Unravelling alkalinity and dissolved inorganic carbon dynamics in an alpine stream network

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To the abstract:

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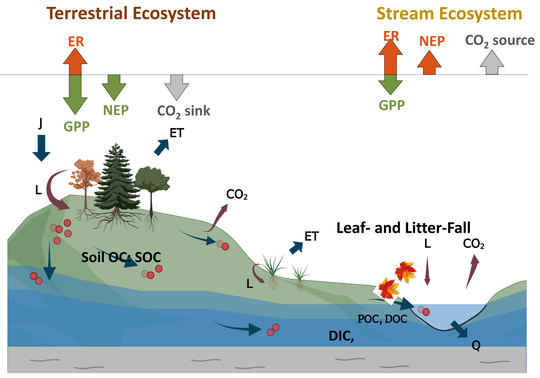
FLUVIAL METABOLISM FLUXES

Alkalinity plays a crucial role in the carbon cycle by buffering pH and regulating the chemical speciation of inorganic carbon in aquatic systems, directly influencing the equilibrium between CO_2, bicarbonate, and carbonate. Accurate quantification of alkalinity is essential for assessing carbon fluxes and understanding ecosystem responses to environmental change.



- **DOC:** Dissolved Organic Carbon.
- **DIC:** Dissolved Inorganic Carbon.
- **POC:** Particulate Organic Carbon.
- **Gross primary production** (GPP) is the amount of **inorganic carbon** converted into **organic carbon** by **autotrophic** organisms in the ecosystem.
- **Ecosystem respiration (ER).** The sum of all the respiration fluxes form auto- and heterotrophic organisms present in an ecosystem.
- **Net Ecosystem Production (NEP=GPP-ER).** NEP is stored in the ecosystem as OC.

AIM & SCOPE

Aim of the project is to unravel fluvial C cycling under varying spatial and temporal scale.

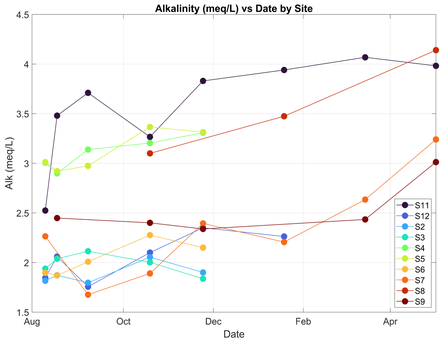
Specific goals include:

- Modeling the coupling dynamics of O_2 and CO_2;
- Using a stream transport model based on a mass balance approach to characterize the alkalinity concentration in the lateral discharge across different stream reaches;
- Linking land cover and soil local geology to alkalinity concentration of the lateral flow;
- Quantify DIC balance at the scale of a single stream reach.

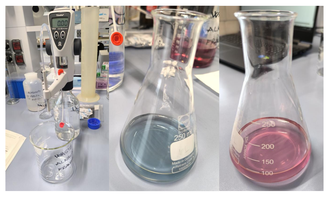
SITE & DATA: THE RIO VALFREDDA INSTRUMENTED CATCHMENT

Rio Valfredda is a headwater mountain stream located in the North-East of Italy, within the Italian Alps. Its pristine catchment covers an area of 5.30 km^2 from nearly 1500 to almost 3000 m a.s.l., with an average altitude of 2000 m a.s.l. Alpine climate shapes Valfredda hydrologic regime with abundant precipitations throughout the year, snowfall in winter, and snowmelt in spring. Data collected as from 2018 include **continuous measurements of hydrologic and environmental variables.**

Water samples for the evaluation of alkalinity are collected **monthly** in order to detect temporal and spatial variations. The collection points are marked as "S1" to "S12".

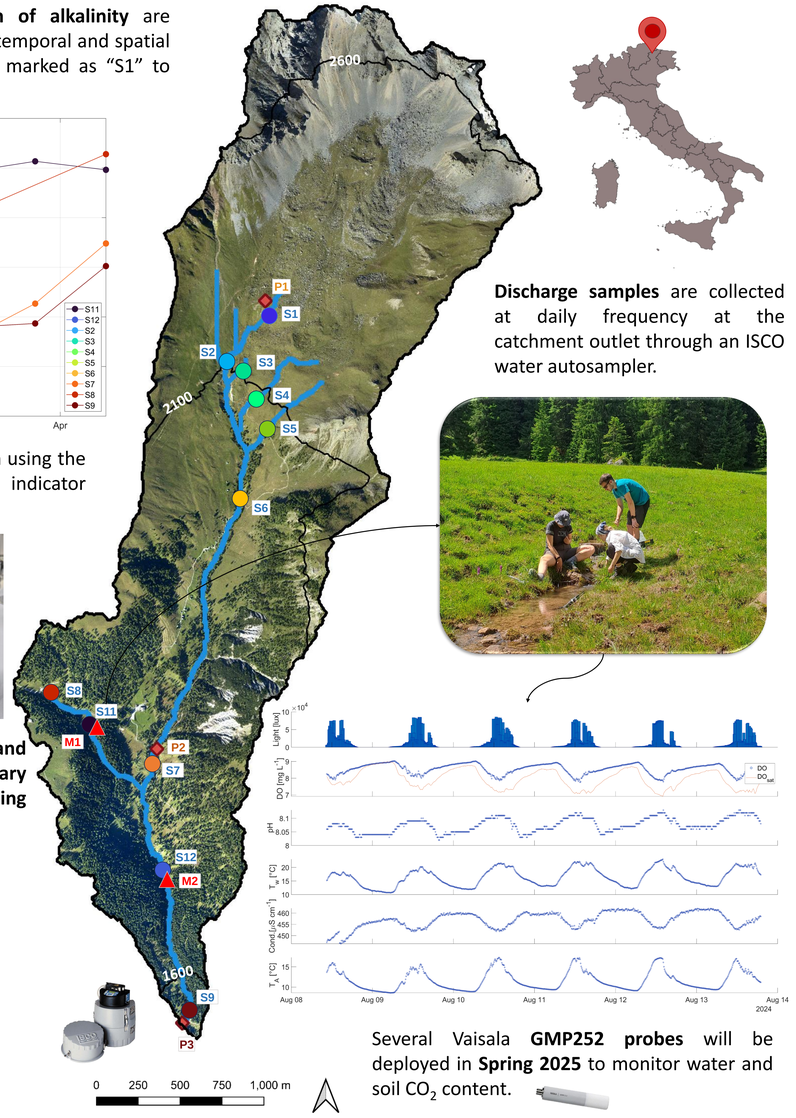


The samples are analyzed by **titration** using the bromocresol green/methyl red as indicator solution.



▲ **Stream Metabolism Stations M1 and M2 monitor water quality and ancillary variables at 10-minute frequency using the HOBO loggers family:**

- Dissolved Oxygen
- Water and Air Temperature
- Barometric Pressure
- Solar Radiation
- Electrical Conductivity
- pH

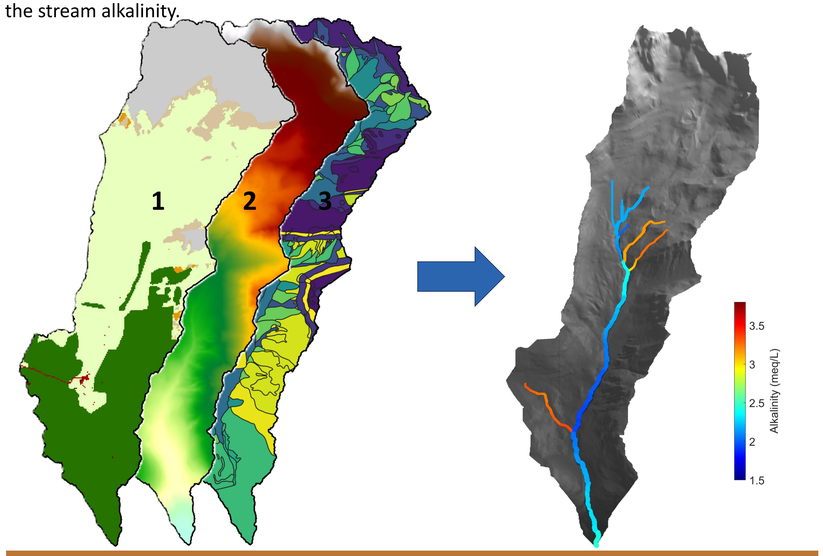


Discharge samples are collected at daily frequency at the catchment outlet through an ISCO water autosampler.

Several Vaisala **GMP252 probes** will be deployed in **Spring 2025** to monitor water and soil CO_2 content.

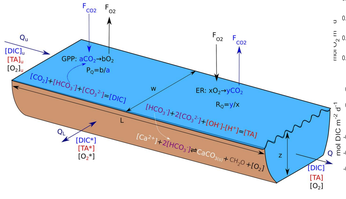
RESULTS: ALKALINITY SPATIAL VARIATION PREDICTION

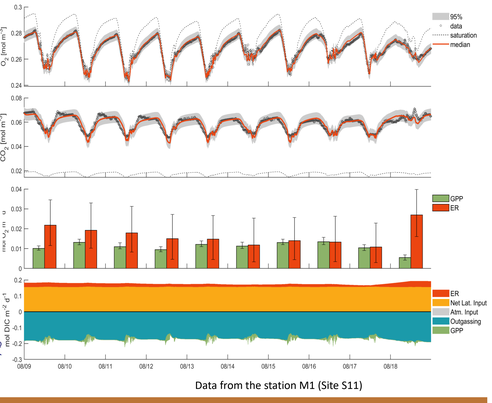
Having defined the subcatchments that drain in every sampling points, using the DEM raster (2), the percentages of land cover (1) and sedimentological types (3) were calculated. These were used for a statistical model (LASSO Regression) to link the characteristics of the drained area to the stream alkalinity.



NEXT STEP: APPLICATION OF THE DIC MODEL

Model description in Diamond, J. S., & Bertuzzo, E. (2025). "*A coupled O2-CO2 model for joint estimation of stream metabolism, O-C stoichiometry, and inorganic carbon fluxes*". Journal of Geophysical Research: Biogeosciences.





Data from the station M1 (Site S11)

ACKNOWLEDGMENT

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