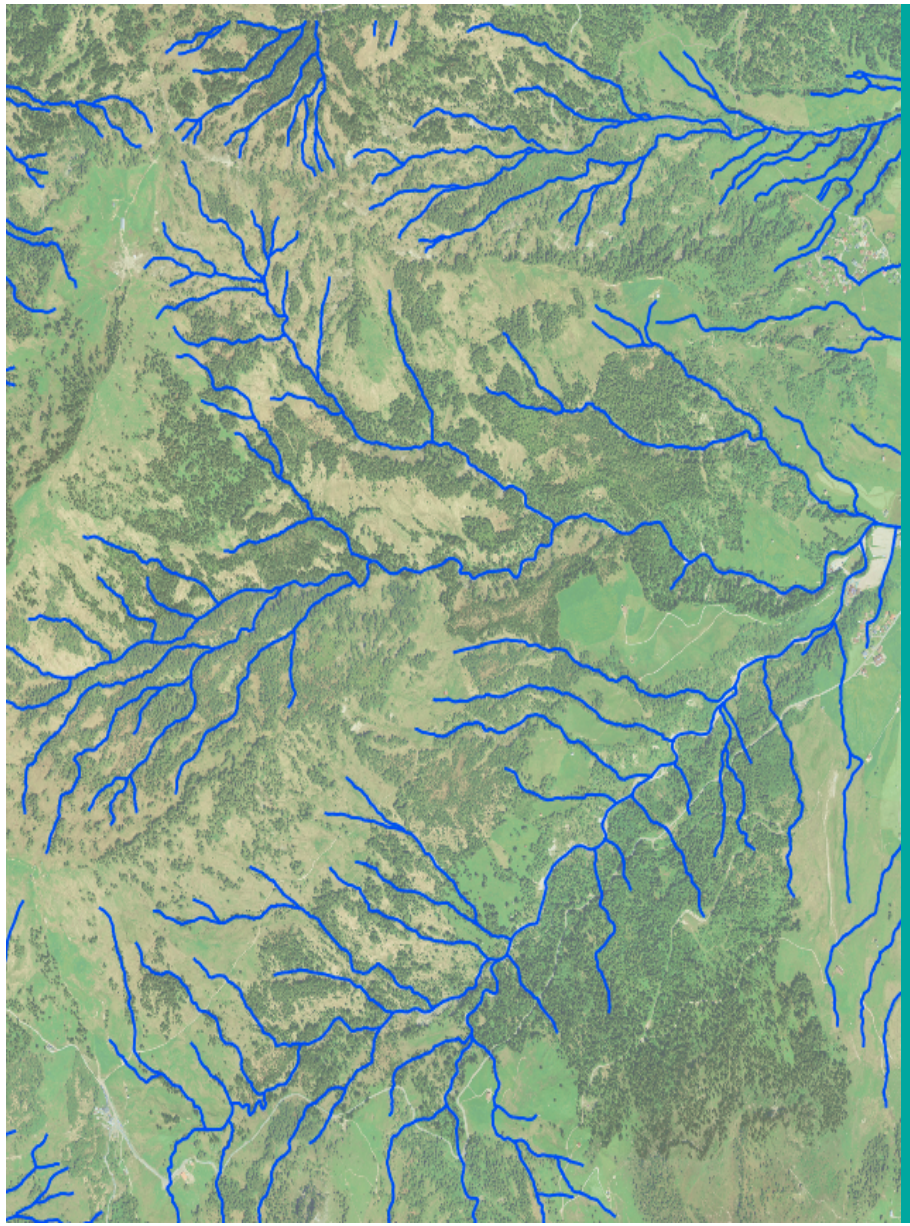


EGU22-4435

Monitoring changes in temporary stream networks during rainfall events

Jana von Freyberg[1,2]

Izabela Bujak[1,2]

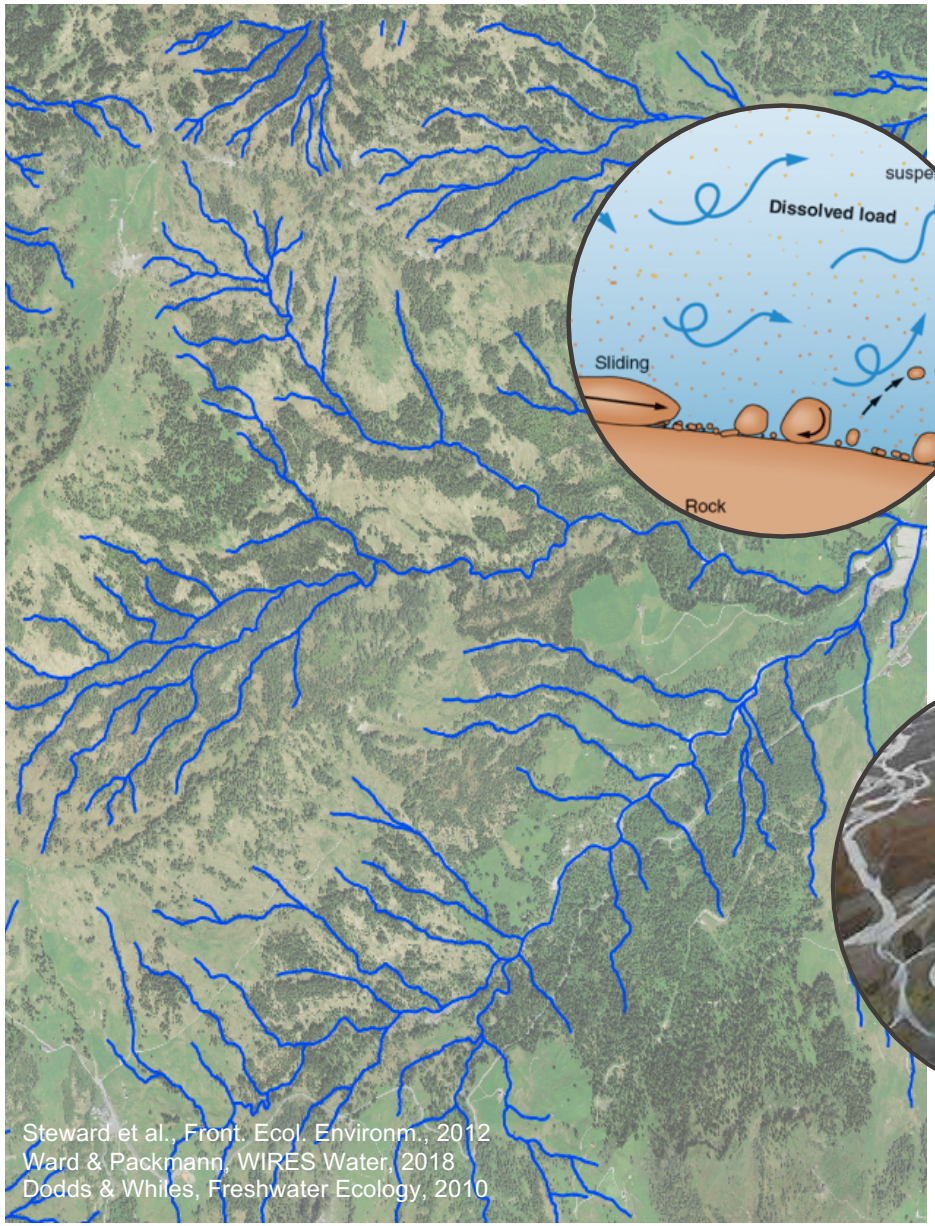
Andrea Rinaldo[1,3]

Ilja van Meerveld[4]

1 EPFL, Lausanne, Switzerland
2 WSL Birmensdorf, Switzerland
3 Università di Padova, Italy
4 University of Zurich, Switzerland

Swiss National Science Foundation

Stream networks



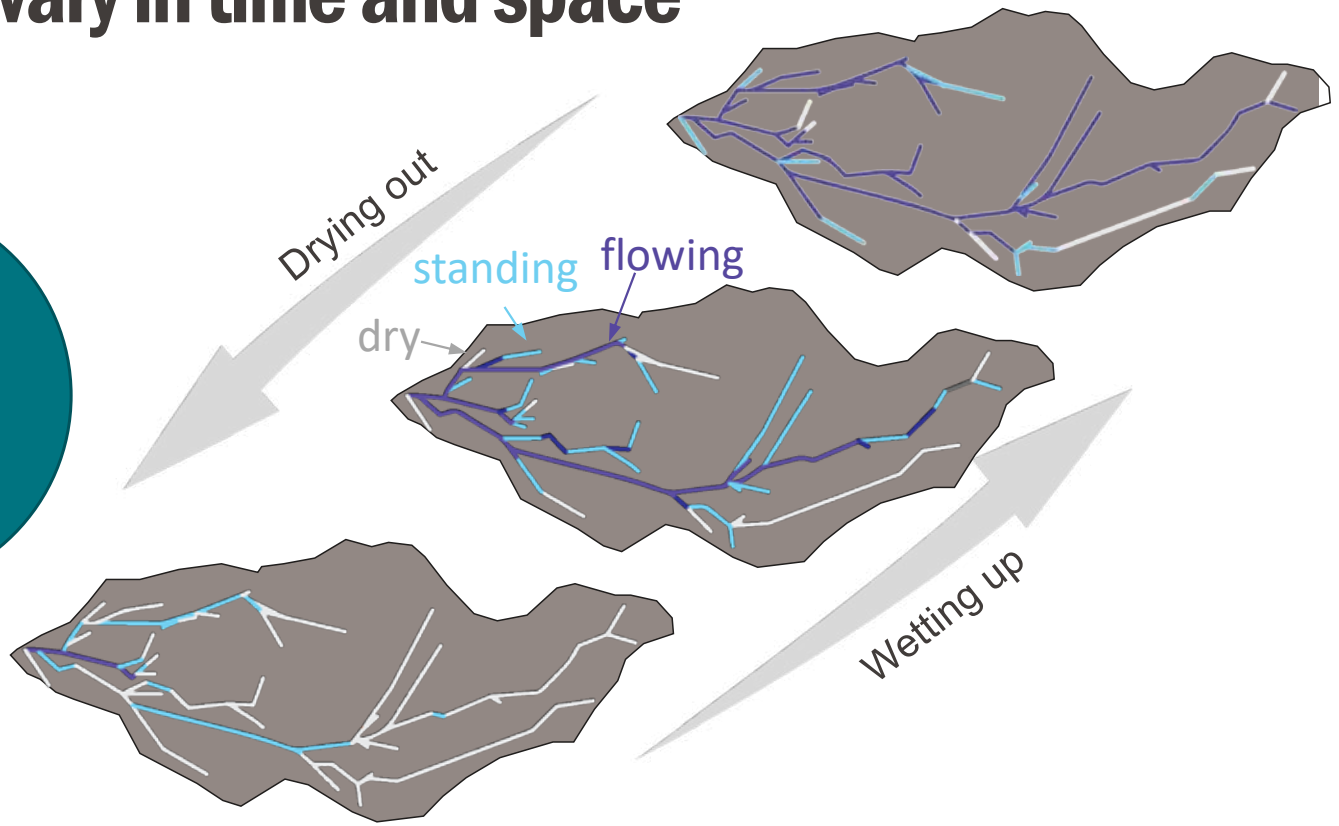
Steward et al., Front. Ecol. Environm., 2012
Ward & Packmann, WIRES Water, 2018
Dodds & Whiles, Freshwater Ecology, 2010

Control supply and transport of water, sediment and nutrients

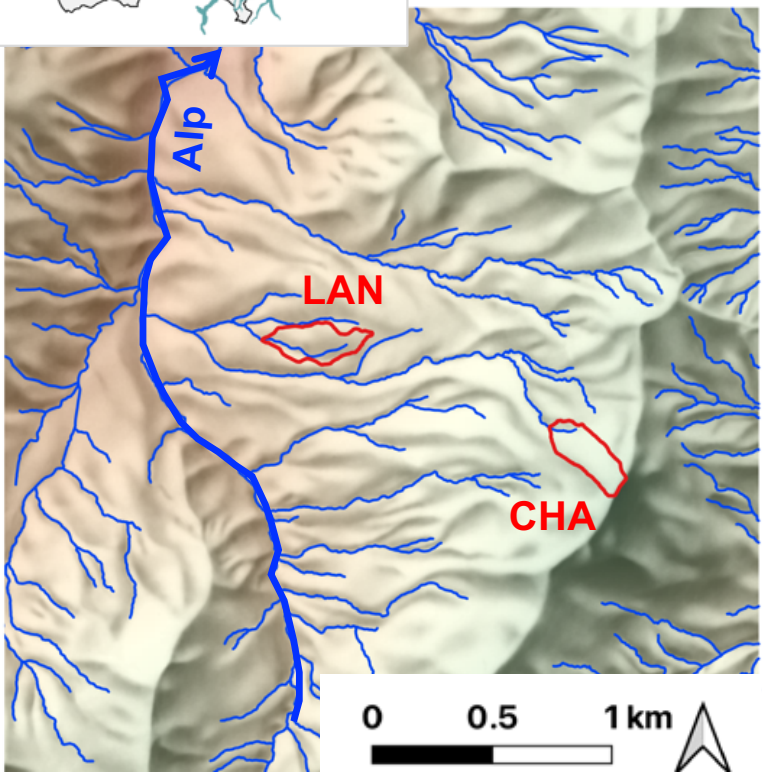
Create refuges for specialized aquatic organisms

Form corridors for terrestrial biota

Flowing stream networks vary in time and space

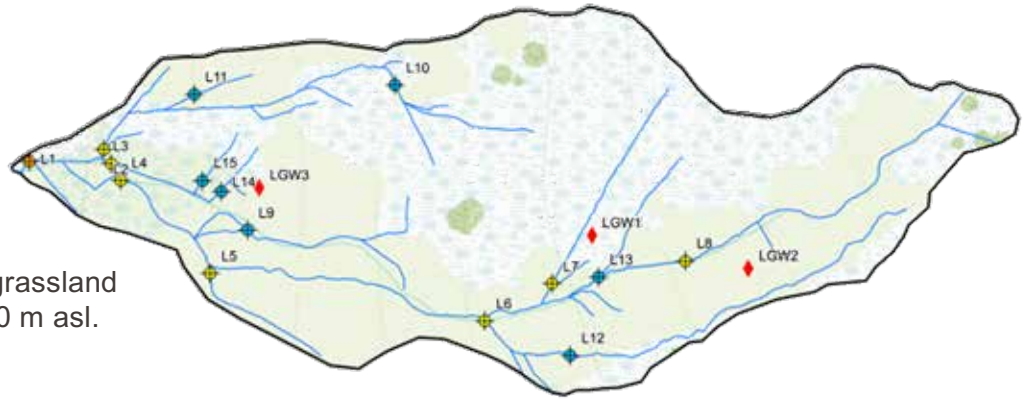


Study sites in the Swiss Alptal catchment



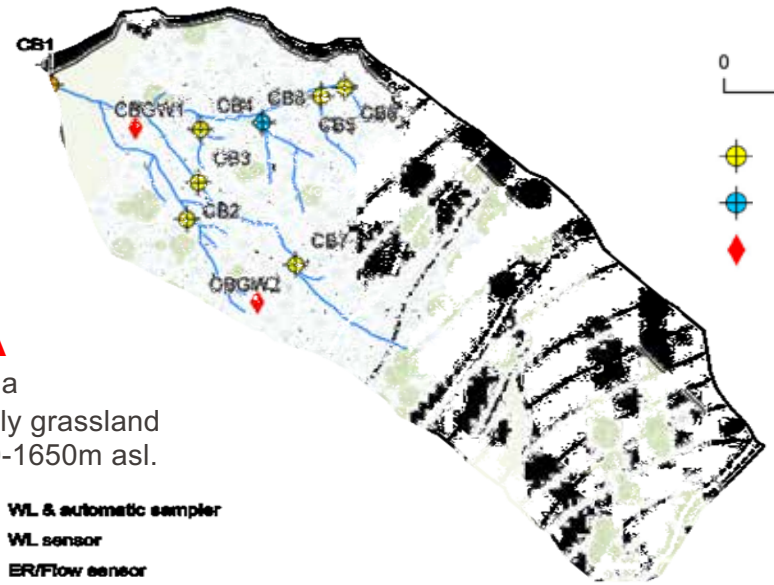
LAN

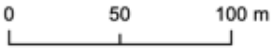
- 4.8 ha
- Forest + grassland
- 1200-1290 m asl.



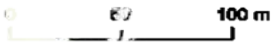
CHA

- 4.9 ha
- Mainly grassland
- 1400-1650m asl.





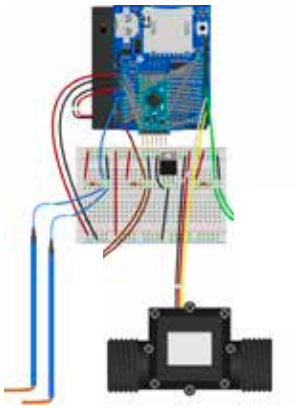
- Stream water level
- Elec. res. & flow
- Groundwater level



Data collection

Water level

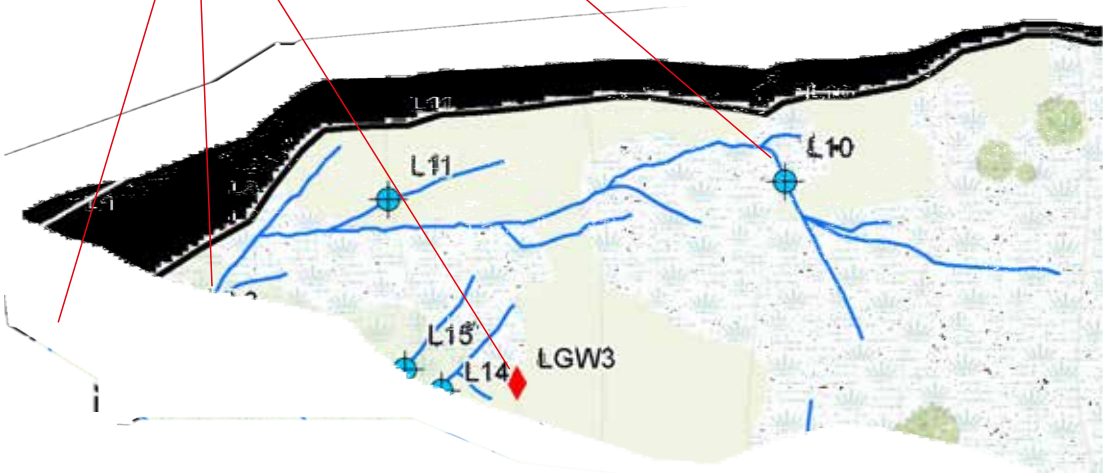
Assendelft & van Meerveld, Sensors, 2019



Electrical resistivity & flow

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

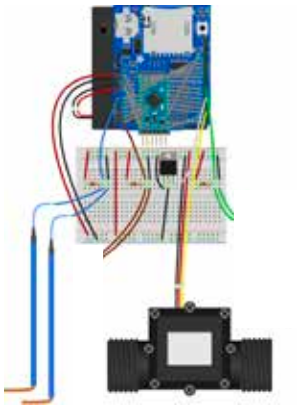
Mapping surveys



Data collection

10min: water level

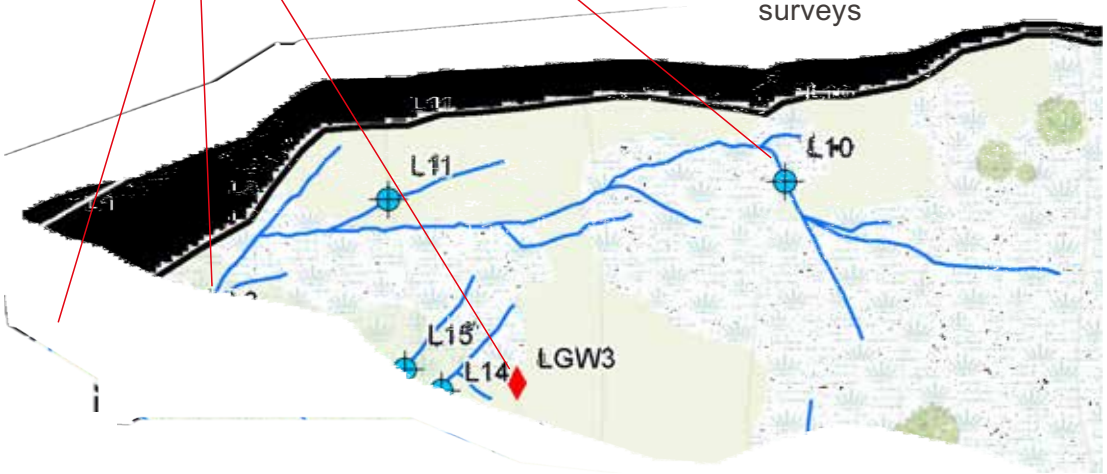
Assendelft & van Meerveld, Sensors, 2019



10min: electrical resistivity & flow

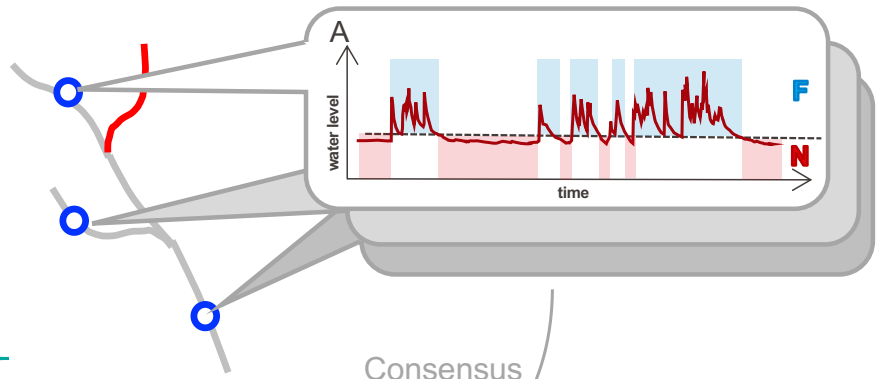
https://apps.apple.com/pl/app/tempaqua/id1576484945

1-2 weeks: mapping surveys

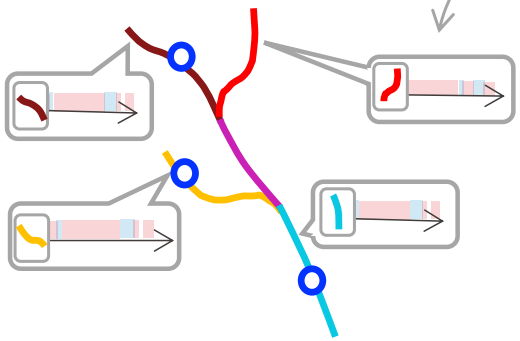


Processing

To predict  :

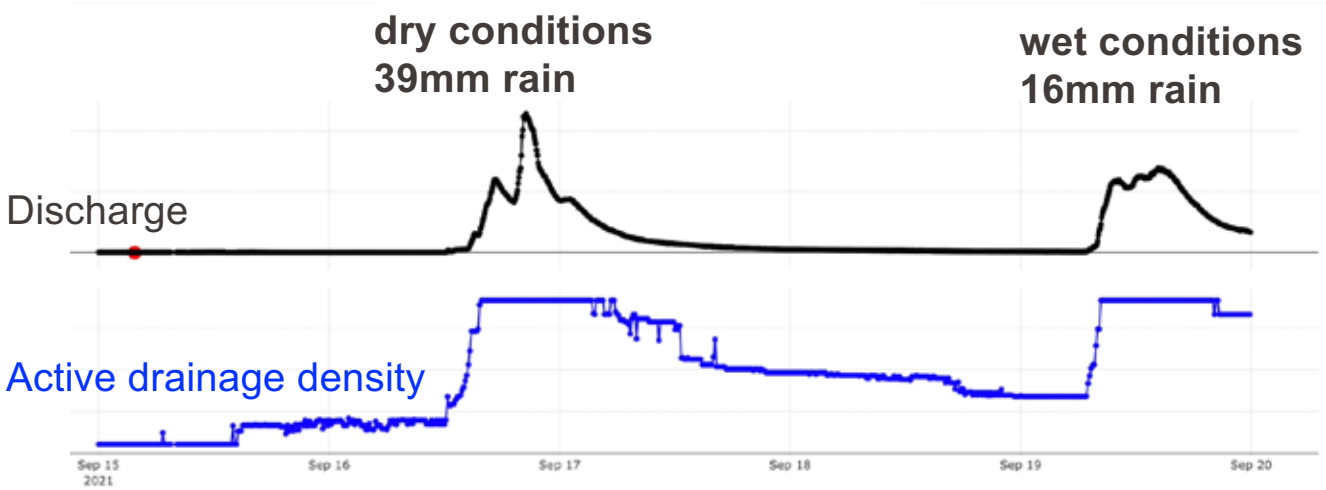


Consensus



High-resolution changes in active drainage density

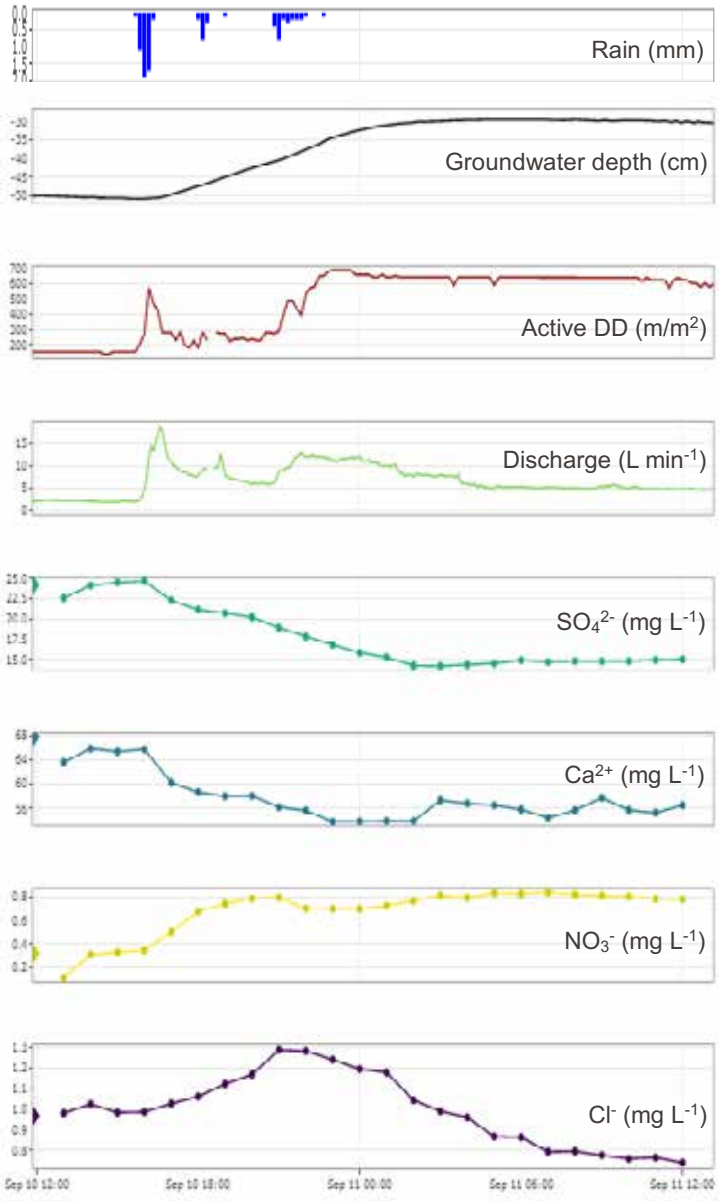
LAN catchment



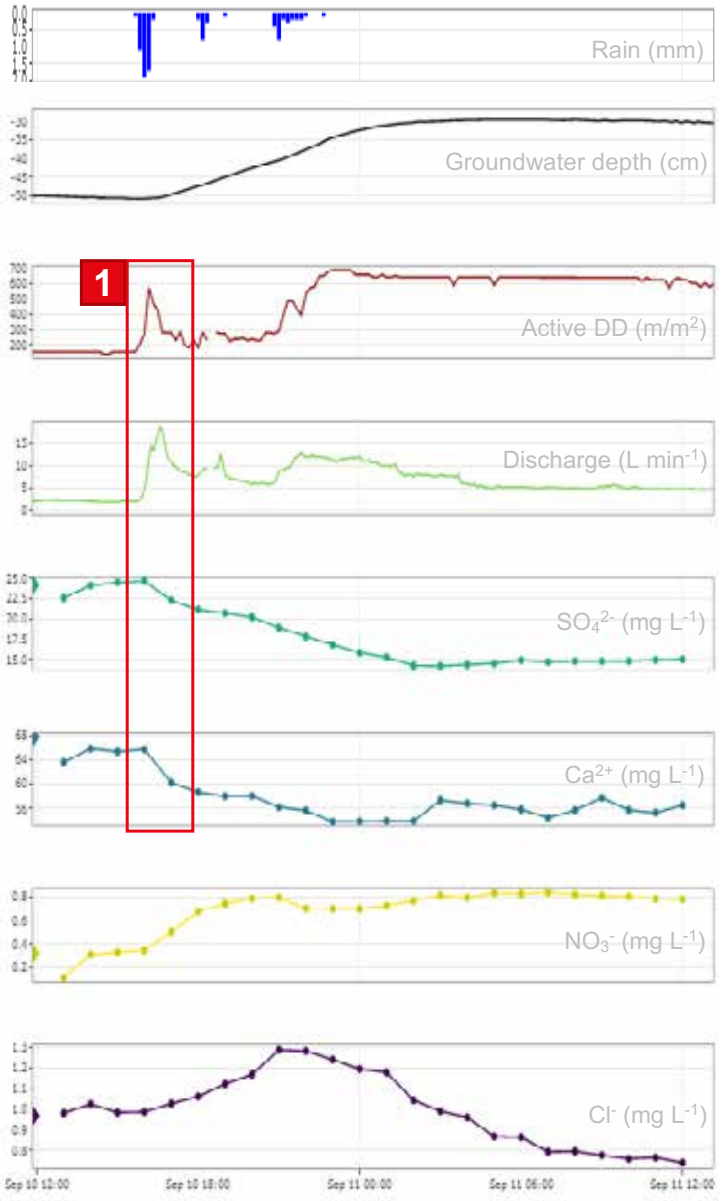
Active channels

- The active drainage density (DD) increases rapidly during rainfall events
- 5-fold increase in active DD
- Some parts of the channel network remain inactive throughout the event

LAN catchment, dry conditions, 9mm rain

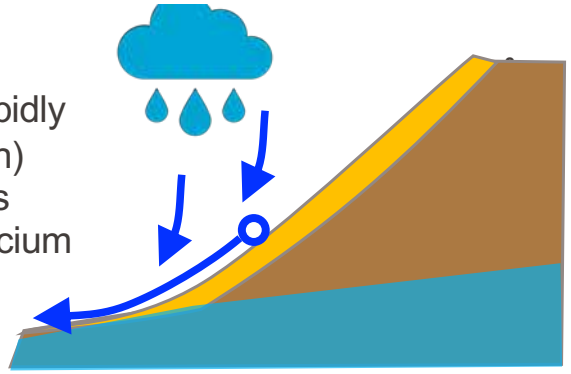


LAN catchment, dry conditions, 9mm rain



1 Surface runoff

- DD increases rapidly (3.7-fold in 30min)
- Rainwater dilutes sulphate and calcium in streamwater



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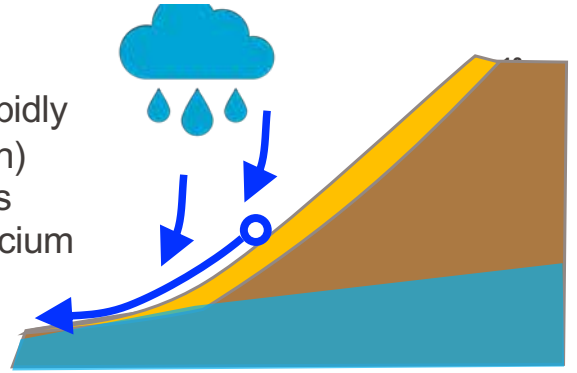
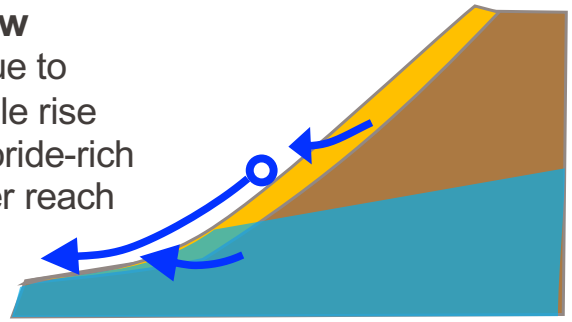


2 Subsurface flow

- DD increases due to groundwater table rise
- Nitrate- and chloride-rich subsurface water reach the stream



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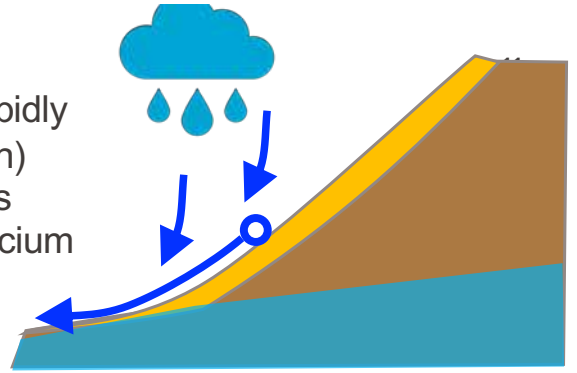

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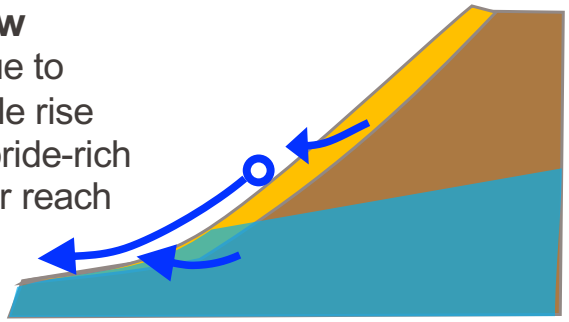
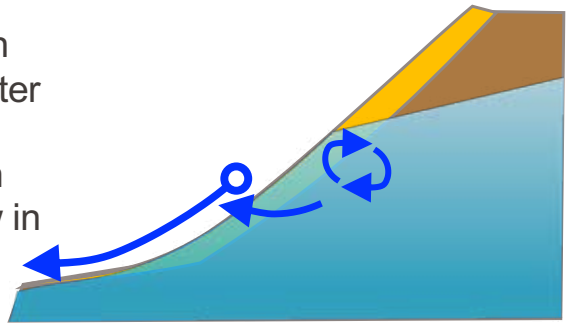


3 Mixing

- DD remains high
- “new” groundwater mixes with soil water that is rich in nitrate but low in chloride



Summary

High-resolution measurements of stream network expansion and contraction are rare, limiting our understanding of the physical and biogeochemical processes linked to temporary streams

- We combine sensor data with mapping surveys to determine changes in active drainage density across time and space
- Active drainage density changes by up to 5-fold during individual events, due to surface runoff and groundwater discharge
- Stream hydrochemistry reflects changes in hydrologic connectivity between stream and subsurface storage

Thank you

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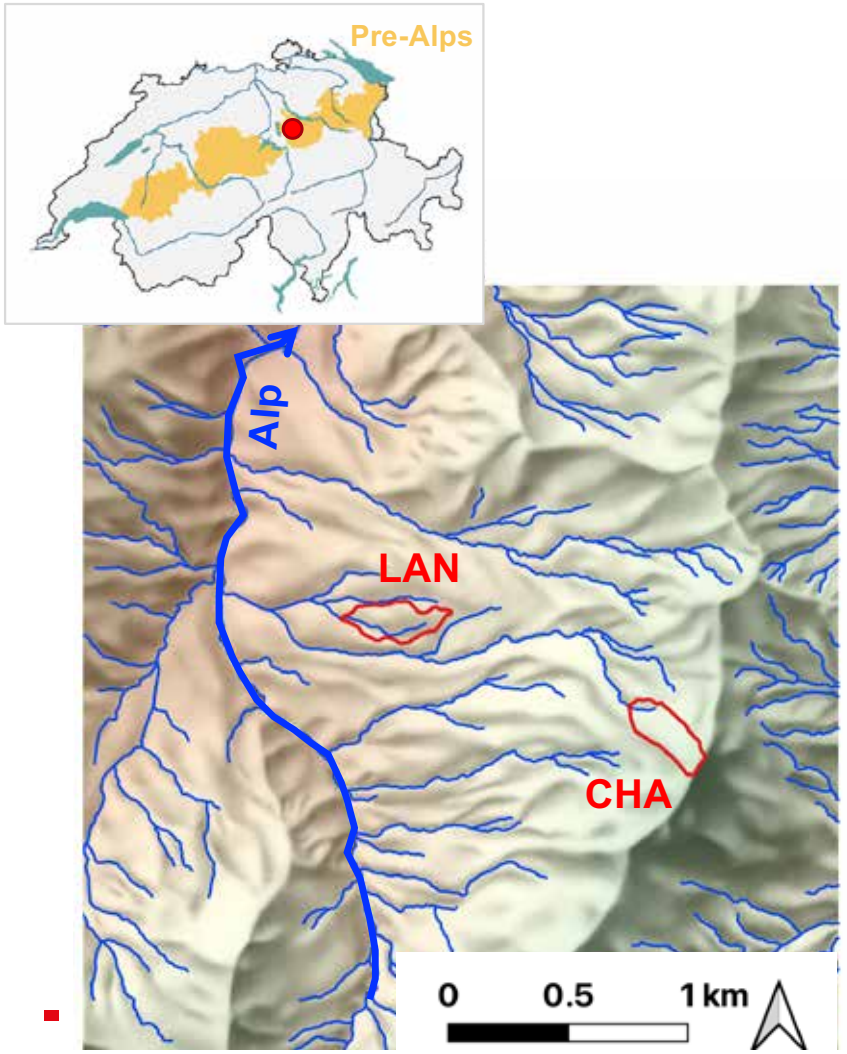
Monitoring changes in temporary stream networks during rainfall events

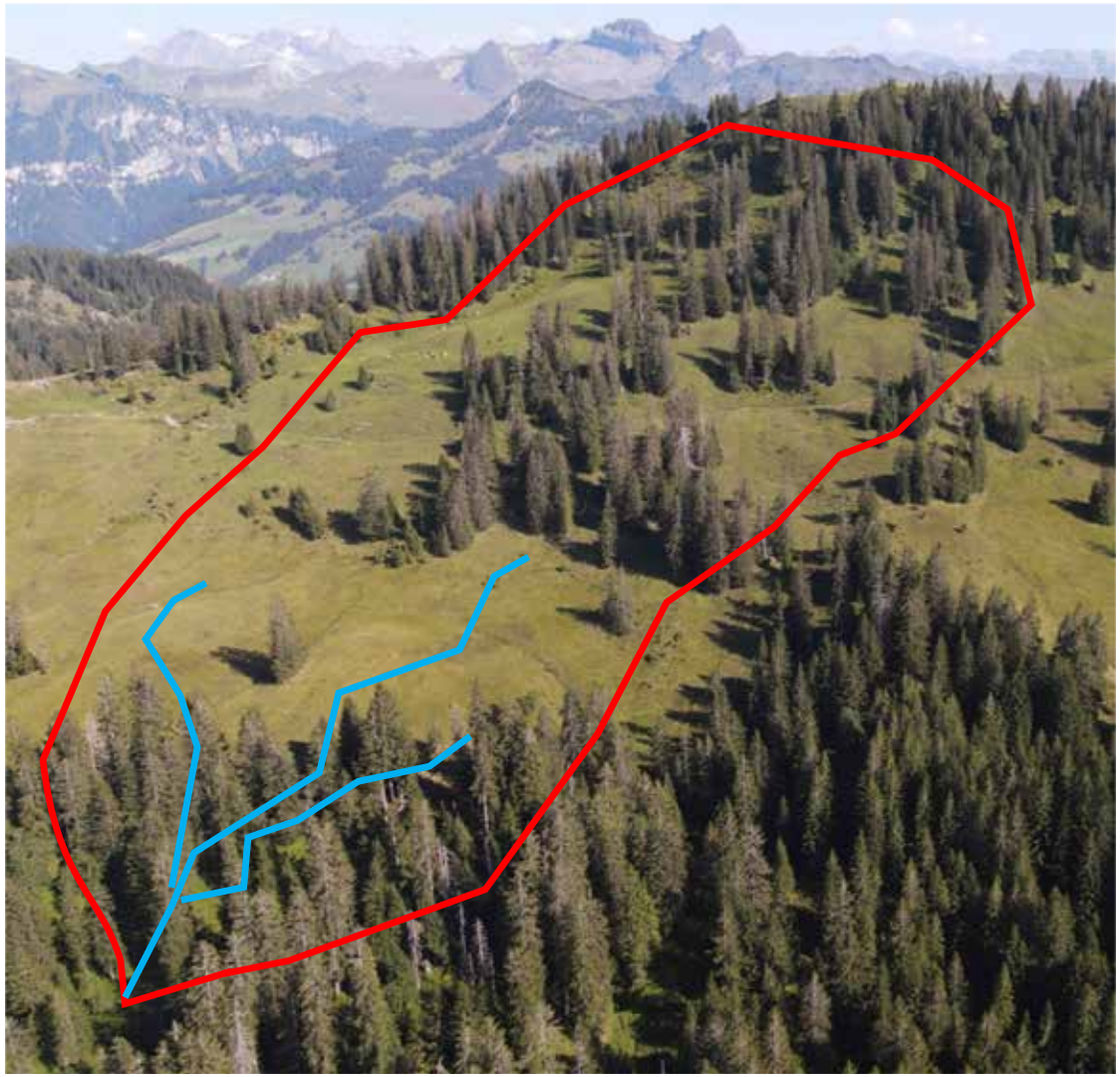
For questions & suggestions,
please contact us:

Izabela.Bujak@epfl.ch
Jana.vonFreyberg@epfl.ch

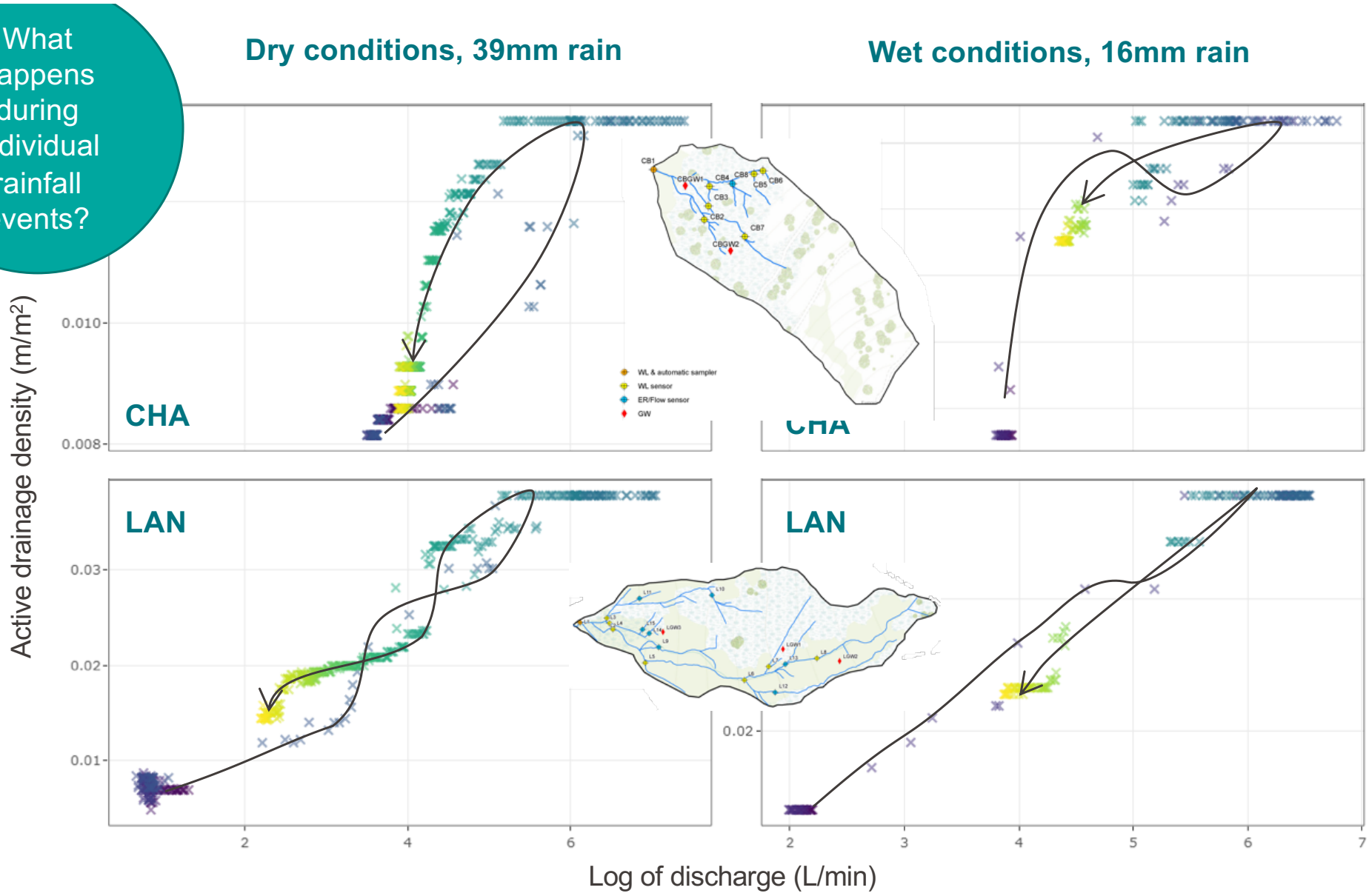
Follow us on Twitter #TempAqua

Study sites in the Swiss Alptal catchment





What happens during individual rainfall events?



Using the TempAqua App to map the dynamic expansion and contraction of stream networks in the Swiss Alptal catchment

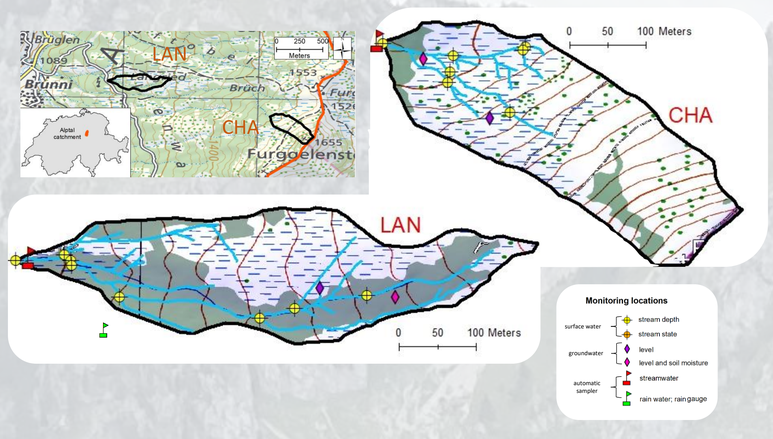
Izabela Bujak[1,2], Andrea Rinaldo[1,3], Ilja van Meerveld[4], Jana von Freyberg[1,2]

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

Motivation

Our knowledge of the relationships between flowing stream network dynamics and water quantity and quality in headwater catchments is still limited because experimental data on dynamic expansion and contraction of stream networks remain sparse due to time- and labor- intensiveness hindering the data collection.

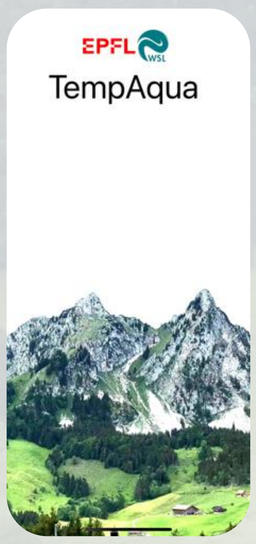
Field sites

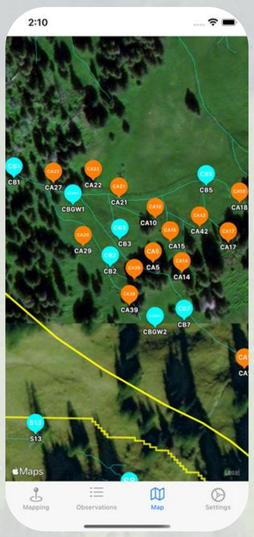


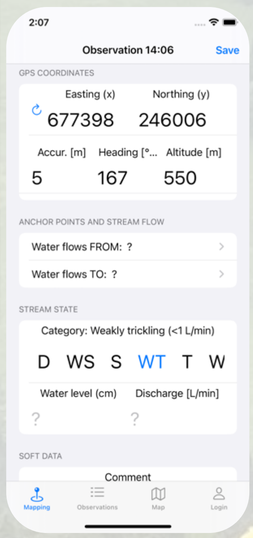
Methodology

In summer 2021, we performed 32 mapping surveys in the two study catchments CHA and LAN. To shorten the time required for mapping and obtain high spatial-resolution data of the dynamic stream networks we used **a self-developed mobile phone application** (TempAqua app available on App Store).

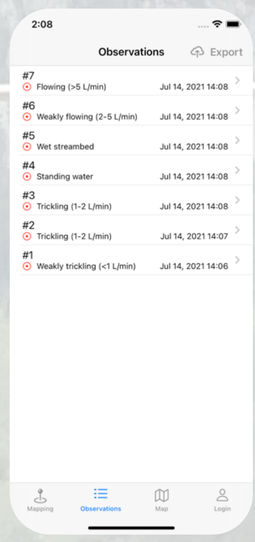
The new TempAqua App for fast and exact mapping of temporary streams

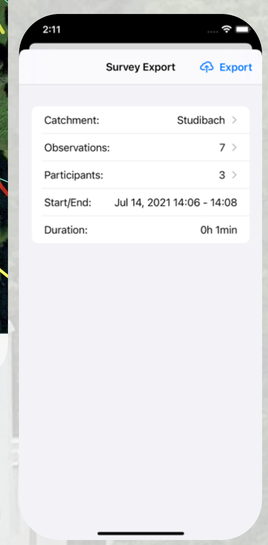






- The app helps you to navigate in the field, and to record the stream-related data during your field survey.
- The app is configurable; you can import your own maps (e.g, pre-defined mark-points, stream networks, and catchments boundaries).
- The mapping mechanics is fairly simple. You navigate to interested locations based on your current position and imported maps. You enter in the app the data collected in these locations, like current stream state, discharge, water lever, comment, photos, or even movies of the flowing stream.
- The app does not require internet connection during mapping.
- After all, you click a button to simply export all the data directly to the database.





Results

Short-term variations in drainage density are substantial.

The temporary stream networks in the two investigated catchments were highly variable with a drainage density of the flowing stream network ranging from:

- 2.1 to 29.7 km/km^2 for the LAN catchment (left)
- 7.0 to 14.5 km/km^2 for the CHA catchment (right).

Outlook

The collected high spatial-resolution data on stream network dynamics combined with monitored hydrochemical (major ions, stable isotopes of water) and hydrometric (i.e., flow state, discharge, groundwater levels, soil moisture, precipitation) parameters will be used to investigate the relationship between flowing stream network dynamics and water quantity and quality contributing to better understand the processes driving stream network dynamics.

Contact: izabela.bujak@epfl.ch, izabela.bujak@wsl.ch,
EPF Lausanne, School of Architecture, Civil and Environmental Engineering, Lausanne, Switzerland,
Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Mountain Hydrology and Mass Movements, Birmensdorf, Switzerland
www.izabelabujak.com