TRACING STEMFLOW INFILTRATION WITH A SIMPLE EXPERIMENT USING GEOPHYSICAL SURVEYS AND STABLE WATER ISOTOPES

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Motivation and objectives

In forested catchments, **stemflow** affects the precipitation amount infiltrating into the soil

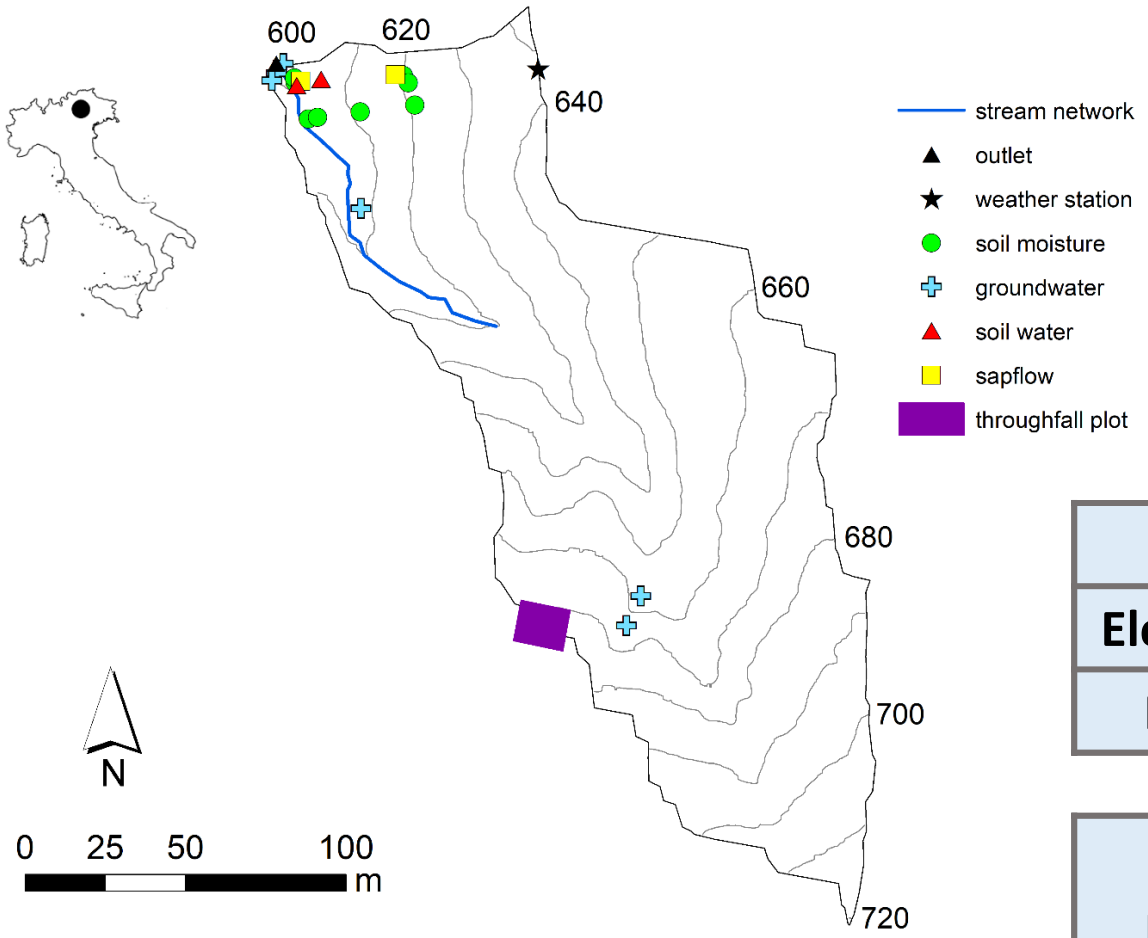
The role of stemflow depends on the **infiltration area** and its size is currently a topic of interest and debate within the ecohydrological community

However, **direct observations** of stemflow infiltration area are **rare**

Research objectives

- Present a simple experiment to simulate stemflow
- Verify the usefulness of stable isotopes and time-lapse geophysical measurements to trace stemflow infiltration

Study area: Ressi experimental catchment

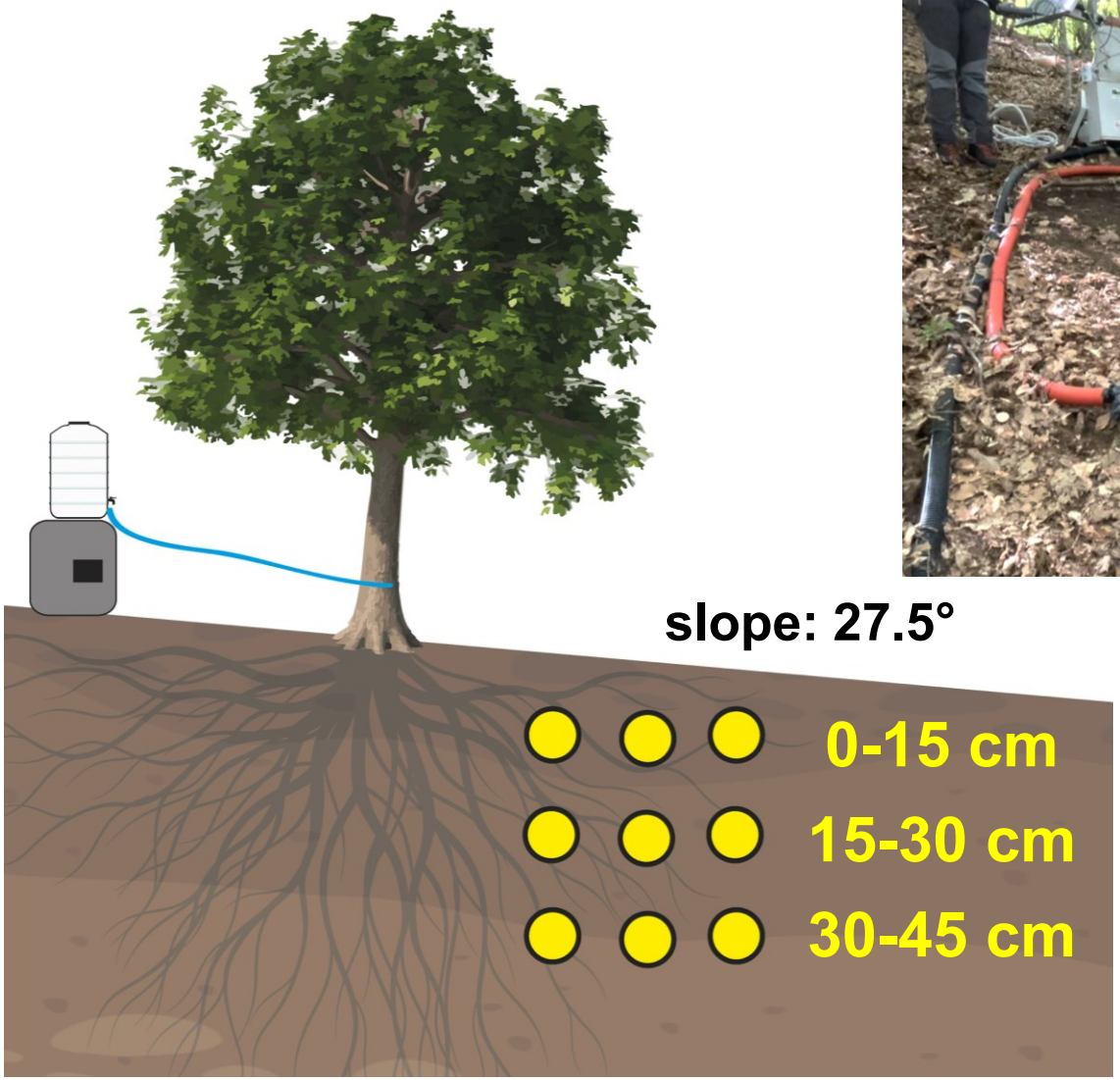


Area (km²)	0.02
Elevation (m a.s.l.)	598-721
Mean slope (°)	31

Average annual precipitation (mm)	1695
Average annual temperature (°C)	9.7

Information on the catchment and the hydrometeorological monitoring in Zuecco et al. (2021)

Description of the experiment



- Beech tree with a 12 cm diameter
- Dry period in September 2022
- Soil samples at three different depths

Description of the experiment

- 26 L of water, stemflow rate of 6 L/hr
- Procedure similar to Llorens et al. (2022)
- Labelled water enriched in salt (electrical conductivity was 1072 µS/cm) and depleted in heavy isotopes ($\delta^{2}H$: -88.7 ‰, $\delta^{18}O$: -12.92 ‰)

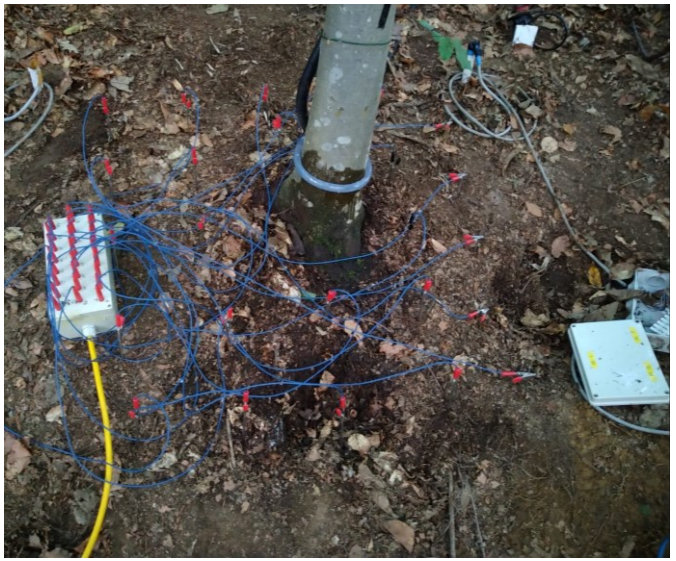
Time-lapse geophysical measurements

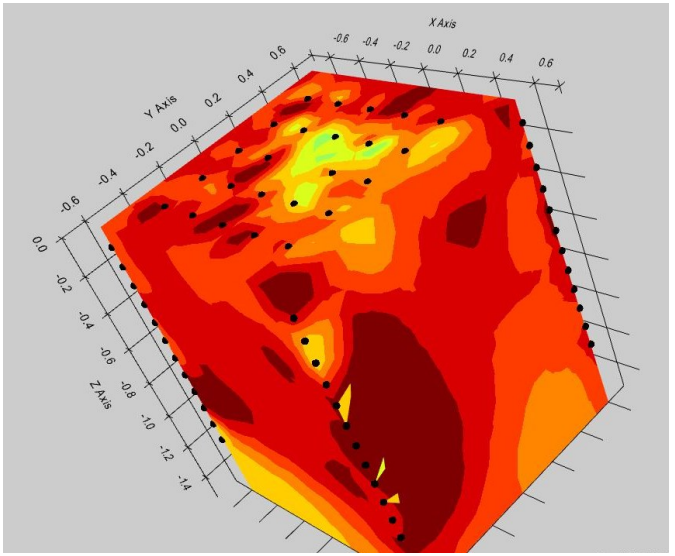
Geophysical surveys (by ERT) took place on 6-7 September 2022:

- t0 as background measurement before the simulated stemflow
- t1-t4 during the stemflow
- t5-t8 after the end of the stemflow

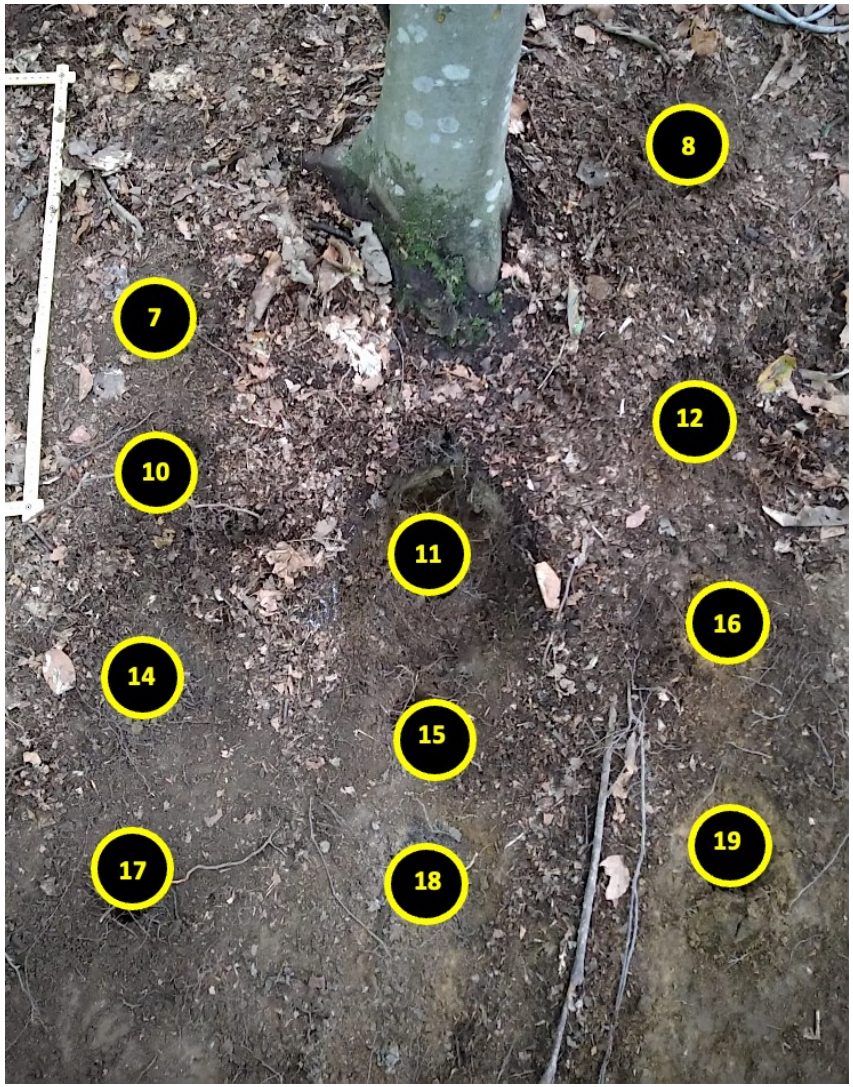
t8 measurement taken about 24 hours after the start of the simulated stemflow

Differences in resistivity were determined between t1-t8 and the background t0





Samples for extraction of soil water for isotopic analysis

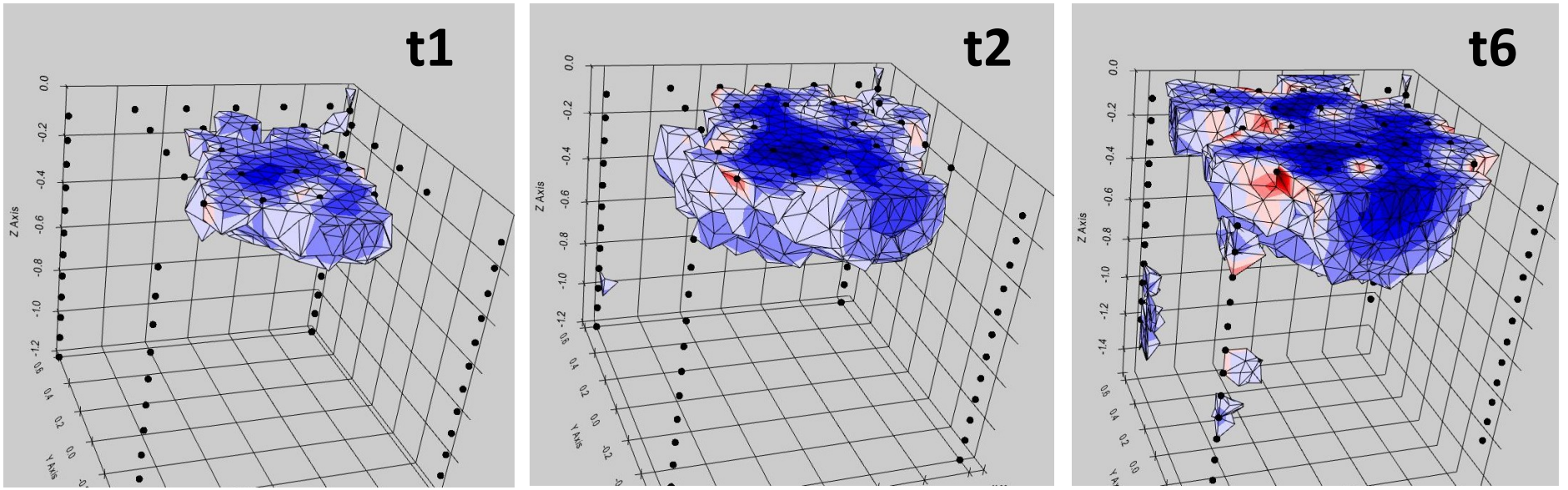


- After t8, manual soil moisture measurements at 0-6 cm depth were taken between the electrode locations
- 66 soil samples for isotopic analysis collected from 11 locations at 0-15, 15-30 and 30-45 cm
- Cryogenic vacuum distillation for soil water extraction

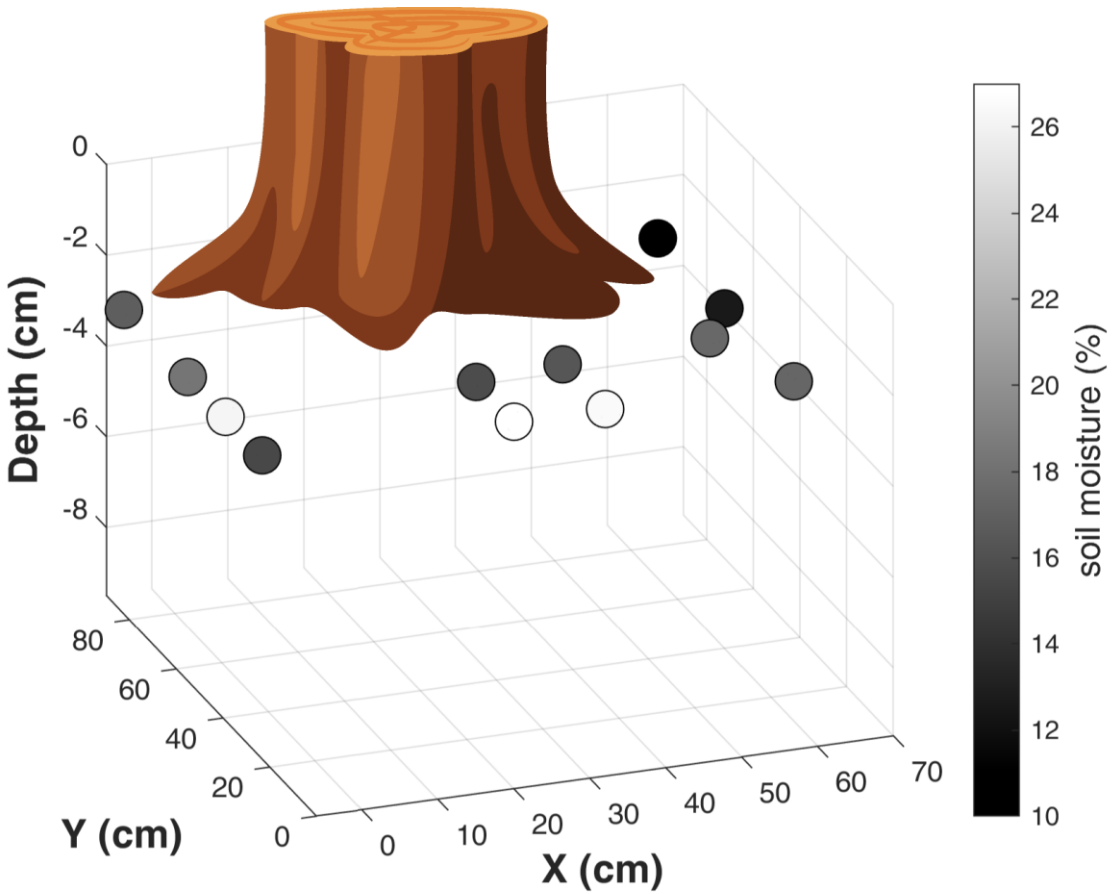
Results: time-lapse geophysical measurements

- Fast infiltration and movement of the water downslope
- At the monitored site, in the first 24 hours the infiltrated water reached a 60-80 cm depth

1 hr after the start **2 hr after the start** **≈7 hr after the start**

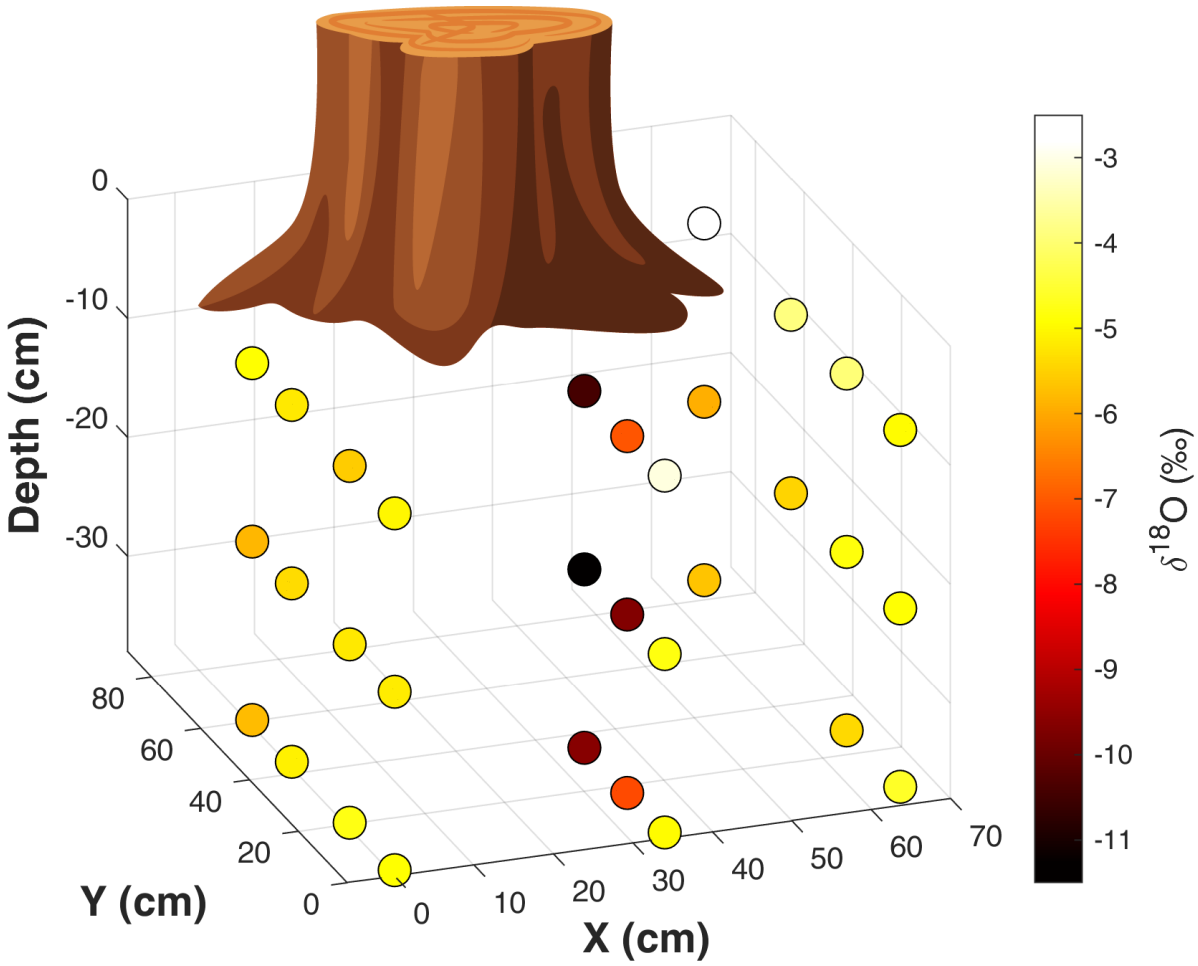


Results: surface soil moisture



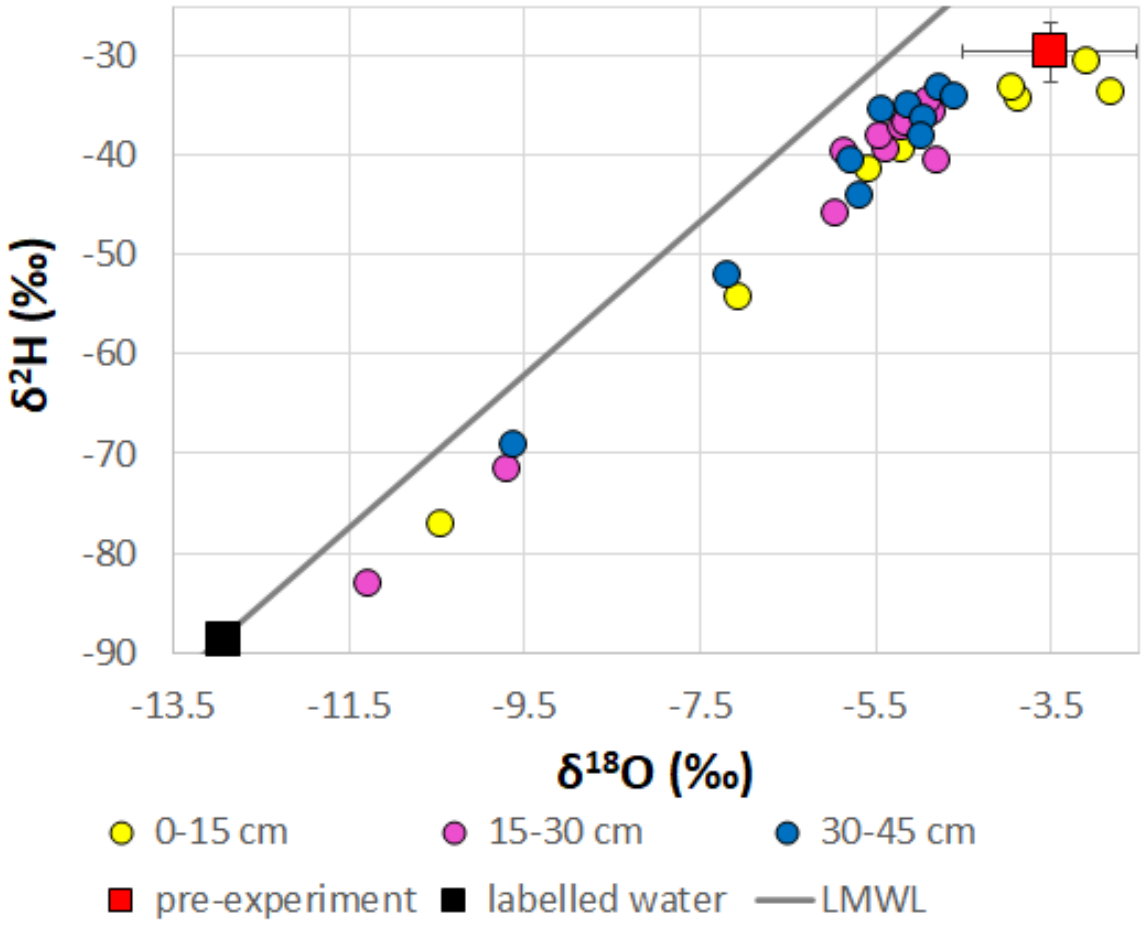
- High spatial variability of shallow soil moisture
- Clear role of surface microtopography which drove the infiltration

Results: isotopic composition of soil water



- Stemflow infiltrated mainly following the maximum slope gradient
- Clear role of surface microtopography which drove the infiltration

Results: isotopic composition of soil water



- Soil water after the experiment reflected the mixture between soil water pre-experiment and the negative labelled water
- Soil water had an isotopic composition close to the labelled water in some specific sites located downslope of the stem

Concluding remarks

- Rapid infiltration of stemflow along the root system of the beech tree. The infiltration path was confirmed by the results of the time-lapse geophysical surveys

- Isotopic signature of soil water clearly indicates the preferential infiltration of the stemflow

- Isotopically-labelled water is useful to simulate stemflow and trace double-funneling, but the sampling is destructive

- **Next steps:** check uncertainty and artefacts in the resistivity data, estimate the stemflow infiltration area and volume, estimate the mixture in soil water by stable isotopes…

References:

Llorens et al., 2022. Stemflow infiltration areas into forest soils around American beech (*Fagus grandifolia* Ehrh.) trees. *Ecohydrology, 15, e2369*. DOI: 10.1002/eco.2369

Zuecco et al., 2021. Ressi experimental catchment: ecohydrological research in the Italian pre-Alps. *Hydrol. Process., 35, e14095.* DOI: 10.1002/hyp.14095

Thank you for the attention