

Closing the conceptual gap between the hyporheic zone and the river corridor

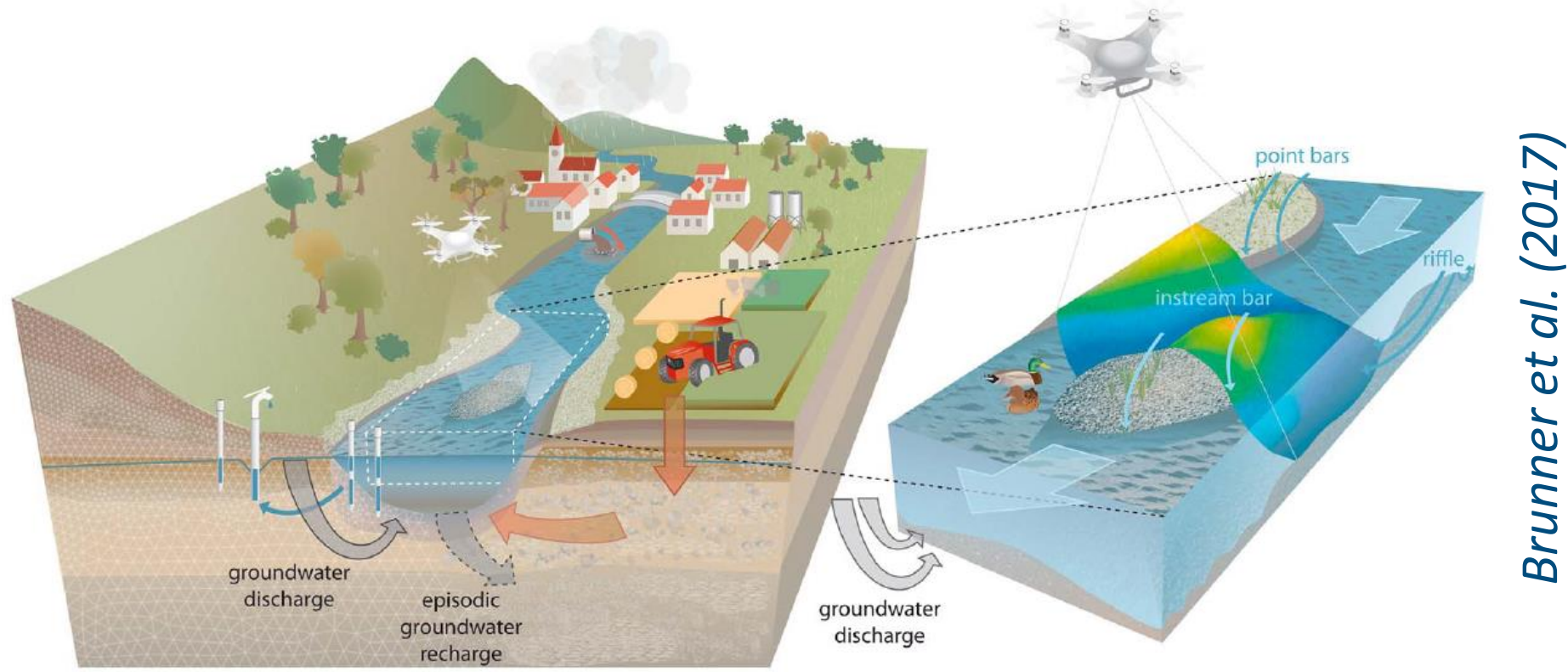
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1. INTRODUCTION

Despite numerous modelling studies on hyporheic exchange have advanced our understanding of general mechanisms, they are often focused on local-scale processes with highly simplified boundary conditions (BC). This may lead to a misrepresentation of the hyporheic exchanges and biogeochemical turnover capacity in river corridors.

To close this conceptual gap, we aim to provide and integrate field and modelling approaches to quantify exchange fluxes and processes between the hyporheic and stream system across different spatial and temporal scales.

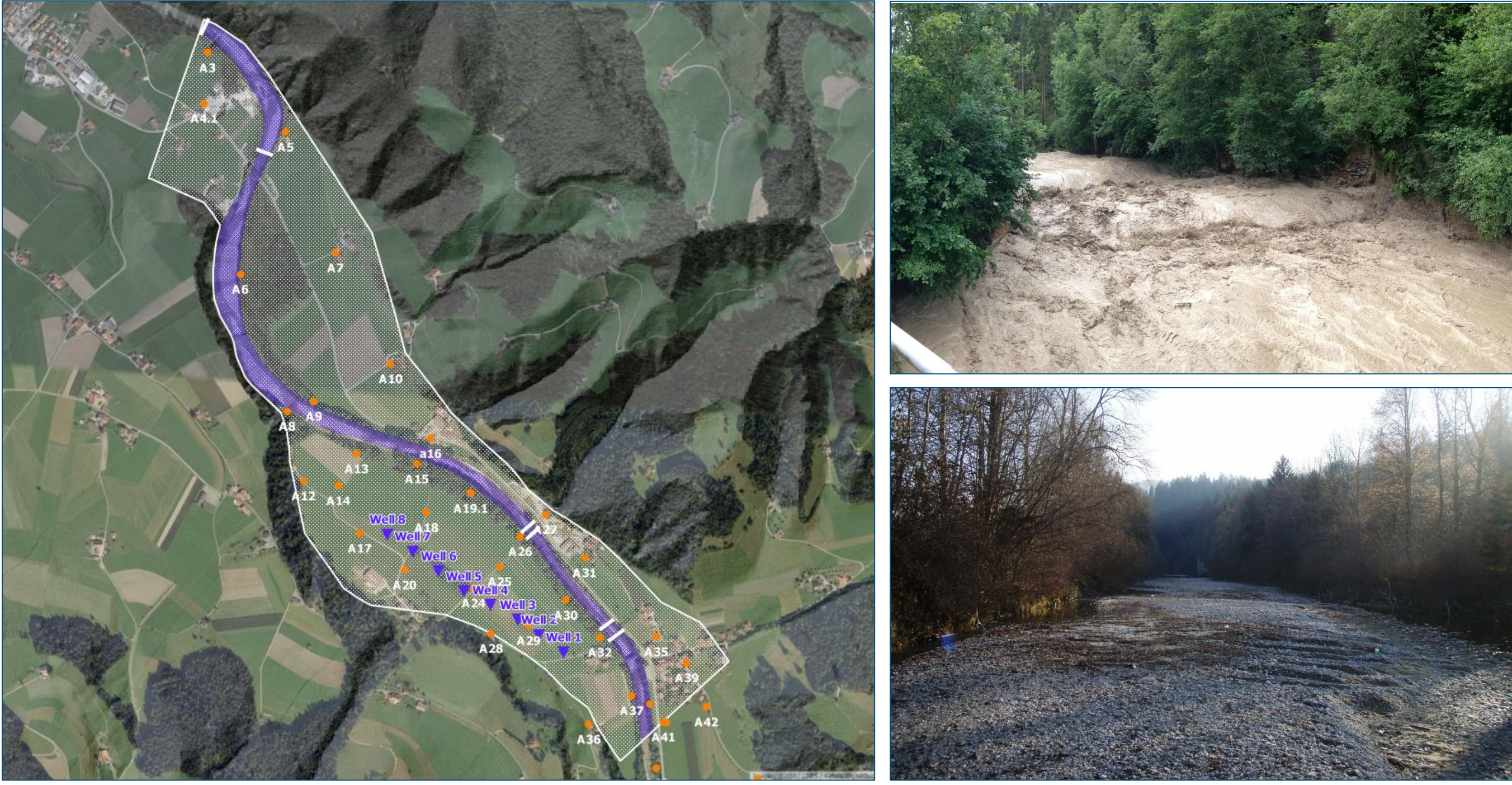


2. STUDY SITE

Lowest part of the Upper Emme valley [A=0.9 km²], Emmental, Switzerland

- Extremely dynamic pre-alpine alluvial catchment
- Q_{m,an}: 4.4 m³/s (higher during snowmelt)
- Dense continuous monitored measurement network
 - 8 GW abstraction wells (45% of Bern's drinking water)
 - 4 SW gauging stations (10 min interval)
 - +30 piezometers (10-15 min interval)
- K_{aq} = 550 m/d, n_{aq} = 0.1
- K_{rb} = 2.4 m/d, n_{rb} = 0.41

Schilling et al., 2017



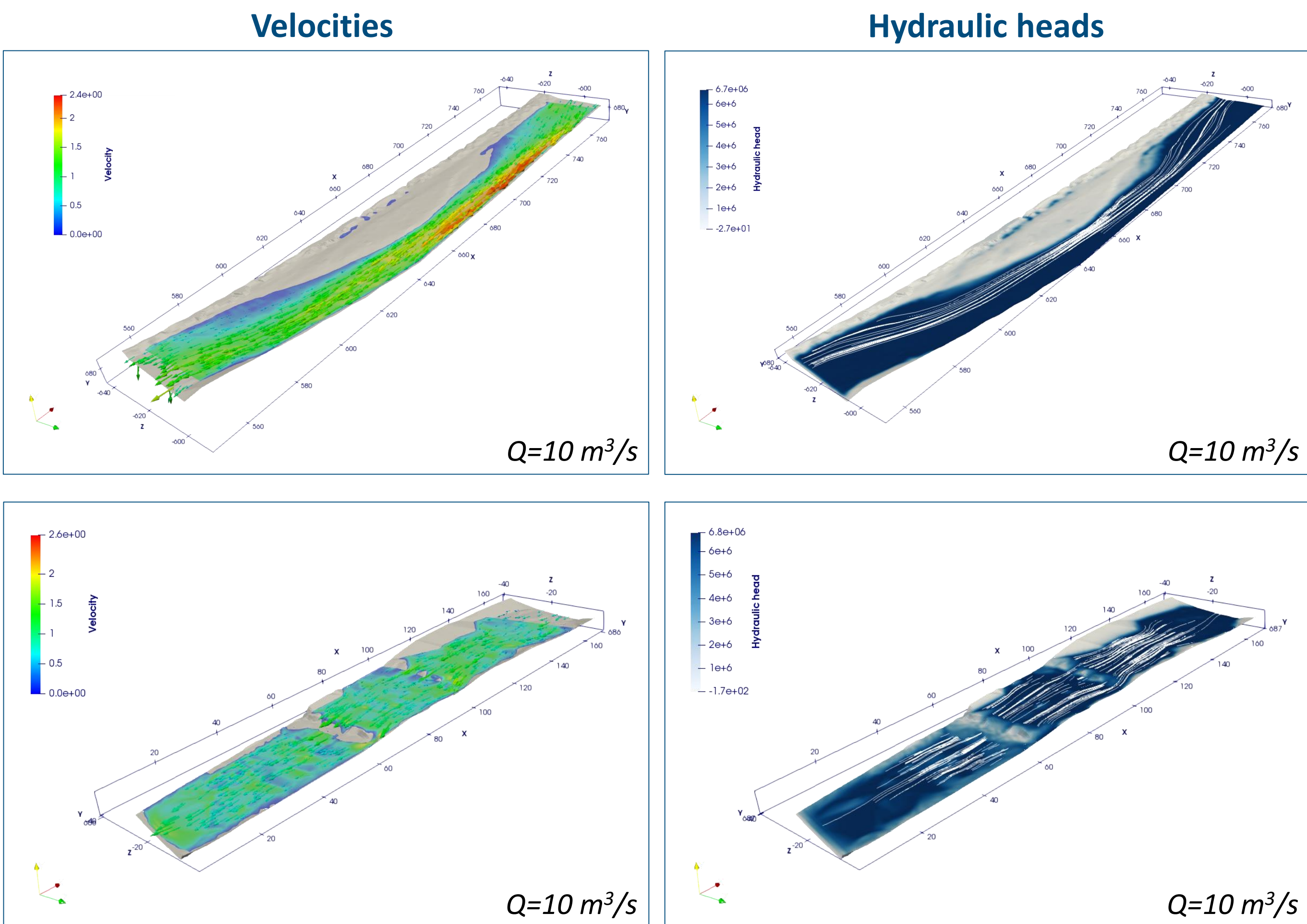
3. OBJECTIVES

- Exploring realistic hydraulic boundary conditions for CFD modelling
- Using a highly advanced modelling framework to explore the superposition of different spatial and temporal scales for both synthetic and highly instrumented field based environments (Emme-catchment)
- Integrating innovative field observations (tracer and UAV data) in this modelling process

4. STREAM FLOW SIMULATIONS

Computational Fluid Dynamics (CFD) code: OpenFOAM

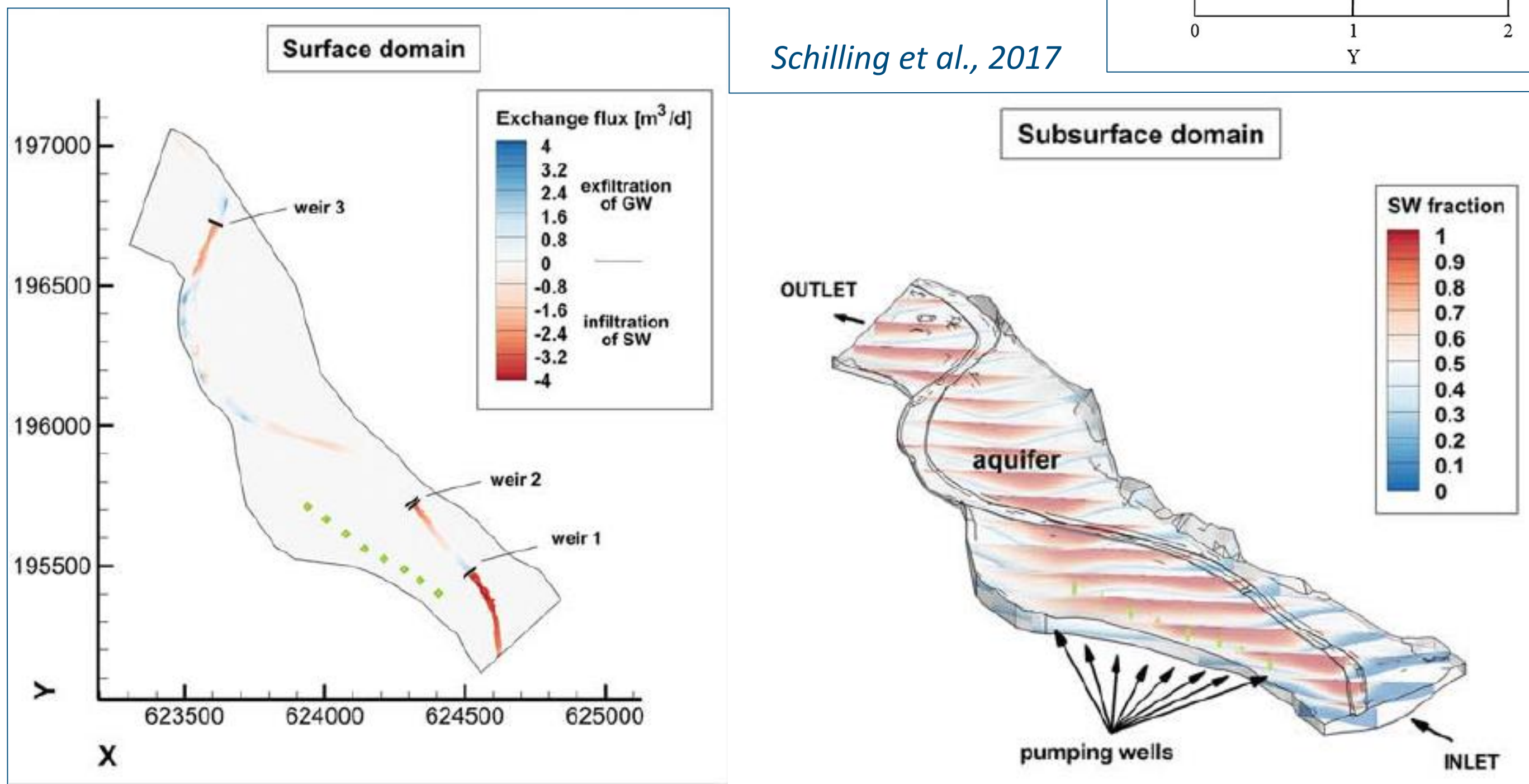
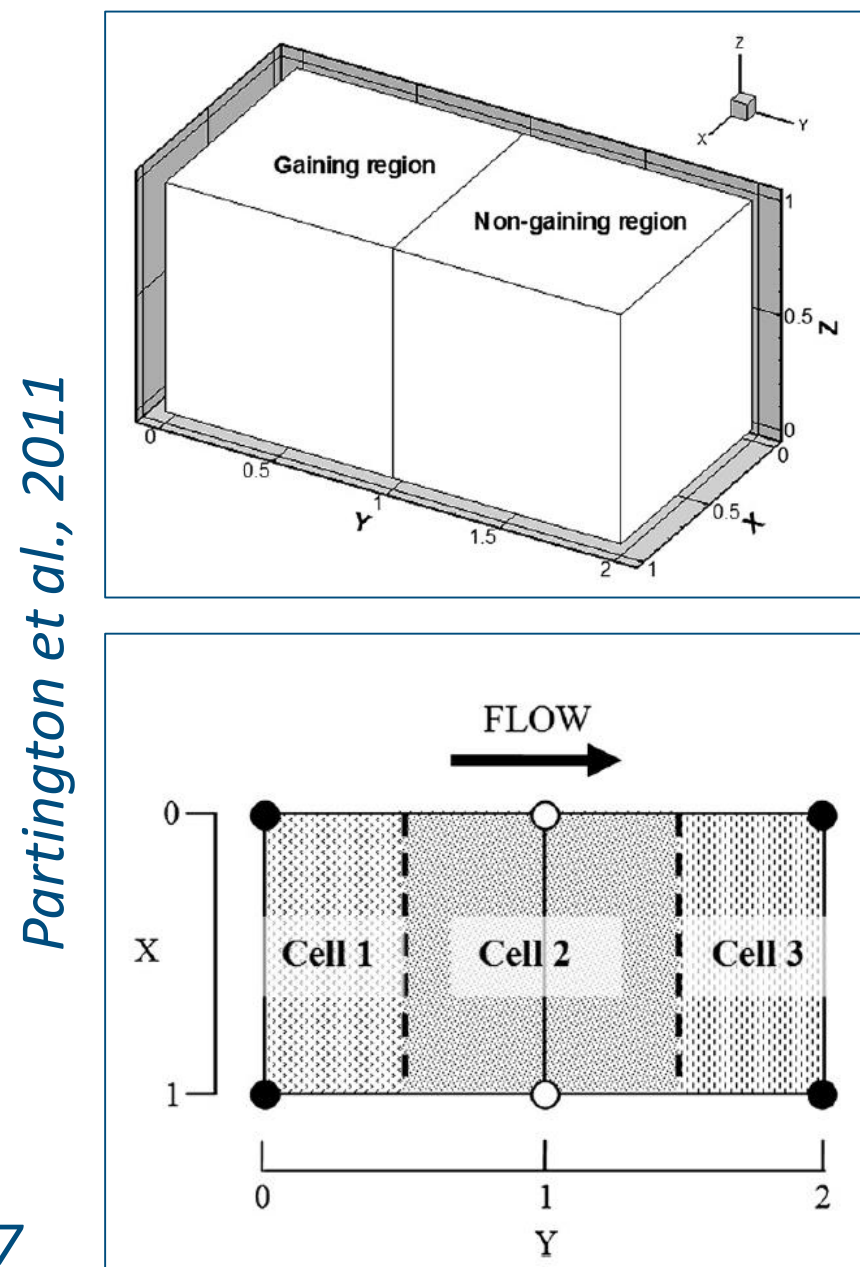
- Solver: two-phase (air-water) algorithm **interFoam** based on the volume of fluid (VOF) method
- Transient flow simulation (Trauth et al., 2017)
- Local hydraulic head distribution at the streambed



5. GROUNDWATER MODELLING

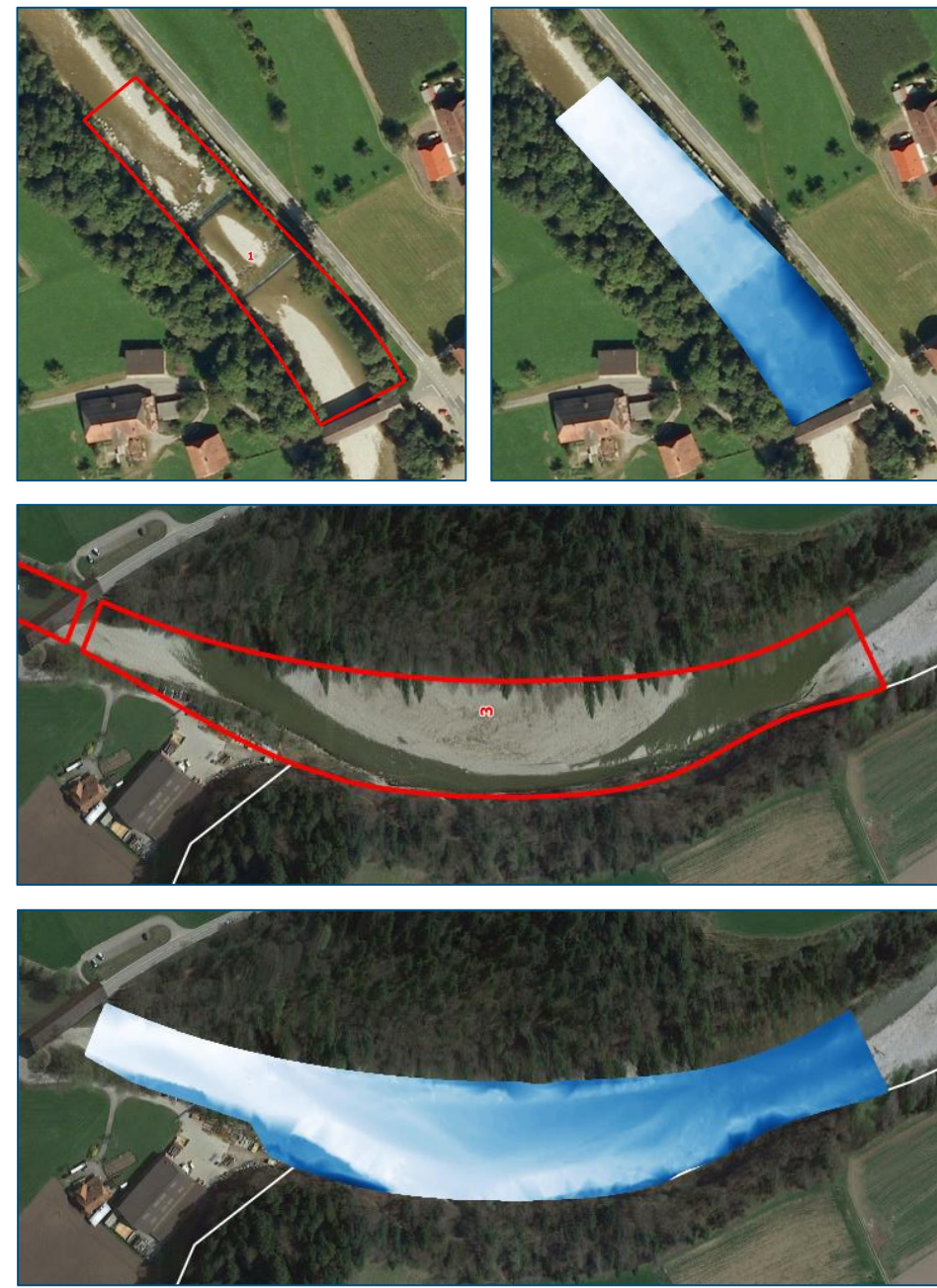
Fully coupled surface-subsurface flow and reactive transport model: **HGS**

- Sequentially coupling:** transient streambed pressures obtained from CFD modelling used as BC
- Simulate both exchange flow and biogeochemical turnover in the hyporheic sediments
- Hydraulic Mixing Cell (HMC)** flow tracking tool for mixing ratios simulation throughout the entire domain (Partington et al., 2011)
- Parameter estimation: **PEST**



6. FIELD DATA

- High-resolution state-of-the-art LIDAR-UAV characterization of the streambed (pre and post-flood event)
- Multitracer data:** novel ³⁷Ar-method (on-site → MiniRuedi) in addition to ²²²Rn (on-site → RAD7), ³H/³He and atmospheric noble gases for appropriate flow model parametrization
- Hydraulic (groundwater heads, pumping rates, precipitation, solar radiation + temperature (PET)) –and also UAV– field data



7. OUTLOOK

We expect that simulation results will provide a more realistic representation of exchange flows and reactions between the stream channel, hyporheic zone and the underlying aquifer than by using steady hydraulic boundaries.

8. REFERENCES

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