Tracing Subsurface Stormflow (SSF): Insights into Preferential Flow and Pre-Event Water Contributions from Controlled Sprinkling Experiments

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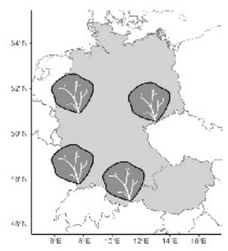
Intro

- SSF may account for up to 90% of rainfall input in stream discharge [a]
- Occurs below ground, therefore difficult to observe and measure
- High spatial variability and different activation thresholds [b]

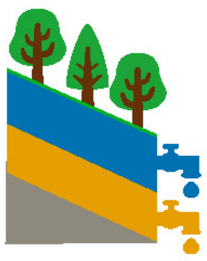
HYDROLOGY

How does precipitation become SSF?
SSF is a fast event response - so does it mainly consist of event-water?

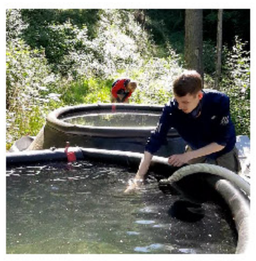
Methods



Four low mountain/ alpine catchments

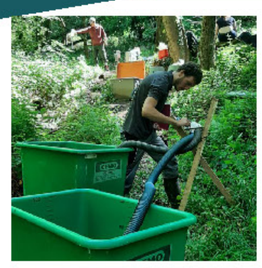


1-3 dual layer Trenches sprinkeled



Two Reservoirs One labeled δ^2H

Sprinkled with ~16 mm/h for >3h



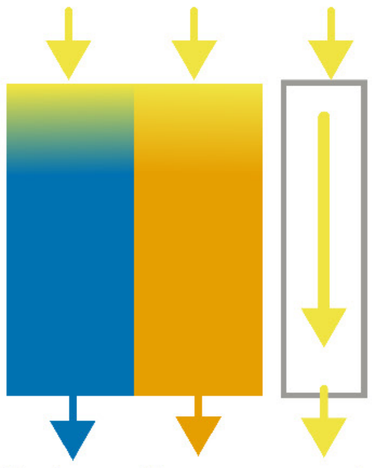
Continuous outflow monitoring

Manual samples every 20 min

Drilling to refusal depth

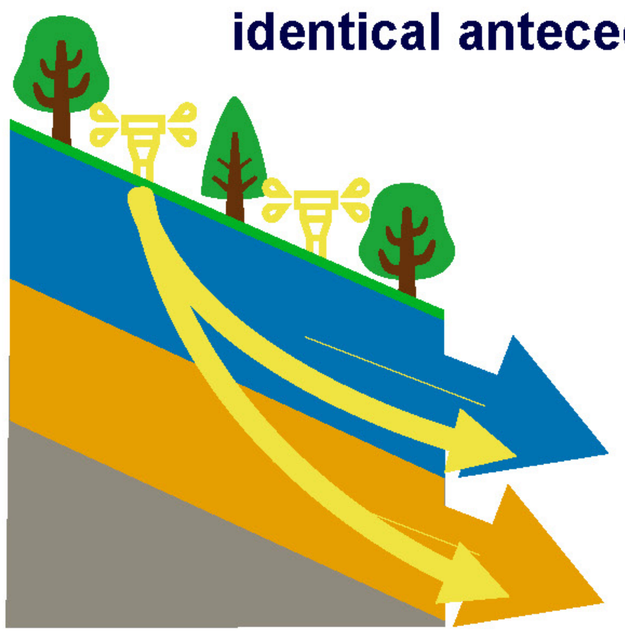
Sampling for Direct Vapor Equilibration

Flow Mechanisms



- **Piston flow** remobilizing stored water
- **Preferential flowpaths** transport quick but little traced water

Hillslope SSF reaction is highly variable, even in the same catchments with identical antecedent conditions

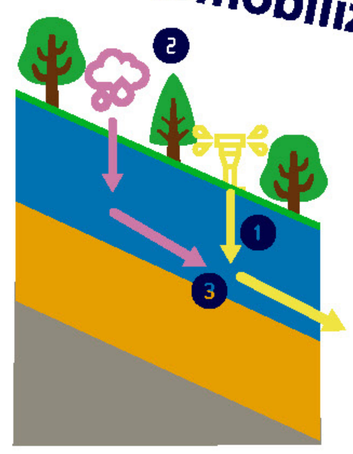


Time to 1% traced water in SSF: **1 min to 71 min**

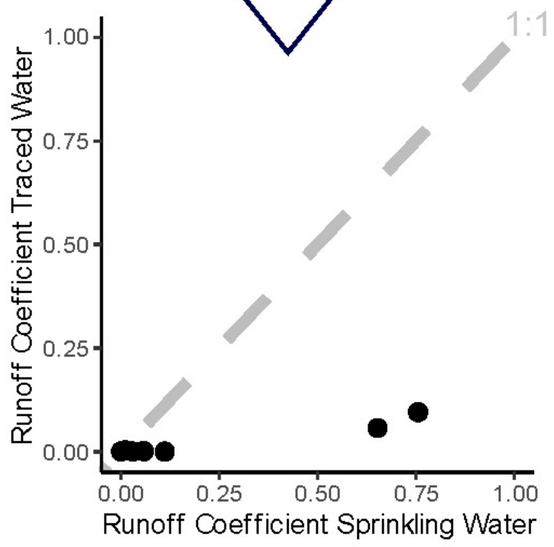
Maximum traced water: **4% to 61%**

Traced water at discharge peak: **0.5% to 17.5%**

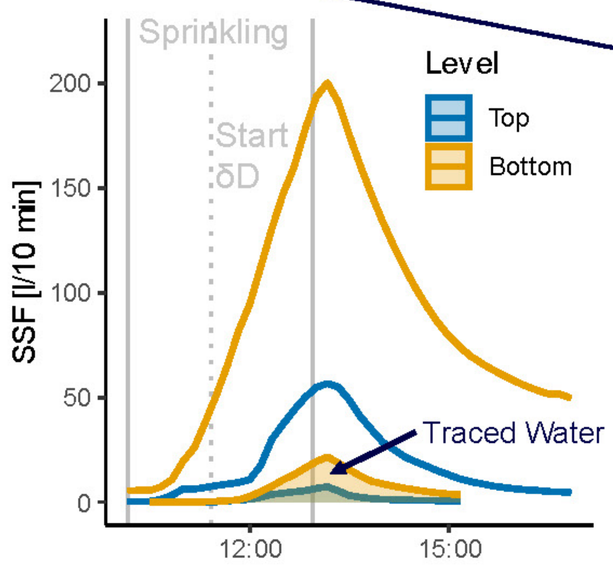
Storage & Remobilization



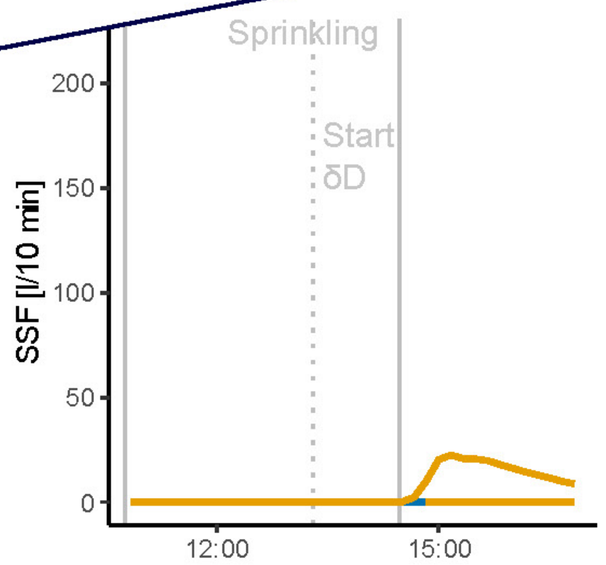
1. Traced water infiltrates & is stored in soil
2. Next rainfall infiltrates & remobilizes water
3. Traced water contributes to SSF



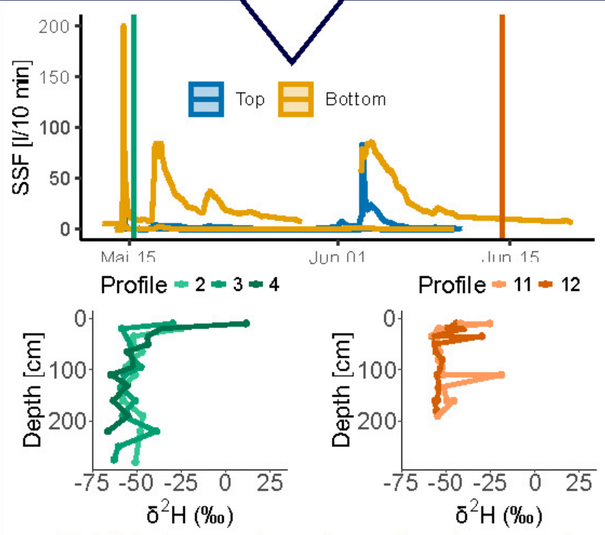
- Trench SSF reaction is only fraction of sprinkling input
- Traced water contributes substantially lower to SSF



- Bottom trench section has substantially higher SSF, also more traced water discharged
- No steady state was reached



- Only Bottom section reacted after irrigation was stopped
- No traced water was detected within the day



- 7.5% traced water discharged on the same day, min. 70% water stored in topsoil
- 27% traced water discharged in the first month

Conclusion

- **Precipitation infiltrates into hillslope soils where a small portion is directly discharged as SSF while the rest seeps into soil storage**
- **The majority of SSF water was in the hillslope previous to precipitation**

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Sources:
[a] Beasley (1976). Contribution of Subsurface Flow from the Upper Slopes of Forested Watersheds to Channel Flow
[b] Woods & Rowe (1996). The Changing Spatial Variability of Subsurface Flow Across a Hillside

[3] BFW AUSTRIAN RESEARCH CENTRE FOR FORESTS
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