HS2.4 – R197

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Investigating surface and subsurface mixing using hand-held IR, isotope tracers, and piezometers in a small headwater catchment (Luxembourg).

Jay Frentress[1, 2]; Núria Martinez-Carreras[1]; Jeffrey J. McDonnell[3]; and Laurent Pfister[1]

(1) Department Environment and Agro-Biotechnologies, Centre de Recherche Public - Gabriel Lippmann, Belvaux, Luxembourg; *Email: frentres@lippmann.lu
(2) Oregon State University, Department of Forest Engineering, 004 Peavy Hall, Corvallis, OR 97331-5706, USA
(3) Global Institute for Water Security, University of Saskatchewan, National Hydrology Research Centre, Saskatoon, Canada

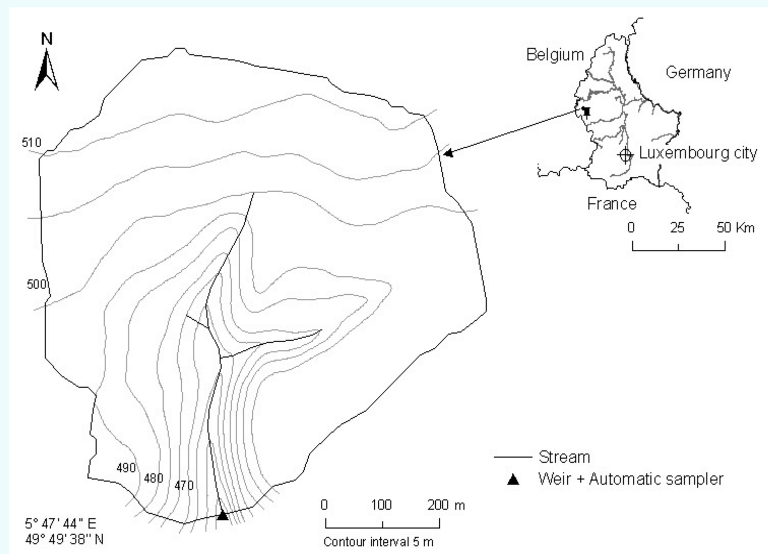
Background

Introduction

- Recent results from tracer studies implementing terrestrial diatoms indicate **surface connectivity** during rainfall events (see Pfister et al 2009). However, EMMA and hydrograph separation results suggest largely subsurface flowpaths (see **poster R202**, same session).
- While macropore or subsurface flow could potentially explain terrestrial diatom results (see **poster R201**, same session), it is possible that **exfiltrating subsurface water mobilizes** terrestrial diatoms from the near stream riparian zone.
- Controls on **mixing and connectivity of subsurface and surface sources** during events are poorly understood yet have important ramifications on fundamental mixing assumptions for EMMA and simple hydrograph separation techniques.
- The objective of this work is to **investigate subsurface and surface mixing processes** in the riparian zone using natural tracers (heat, water isotopes, cations/anions, silica) and hydrometric information (piezometers, discharge, soil moisture).

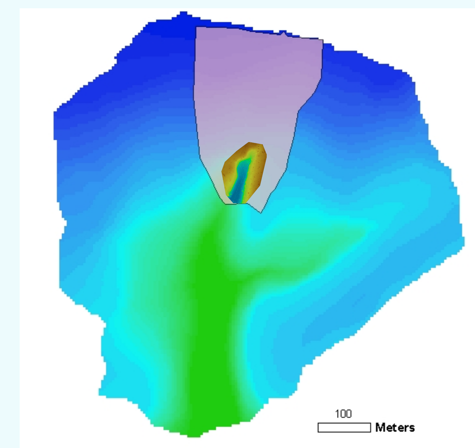
Catchment Description

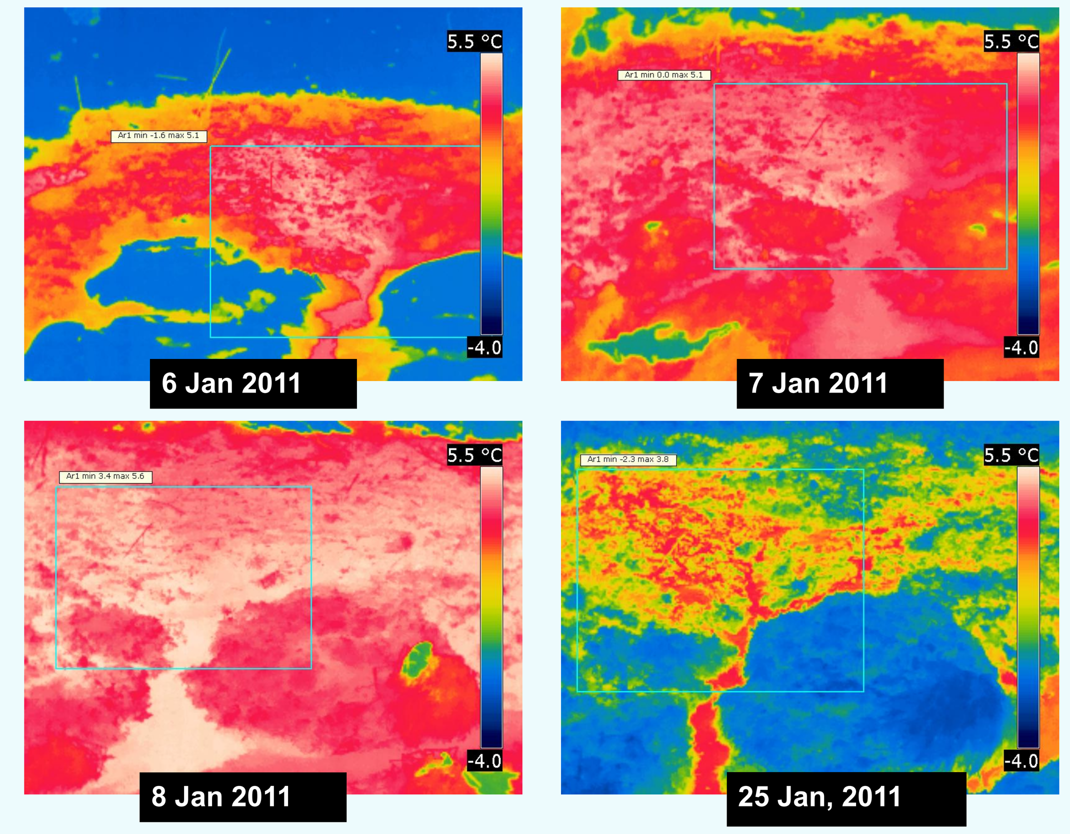
- Weierbach experimental catchment (Attert River basin, Luxembourg).
- Forested 45 ha with loamy soils (0.2 – 2 m) underlain by fractured schist bedrock.

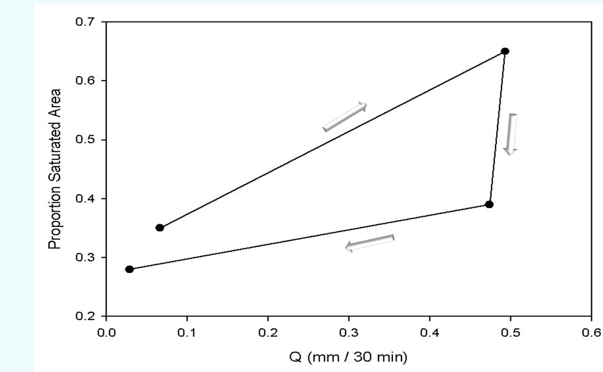


Study Area

- A 6.4 ha headwater region of the Weierbach catchment has been selected to investigate surface and subsurface mixing mixing processes.
- Shallow, saturated riparian soils (20-40 cm) within this headwater region mediate subsurface inputs to the stream network.





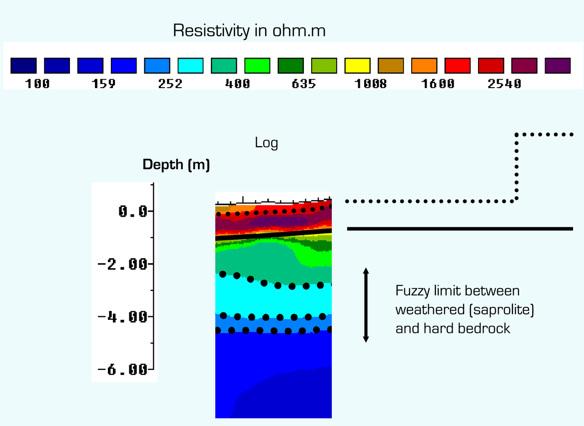


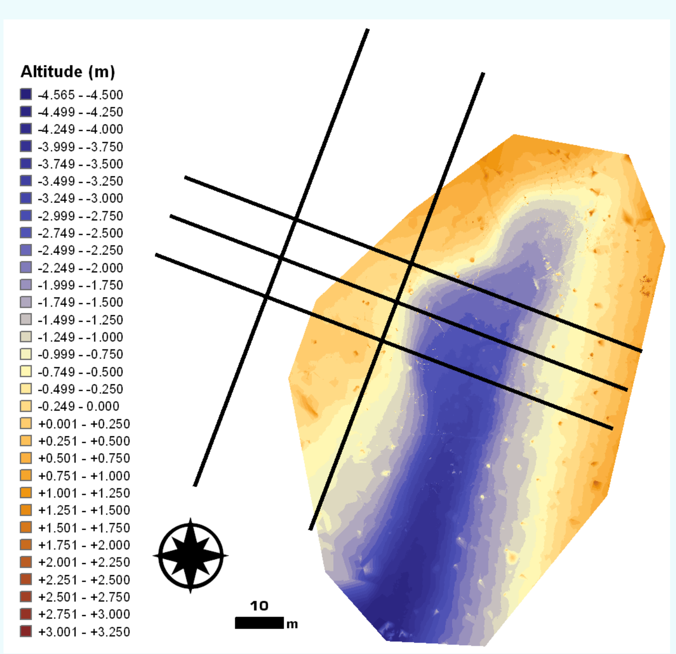
Surface Saturation Dynamics

- Infrared imagery of in this near-stream zone during a rain on snow event (4 images, left)
- Surface saturation exhibits a hysteretic relationship to discharge (above), potentially indicating a shift in surface saturation sources.

Ongoing Work

Subsurface Information from Electrical Resistance Tomography

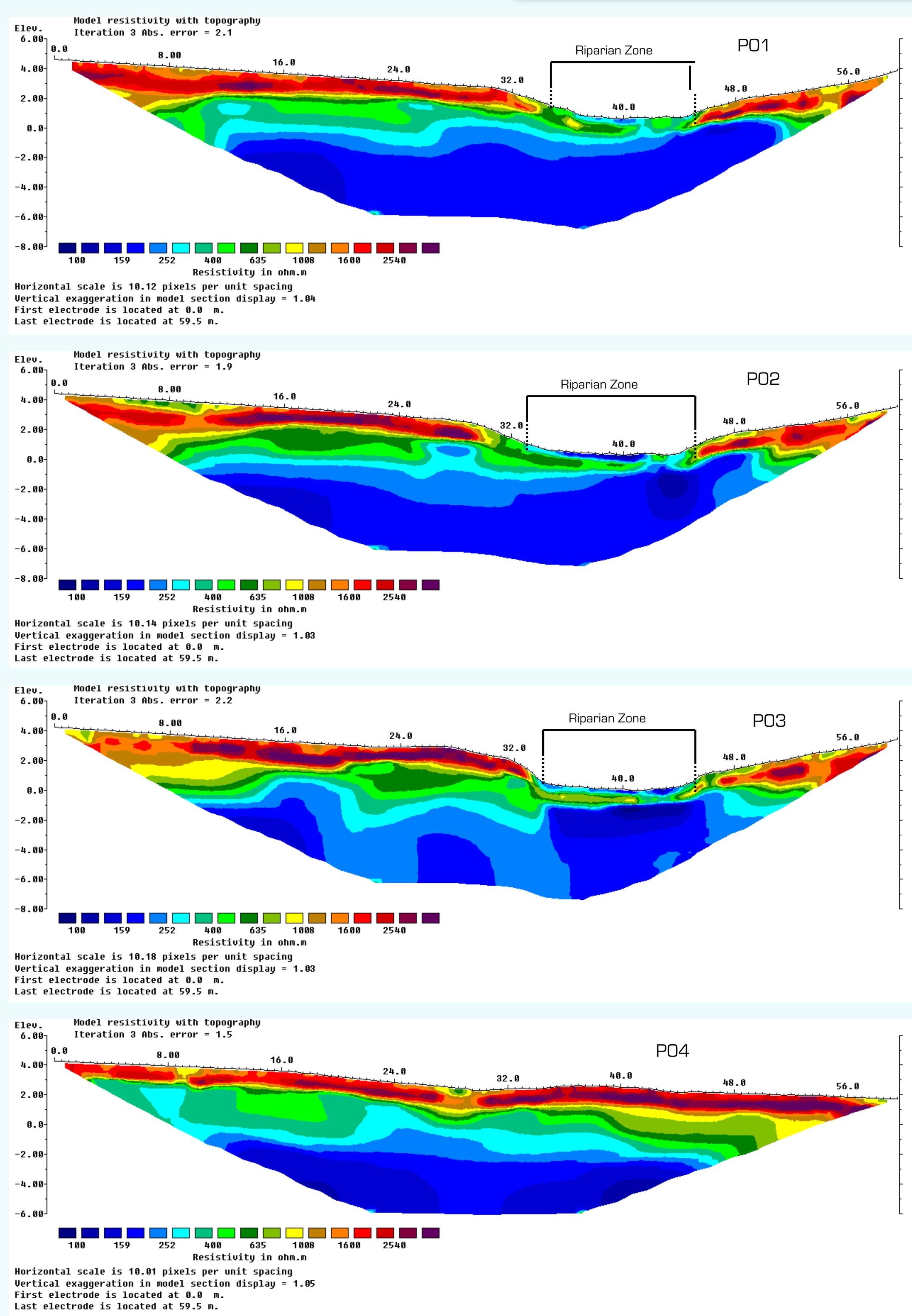




Above: Soil profile and relation to ERT.

Left: Schematic of surveyed riparian zone and hillslope.

Right: Depth and resistivity at four ERT profiles.



ERT Results

- Suggest potential subsurface flowpaths likely exist at 1-2 m depth along an interface between weathered saprolite and clastic soils (periglacial coverbeds).
- Uncalibrated results require validation of subsurface materials to ascertain hydrologic conductivity through the weathered saprolite.

Research Questions and Instrumentation

Question 1: How do subsurface dynamics relate to surface saturation development?

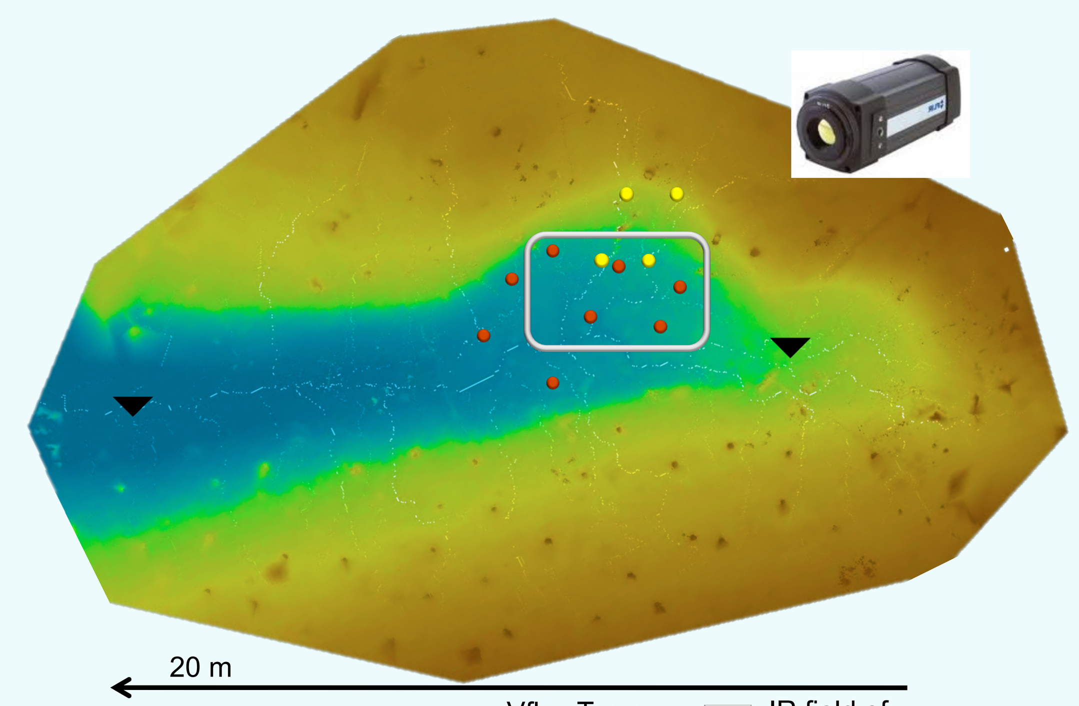
- Measure surface saturation using infrared imagery during events in near-stream zone.
- Quantify subsurface dynamics using piezometers (2 within saturated riparian and 2 at hillslope interface) & Vflux rods within IR image extent to calculate vertical component of subsurface exfiltration (see Gordon et al 2011).

Question 2: How do rainfall, surface and subsurface water sources mix and connect to the stream network?

- Compare isotopic and chemical composition of samples taken from surface saturated zone with subsurface and channel discharge samples to identify mixed and isolated areas.
- Compare periods, areas of mixing and retention to temperatures infrared imagery.
- Compare mixing and isolated area locations to downslope index (Hjerdt 2004).

Question 3: Can subsurface exfiltration account for surface overland flow tracer movement to the stream channel?

- Correlate subsurface dynamics, as measured by piezometers and vertical flux rods, with terrestrial diatom abundance in stream drift samples.
- Sample surface saturated areas during periods of enhanced subsurface exfiltration for increased terrestrial diatom presence.



Instrumentation

- **Above:** LIDAR DEM of the saturated riparian zone with piezometers, vflux rods and weirs
- **Left:** FLIR camera installation to image instrumented area
- **Below left:** Imaged area showing partial saturation during snowmelt

Acknowledgements:
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OSU Oregon State University

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Jay Frentress
frentres@lippmann.lu