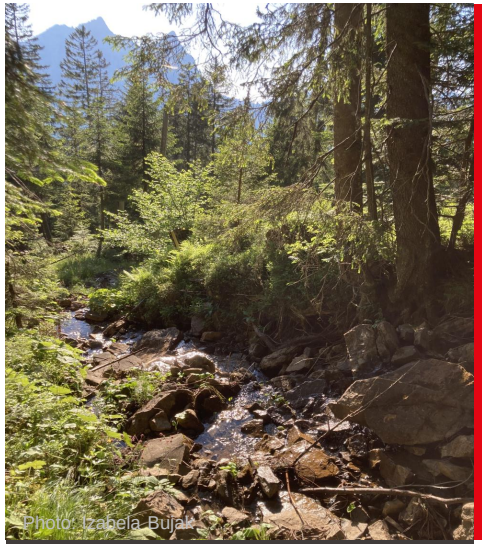

Short-Term Dynamics of the Flowing Stream Drainage Density

Izabela Bujak[1,2], Ilja van Meerveld[3], Andrea Rinaldo[1,4], Jana von Freyberg[1,2]

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[2] Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Mountain Hydrology and Mass Movements, Birmensdorf, Switzerland
[3] University of Zurich, Department of Geography, Zurich, Switzerland
[4] Università di Padova, Department of Civil, Environmental and Architectural Engineering (DICEA), Padova, Italy

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28.04.2023

Many headwater streams are temporary

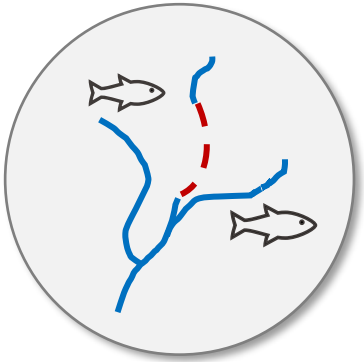
(e.g., Blyth & Rodda, WRR, 1973; Durighetto et al., WRR 2019; Jensen et al., Hydrol. Process., 2017)

habitat to **endemic species**

(Stubbington et al., WIREs WATER, 2017)

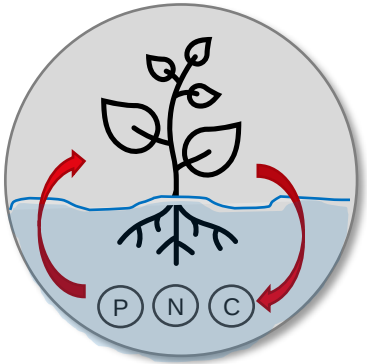
high **biodiversity**

(Meyer et al., JAWRA, 2007)



transport and processing of **nutrients** and **carbon**

(von Schiller et al., AP, 2017)



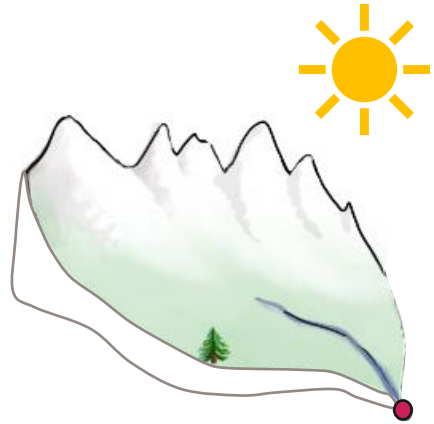
connectivity corridors

(Rinaldo et al., ADV, 2018)

Temporary streams

Intermittent flow in temporary streams
→
variations in **drainage density** (DD)

$$DD = \frac{Length_{\ flowing\ channels}}{Area}$$



low DD

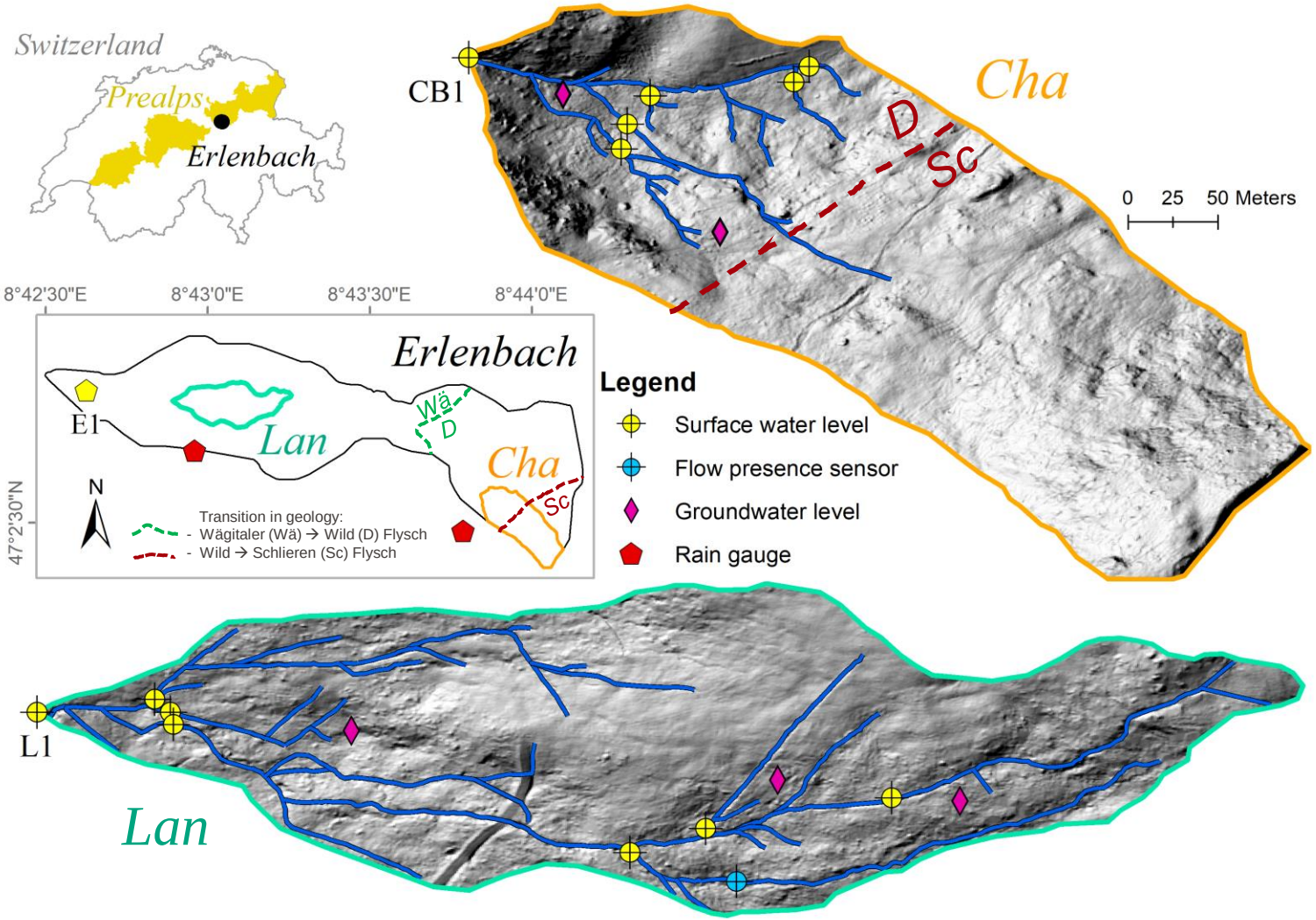
high DD

Temporary streams

Intermittent flow in temporary streams
→
variations in **drainage density** (DD)

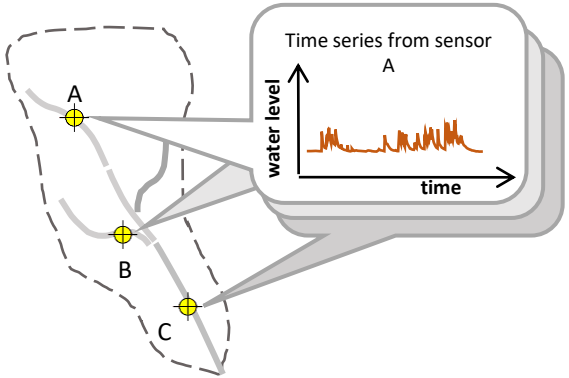
Photo: Izabela Bujak

- How dynamic is the DD during rainfall events?
- What can we learn from DD variations about subsurface flow processes?

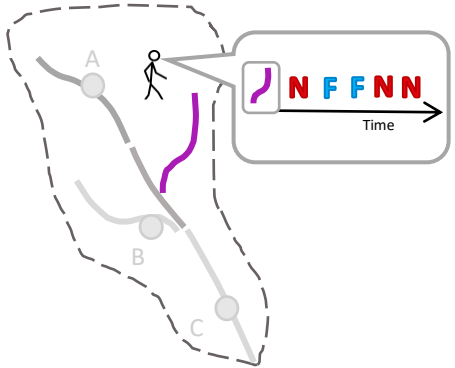

Switzerland
Prealps
Erlenbach
CB1
Cha
D
Sc
0 25 50 Meters
8°42'30"E
8°43'0"E
8°43'30"E
8°44'0"E
47°2'30"N
Erlenbach
E1
Lan
Wä
D
Cha
Sc
N
Transition in geology:
- Wägitaler (Wä) → Wild (D) Flysch
- Wild → Schlieren (Sc) Flysch
Legend
Surface water level
Flow presence sensor
Groundwater level
Rain gauge
L1
Lan

ConsEnsuAI State Estimation (CEASE) method

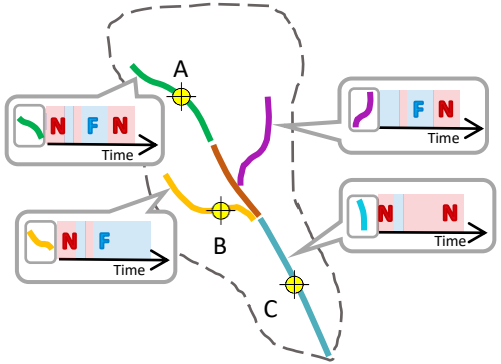
High temporal resolution monitoring using **sensors**



High spatial resolution mapping **surveys**



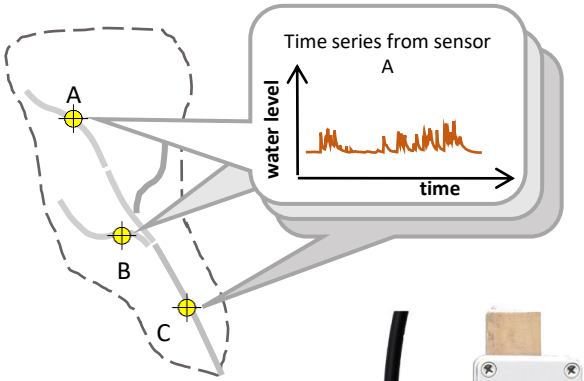
Time-series of flow conditions for each reach



Multiple visual observations of flow presence (flow **F** or no flow **N**) in stream reaches

Data collection

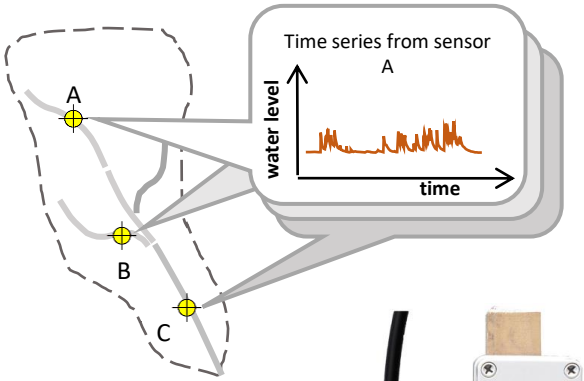
High temporal resolution monitoring using **sensors**



Using pressure transducers

Data collection

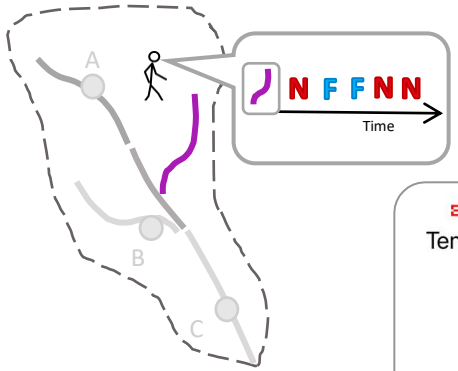
High temporal resolution
monitoring using sensors



Using pressure
transducers

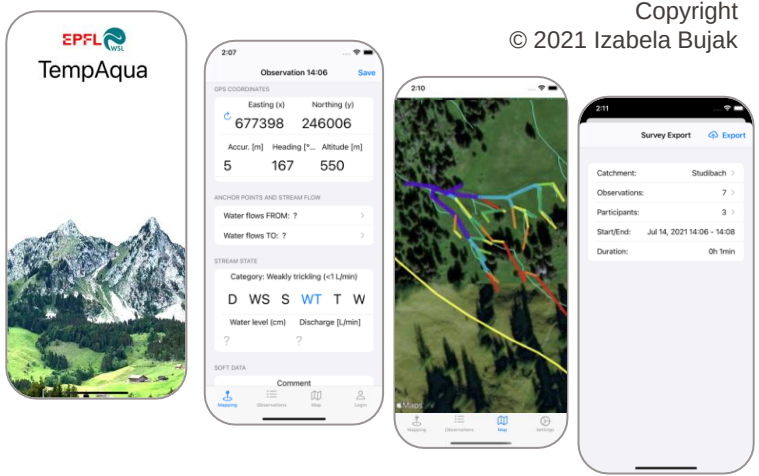
+

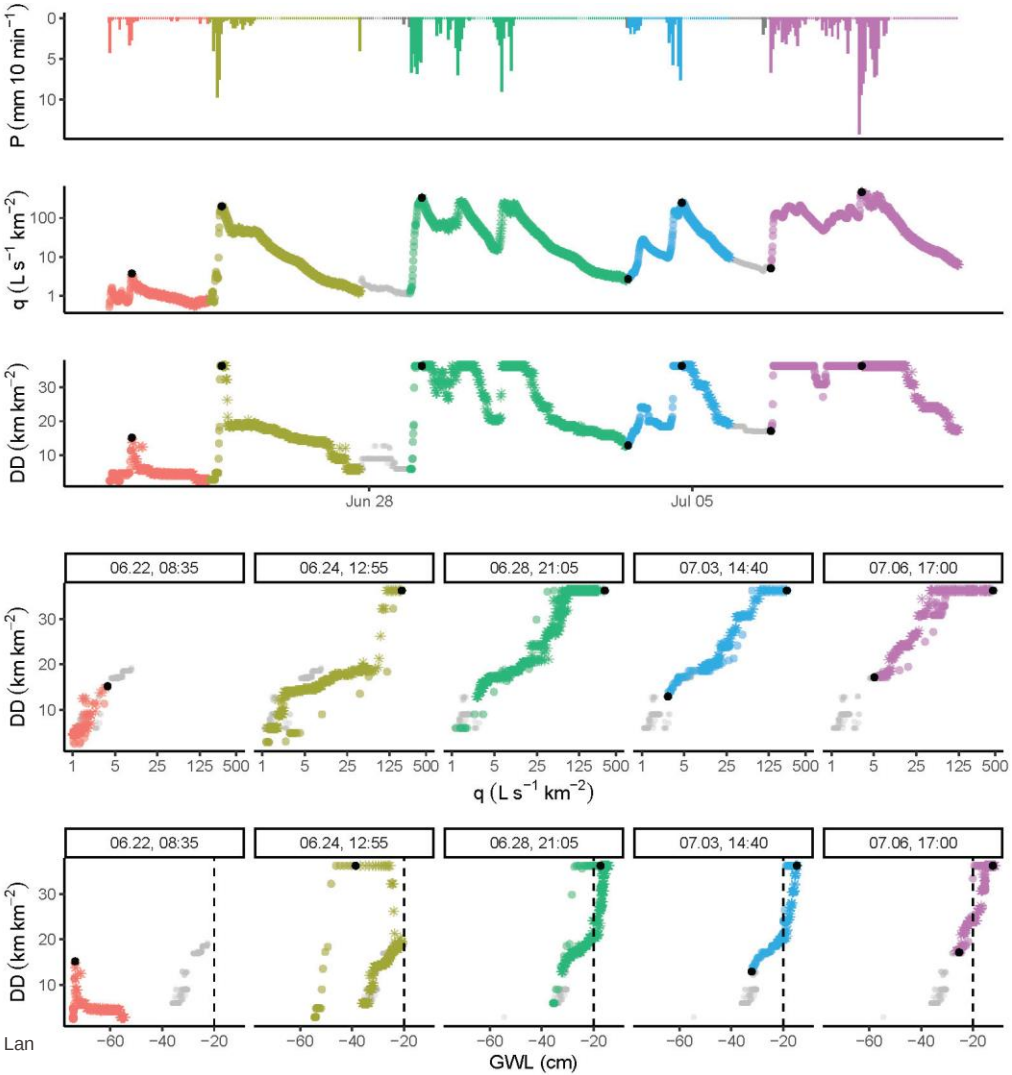
High spatial resolution
mapping surveys



Using TempAqua App

https://apps.apple.com/jm/app/tempaqua/id1576484945





What DD variations tell us about subsurface flow?

Repetitive patterns in DD responses linked to antecedent wetness

Lan:

- Dry conditions → hysteresis pattern
  (caused by zones nearby the outlet with persistency = 1, and seepage at the channel head maintained by rising GWL)
- Wet conditions → no hysteresis
  (rapid increase in DD when the GWL rise and q initiates in multiple shallow channels)

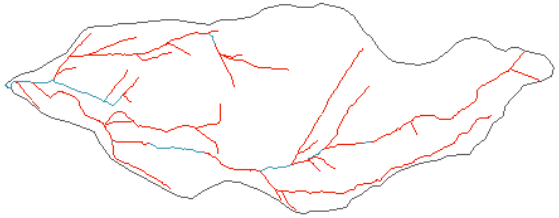
Cha:

- Similarity to Lan during the drier monitoring period

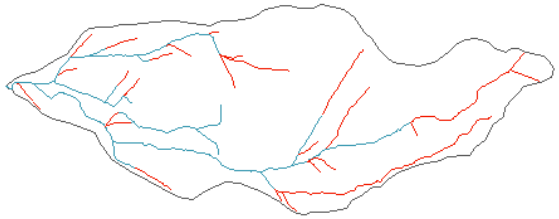
Groundwater plays an important role in sustaining flow in channel heads and maintaining high DD

Spatial responses during rainfall events

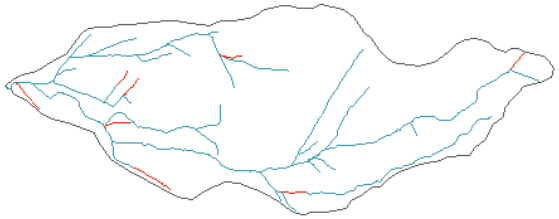
A 2021-09-16 09:00
(base flow)



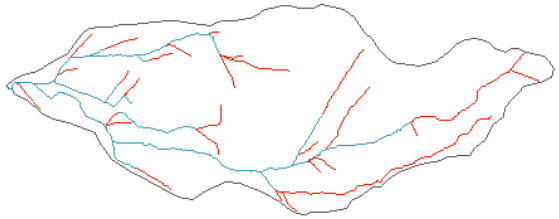
B 2021-09-16 15:00
(1st response)



C 2021-09-16 20:00
(peak flow)



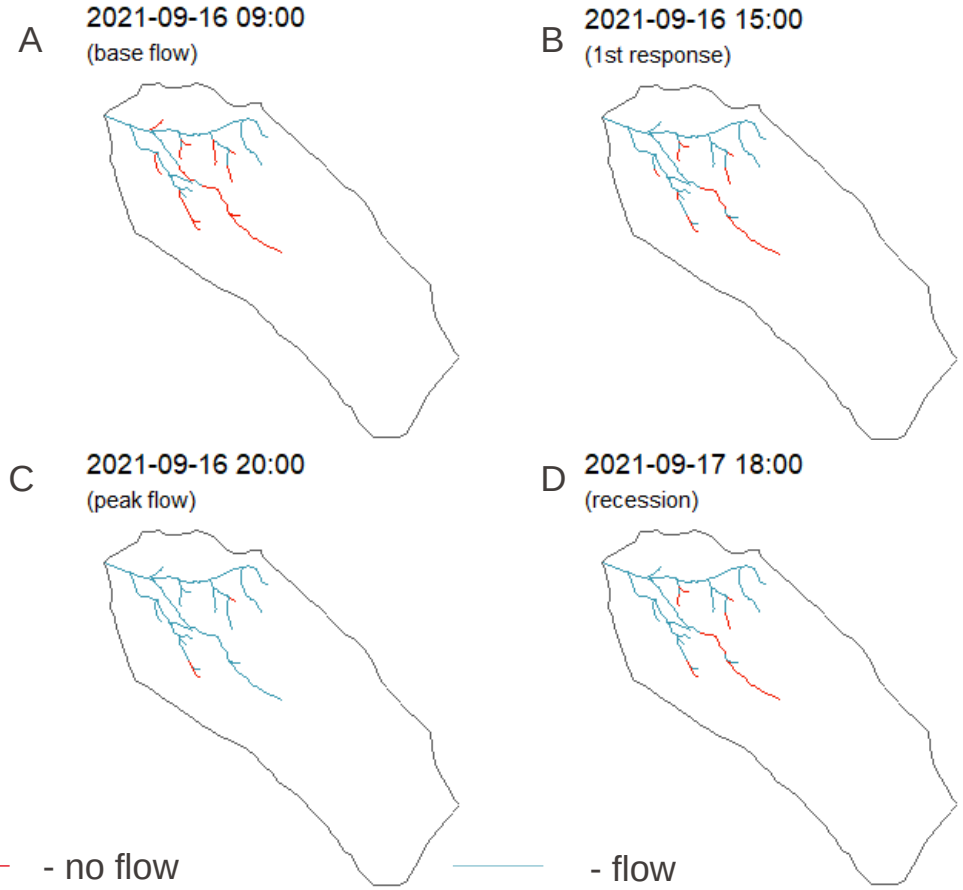
D 2021-09-17 18:00
(recession)



- no flow

- flow

Spatial responses during rainfall events



Summary

- The DD dynamics are very high and different in the two catchments
- Clear link between the short-term DD variation and geology/topography in the Cha
- Groundwater plays an important role in sustaining flow in channel heads
- During wetter conditions subsurface and surface flow are more synchronized than during drier conditions

Questions?

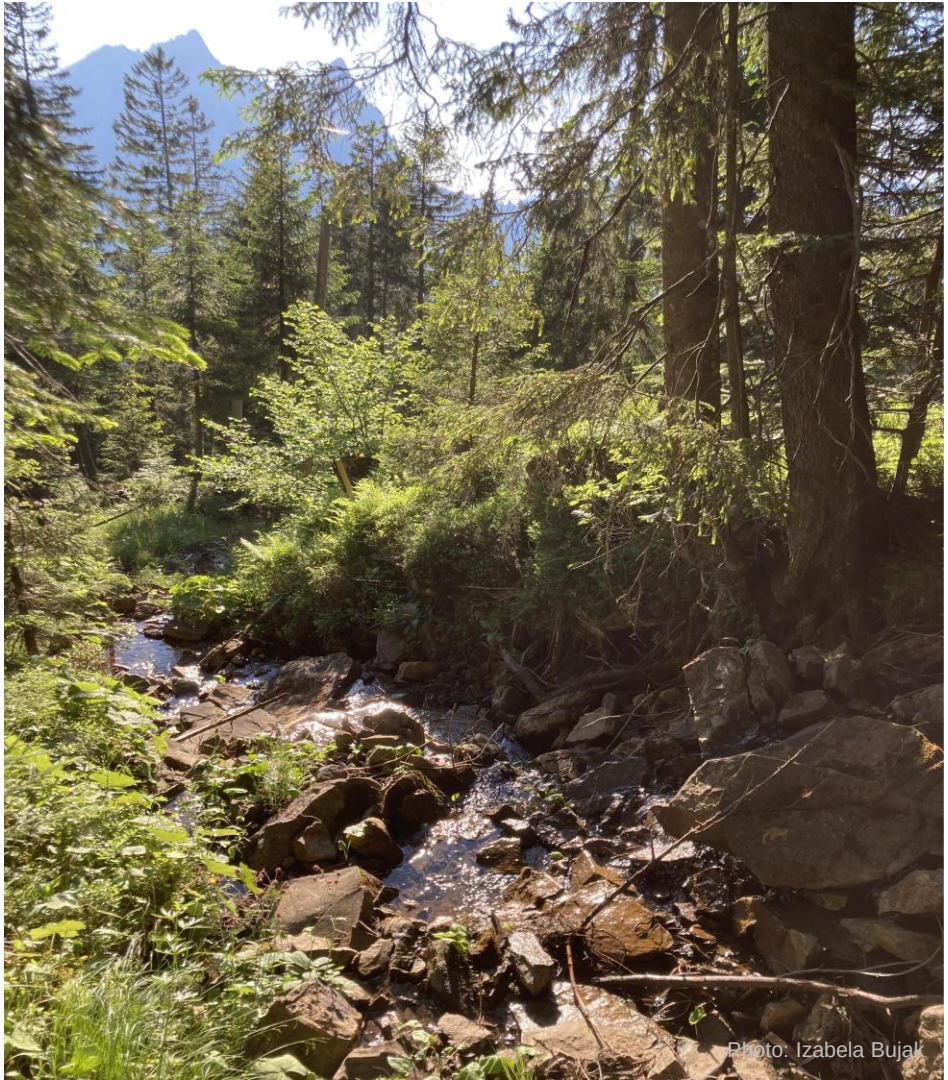


Photo: Izabela Bujak

Curious to know more?

- We are currently working on combining drainage density and environmental tracers data collected during multiple rainfall events in different Swiss catchments
- Come and meet us at our poster:

EGU23-14005 | Posters on site | HS2.2.7

„Quantifying changes in stream-landscape connectivity: combining high-resolution data of non-perennial streams and environmental tracers”

Jana von Freyberg, Izabela Bujak, Andrea Rinaldo, and Ilja van Meerveld

Wed, 26 Apr, 14:00–15:45 Hall A | A.62

- Contact us: izabela.bujak@epfl.ch

TempAqua App for mapping temporary streams and hydrological surveys

- Available for free from Apple Store
- Contact me to set up your own project: izabela.bujak@epfl.ch