountain socio-ecohydrology

Francesco Avanzi et al.

Correspondence to: Francesco Avanzi (francesco.avanzi@cimafoundation.org)

The copyright of individual parts of the supplement might differ from the article licence.

S1 Web scraper: Methods

A webscraper script developed in R was run weekly every Wednesday beginning on 26th August 2022. It was developed to automatically query Google News through the combination of multiple content-specific keywords on drought and related synonyms in Italian (i.e., “siccità”, “scarsità idrica”, “emergenza idrica”, “danni”, “agricoltura”, “idroelettrico”, “turismo”, “pascoli”, “naviga*” - that is, “drought”, “water scarcity”, “water emergency”, “damages”, “agriculture”, “hydroelectric”, “turism”, “pastures”), with geographic-specific keywords on the names of all regions and provinces of Italy. The tool stacks all results from each single query into one dataframe in order to overcome the Google news limit of 100 maximum articles retrieved in each query. Weekly runs and the combination of multiple keywords into multiple queries were implemented in order to overcome this limitation and collect a greater number of news stories, especially but not limited to the most recently released news at the time of collection. The dataset includes information on the title of each article, its date of publication and url, keywords used when scraping, and the text of the body of article. The dataset is filtered to eliminate articles with the same title, date of publication, url or a combination thereof. Google News provides results that span across multiple sources from national, regional, and local newspapers to blogs and specialized websites on agriculture, weather, or hydrological posts. Google News does not provide social media articles. The script was originally only run for provinces and regions belonging to the Italian Alps, namely Valle d’Aosta, Piemonte, Liguria, Lombardia, Trentino-Alto Adige, Veneto and Friuli-Venezia Giulia and after 3rd August 2023 extended to include the names of all provinces and regions of Italy.

S2 Mountain-hut survey

Section 1: General information

1. Hut name
- 20 2. Administrative region
3. Municipality
4. WGS84 coordinates
5. Elevation

Section 2: impacts

- 25 1. How many years have you been managing this mountain hut?
 - Less than 3 years
 - Between 3 and 5 years
 - Between 5 and 10 years
 - More than 10 years
- 30 2. Have you observed any changes in the water supply at your mountain hut in recent years?
 - Yes
 - No
3. If yes, what kind?
4. If yes, how have you managed these changes? For example, by rationing water, requesting external interventions, or
- 35 other measures?
5. Have you observed any other changes, for example in the flora or fauna, in the environment surrounding the hut? If yes, what kind of changes?

Section 3: Opening season

- Is your mountain hut open all year round or only in summer?
- 40
 - Only summer
 - All year round
 - Other

- Have any issues with the water supply played a role in your decision to open or close the hut in recent years?
- Yes
- 45 – No
- Other
- Could you indicate the opening date for 2023?
- Could you indicate the closing date for 2023?
- Could you indicate the opening date for 2022?
- 50 – Could you indicate the closing date for 2022?
- Could you provide us with an estimate of the average opening date for the period prior to 2022?
- Could you provide us with an estimate of the average closing date for the period prior to 2022?
- What does your hut’s water supply rely on?
- Municipal water supply network
- 55 – Surface water abstraction (stream, lake, spring)
- Groundwater (well)
- Water tankers or similar
- Other
- Is your hut equipped with storage systems, such as snow pits or similar?
- 60 – If yes, which one?
- If yes, what problems have you encountered with these systems in recent years?

S3 Flux-tower data: details on instrumentation

Water and energy flux and meteorological data at the two flux-tower sites were collected using an identical setup. Eddy covariance measurements consists of a three-dimensional sonic anemometer (CSAT3, Campbell Sci.) to capture the three directional components of wind speed as well as sonic temperature and an open-path infrared gas analyzer (LI-7500, LI-COR Inc.) for the measurement of CO₂ and H₂O densities, installed at 20 m and 2 m above the canopy for IT-TrF and IT-Tor respectively. Half-hourly eddy fluxes were calculated from raw data recorded at 10 Hz frequency, following the standard procedures implemented in the EddyPro software (LI-COR, Inc.,Fratini and Mauder (2014)). Quality checks, filtering procedures, and partitioning of measured net ecosystem exchange into its component fluxes (i.e., GPP and Ecosystem Respiration, i.e., Reco) were obtained from the ONEFlux processing pipeline Pastorello et al. (2020) and were performed according to Reichstein et al. (2005) using the ‘REddyProc’ R package Wutzler et al. (2025). Air temperature and relative humidity were measured by a HMP45 sensor (Vaisala Inc., Helsinki, Finland), precipitation was measured by the OTT Pluvio2 rain gauge (OTT HydroMet GmbH Kempten, Germany), net radiation was measured with a CNR4 (Kipp and Zonen, Delft the Netherlands) net radiometer, and soil water content was assessed with soil water reflectometers, model CS616 (Campbell Sci., UK).

75 **References**

- Fratini, G. and Mauder, M.: Towards a consistent eddy-covariance processing: an intercomparison of EddyPro and TK3, *Atmospheric Measurement Techniques*, 7, 2273–2281, 2014.
- Pastorello, G., Trotta, C., Canfora, E., Chu, H., Christianson, D., Cheah, Y.-W., Poindexter, C., Chen, J., Elbashandy, A., Humphrey, M., et al.: The FLUXNET2015 dataset and the ONEFlux processing pipeline for eddy covariance data, *Scientific data*, 7, 225, 2020.
- 80 Reichstein, M., Falge, E., Baldocchi, D., Papale, D., Aubinet, M., Berbigier, P., Bernhofer, C., Buchmann, N., Gilmanov, T., Granier, A., et al.: On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm, *Global change biology*, 11, 1424–1439, 2005.
- Wutzler, T., Reichstein, M., Moffat, A. M., and Migliavacca, M.: REddyProc: Post Processing of (Half-)Hourly Eddy-Covariance Measurements, Max Planck Institute for Biogeochemistry (MPI-BGC), Jena, Germany, <https://doi.org/10.32614/CRAN.package.REddyProc>,
- 85 r package version 1.3.4, 2025.