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Monitoring changes in temporary stream networks during rainfall events

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Stream networks are important flow pathways along which water transports solutes, sediments and affects living communities. Field observations in headwater catchments have shown that the networks of actively flowing channels are not static, but rather expand and contract over time, depending on the intensity and timing of hydro-climatic forcing. Until now, however, flowing stream networks (FSNs) have been mapped only sporadically and environmental tracer data to explore the varying stream-landscape connectivity are lacking. Thus, little is known about how and why these networks change and what the implications are for streamflow, water quality and biodiversity.

To gain detailed insights into the mechanistic links between FSNs and catchment hydrological processes, we investigated two 4-ha head watersheds in the Alptal valley in central Switzerland. We deployed a wireless sensor network in the field to obtain spatially distributed continuous data of flow occurrence. In addition, we conducted multiple mapping surveys using a self-developed mobile phone application. Our data show that the total flowing stream length increased rapidly by more than a factor of 3 during individual rainfall events. This suggests that different water stores become dynamically connected to the stream network and disconnect again during subsequent dry periods. We test this hypothesis by linking short-term changes in FSN length to variations in subsurface water storage and water chemistry. The results help to broaden our understanding of flow intermittency in pre-Alpine headwater catchments, and thus aids in developing effective strategies to protect ecosystems dependent on temporary flow conditions.