A new image based approach to measure discharge and soil saturation

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Motivation

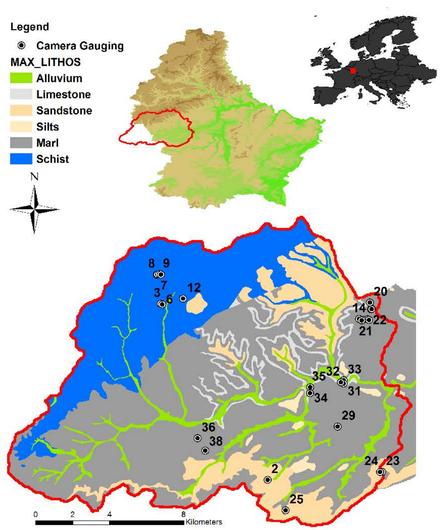
Discharge and soil moisture measurement are crucial to understand the contributions of hill slopes to an expanding stream network. This method was developed as an cheap (~ 150 $ / system) sensor network to monitor multiple streams (~100) in the intermediate-scale Attert catchment. The number of gauging sites and the distances between the sites demanded a system that can be quickly installed and maintained.

Objectives

1. Find a cheap and robust monitoring method which can be installed in an fast and easy way and is capable to be used for monitoring of temporal stream networks.

2. Implement a tool for (semi-)automatic data processing.

Study Area – Attert Catchment



Methods

Sensor Setup

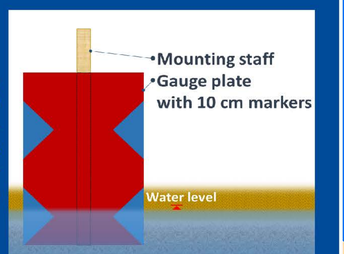
We use a camera system including:

- Wildlife camera Dörr Snapshot Mini 5.0 5 MP, RGB (day) & IR (night)
- Locks & mounting belt
- External battery pack FIAMM FG 10451
- Gauging plate system
- Carbon fiber stick in wooden foundation
- Mechanical/optical saturation sensor system

- Images are taken at 15 min interval
- intervals between 5s and 8h are possible
- Battery and SD-card capacity last for ~ 2 month

Water level measurement

Water level is measured on a wooden plate (40 cm x 60 cm). The scale bar is painted with spar varnish. The design of the scale bar is triangular due to performance issues of the Hough - transformation algorithm during processing.

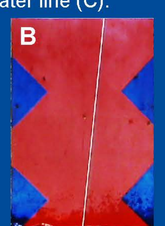


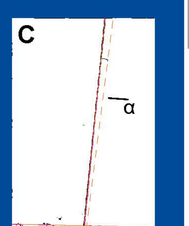
Water velocity measurement

Water velocity is obtained from the relation of water velocity and water pressure. A carbon-fiber stick (2 mm Ø) is used that bends due to water pressure. The bending angle α of the carbon fiber stick can than be related to the water velocity & level. The floating body can transmit more pressure to the stick due to it's bigger profile.

Image Processing

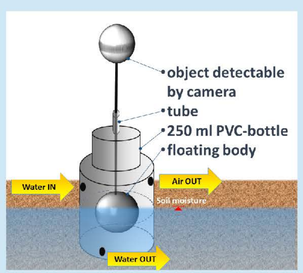
The Java based software ImageJ – Fiji is used for image processing. Semi-automatic data processing is provided by a plugin that can be run in the ImageJ environment.
Reducing the raw image (A) to a smaller extend speeds up computing power on operations. A histogram stretch and Gauß-filter is applied. The cropped image is referenced to a frame of 400 x 600 px that represents the 40 cm x 60 cm extend of the plate. All images of the time-lapse series will be registered and cropped to the extend of the plate (B). Finally a color/brightness threshold and a Sorbel-edge detector is applied to identify the waterline and the carbon fiber stick The final image can be analyzed by a Hough-transformation on the straight lines of the carbon fiber stick and the water line (C).





Outlook

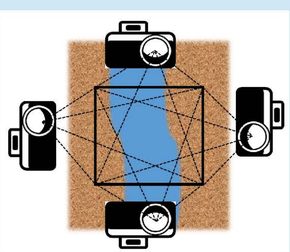
Soil saturation measurements



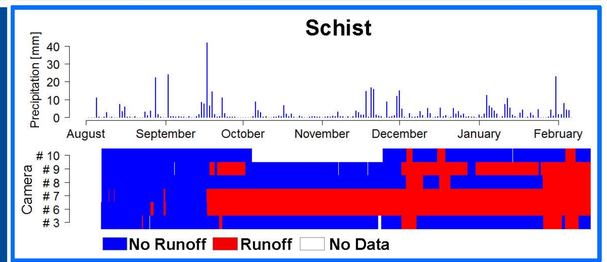
The soil saturation sensor consists of a 250 ml PVC bottle with holes for water in- and out-take. In the bottle a floating body will be risen during higher water level. That floating body is connected with a carbon fiber stick to a marker ball whose position can be monitored by the camera.
A tube will ensure the upright position of the connecting stick. The Sensor is currently in developement

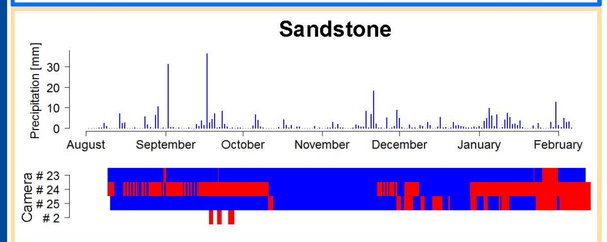
Channel geometry

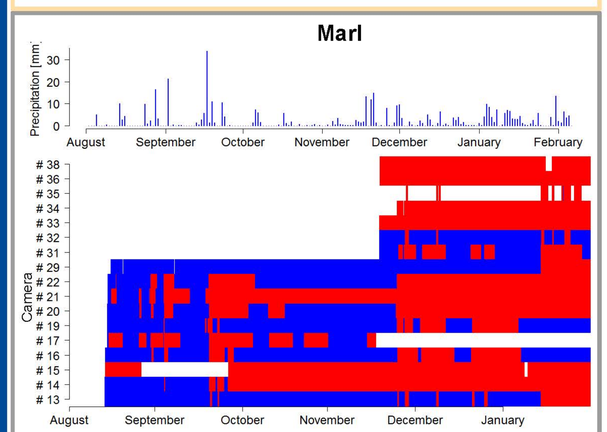
Channel geometry can be measured under low flow or dry conditions in the temporal stream network. A photogrammertric method from Haas et. al (2015) will be used to obtain a micro DEM of the river bed. Therefor pictures from four position around the riverbed will be taken using a frame with markers.



Preliminary Results







References

Haas J., Hagge Ellhöft K. & Schack-Kirchner H. (2015): Rut formation induced by Forwarders – Comparison of three different tire options regarding trafficability preservation of skid trails in highly mechanized timber harvesting. Final Report.

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