Assessment of temporary stream dynamics in a mountainous headwater catchment using a multi-sensor monitoring system

Rick Assendelft, Ilja van Meerveld, Jan Seibert

University of Zürich, Switzerland (rick.assendelft@geo.uzh.ch)

University of Zurich[UZH]

Introduction

Temporary streams: Streams that alternate between wet and dry states, both seasonally or in direct response to precipitation events.

Relevance of temporary streams:

- > 50% of the total length and discharge of the global stream network
- hydrological importance: influence downstream water quality and discharge
- ecological importance: unique habitats, migration corridors and biochemical hotspots
- particulary sensitive to climate change and other human disturbances

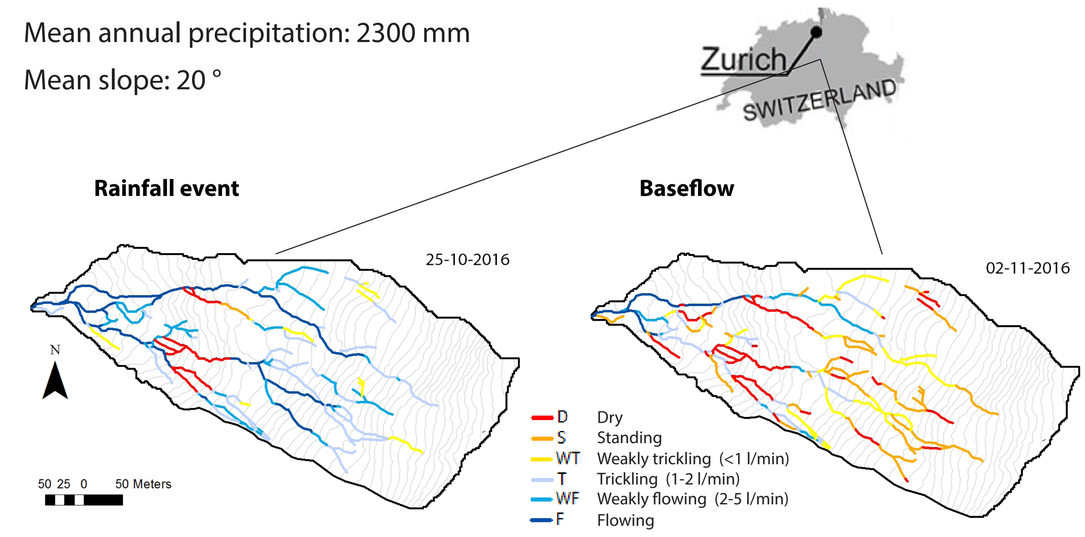
Research gap: Until now, most research on temporary stream dynamics has relied on mapping the stream network and therefore mostly seasonal changes have been described. There is however a lack of high temporal resolution monitoring of dry, pool and flowing states in temporary streams to provide information on temporary stream dynamics during rainfall events.

Objective: Design a system to monitor the presence of water and the occurence of flow in temporary streams and use it to asses temporary stream dynamics during rainfall events.

Study area

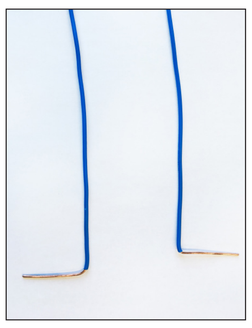
A **0.12 km² headwater catchment** (WS41) of the Alptal catchment in Switzerland.

- Elevation: 1533-1656 m.a.s.l.
- Mean annual precipitation: 2300 mm
- Mean slope: 20 °



Multi-sensor monitoring system

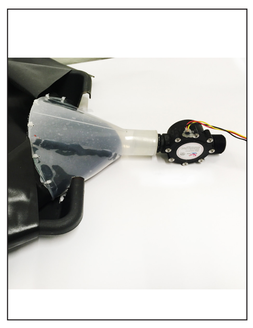
Sensor	Specifications	State info
Electrical resistivity sensor	Two copper wires	Water/no water
Float switch	Float with magnet and reed switch in vertical stem	Water/no water
Temperature sensor	Thermistor	Water/no water
Flow sensor	Valve body, rotor, Hall-effect sensor, funnel and tarp	Flow/no flow



Electrical resistivity sensor

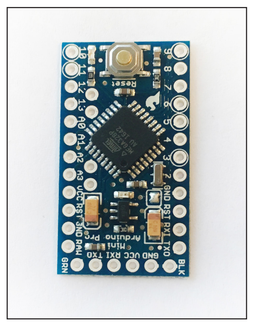
Float switch

Temperature sensor



Flow sensor

Operation	Specifications
Microcontroller board	Arduino Pro Mini 5V, 16MHz, based on ATmega328
Data logger	Shield with SD-card interface and RTC clock



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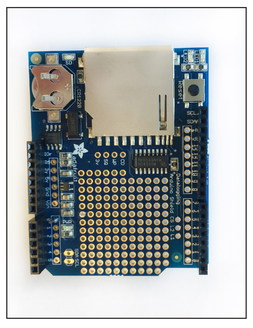


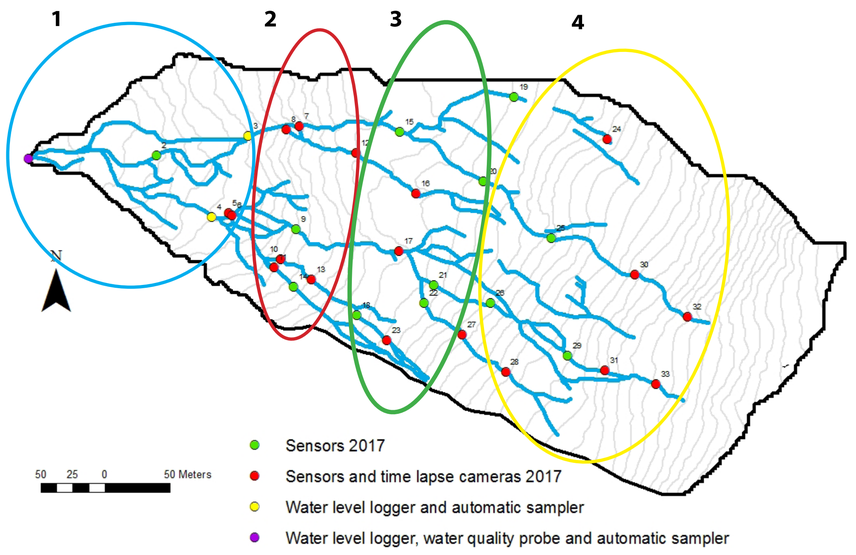
SD-card logger shield

Power saving measures:

- Sleep timer
- Power down senors using MOSFET
- Power LED removal

Monitoring setup

30 monitoring systems were installed throughout the catchment



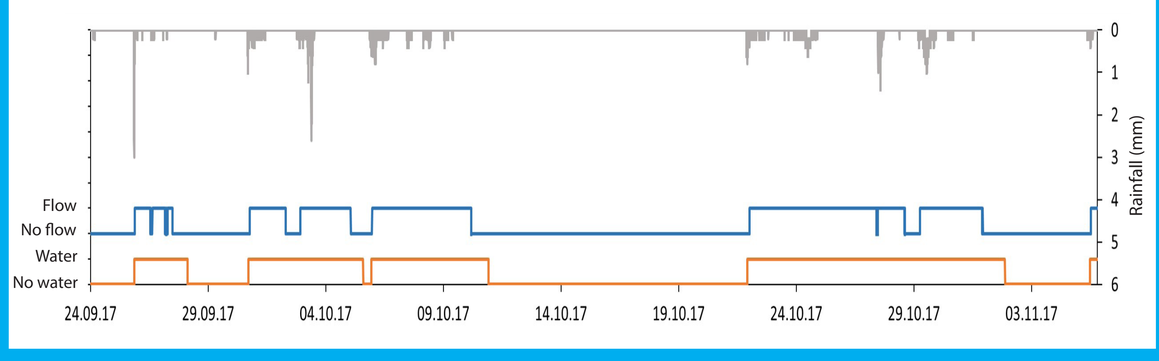
1. Gently sloping forests and wetlands with relatively large streams

2. Steep forested slopes with bedrock and boulder dominated streams

3. Flat wetlands with small streams

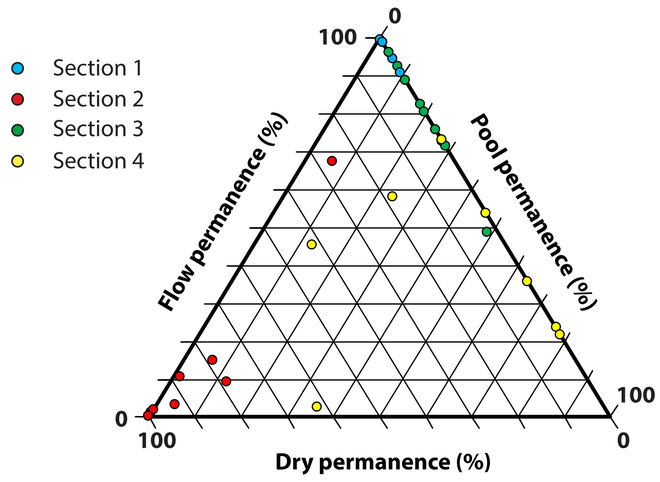
4. Steep meadows with narrow step-pool streams

Example of processed sensor data



Preliminary results - temporary stream regimes

The dry, pool and flow permance were determined for every monitoring location and plotted in a FDP (flow-pool-dry) plot to asses the dominant regime (Gallart et al. 2017). The monitoring locations locations are subdivided into the four main sections of the catchment.



Dominant flow regimes:

Section 1: Quasi-perennial
Section 2: Episodic
Section 3: Quasi-perennial and Fluent-stagnant
Section 4: No dominant regime but relatively high pool permanence

Preliminary results - timing of the onset of flow

The rank of the timing of the onset of flow was determined for six rainfall events. The ranks were similar for most events. To compare the patterns for the six events, the correlation coefficient (r_s) was determined between the ranks of the timing for each event combination. The ranks were most similar for events with similar antecedent moisture conditions ($r = 0.70$, $p < 0.05$).