# Simulating the variability of surface saturation generation in a forested catchment

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**Abstract**

The occurrence of surface saturated areas is an important phenomenon in catchments since it affects runoff generation and water quality. In the past, numerous field and model studies dealt with surface saturation patterns, their generation and their predictability. Nonetheless, the various hydrological processes that lead to the formation of saturated areas and control their spatial and temporal variability are still not fully understood. Integrated surface subsurface hydrologic models (ISSHM) allow to simulate the generation of surface saturation with a holistic approach, including water sources from below and above the surface. Yet, rigorous tests and spatial validations of ISSHM with respect to the complex generation processes of saturated areas and their spatial and temporal variability are missing.

In this study we demonstrate up to which extent an ISSHM can reproduce the variability of surface saturation patterns and of their expansion and contraction dynamics within a small catchment. We implemented the ISSHM HydroGeoSphere for the Weierbach catchment (45 ha), a forested headwater in the west of Luxembourg. The Weierbach is an intermittent stream and surface saturation mostly occurs in the adjacent riparian zones. In order to simulate the spatio-temporal evolution of the stream and the surface saturation in the riparian zones we used a nested mesh with small element sizes (few centimeters) in the stream bed and the adjacent riparian zones. The model parameterization relied on various information derived from field observations and on previous modelling experience for a 6 ha sub-catchment of the Weierbach [1]. Simulations were run for a period of two hydrological years (November 2015 – November 2017).

The simulated surface saturated areas were benchmarked against a comprehensive field campaign of surface saturation observations. The surface saturation patterns were mapped with thermal infrared images, a new technique for mapping surface saturation variability over time and space [1,2]. Several riparian areas distributed along the Weierbach stream were mapped in biweekly recurrence frequency from November 2015 to November 2017. This field mapping campaign provided detailed insight in the variability of surface saturation patterns and dynamics within the catchment. For example, we could differentiate more and less active saturated areas, and surface saturated areas created by groundwater exfiltration could be distinguished from surface saturated areas created by ponding water.

The comparison of the simulated surface saturation with the observed surface saturation patterns (Fig.1) revealed where and when the model captured the surface saturation characteristics and where and when the model failed. On the one hand this demonstrated the capabilities of ISSHMs to reproduce variable surface saturation behaviors over an entire catchment. On the other hand, the failures of the model particularly helped to identify deficiencies in the model setup and to understand the underlying surface saturation generation processes.

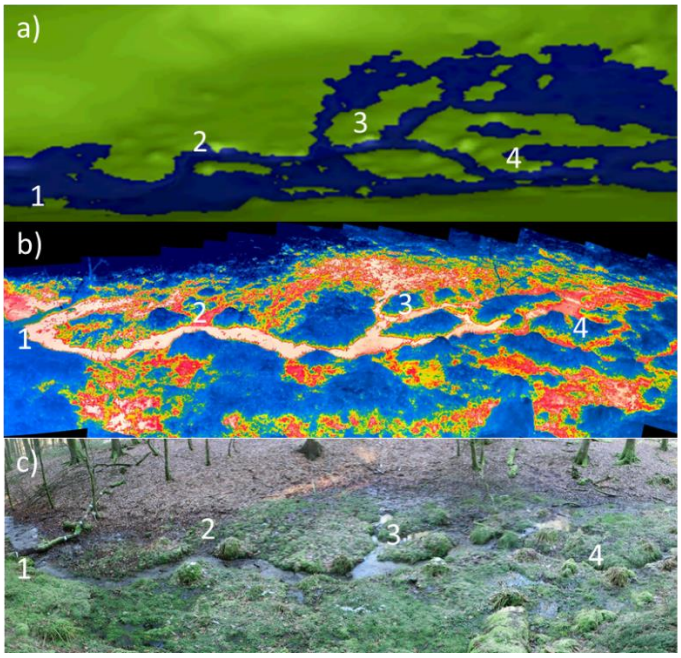


*Figure 1:* Exemplary comparison of simulated (a) and TIR imagery mapped (b) surface saturation patterns for one riparian area along the Weierbach stream (c).

**References**

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