Combining multi-tracer and multiple sediment fingerprinting models to assess sediment connectivity in a mesoscale watershed

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Context and objectives

- What are the reasons for variability of suspended sediment fluxes?

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- Structural connectivity?
- Spatio-temporal rainfall variability?

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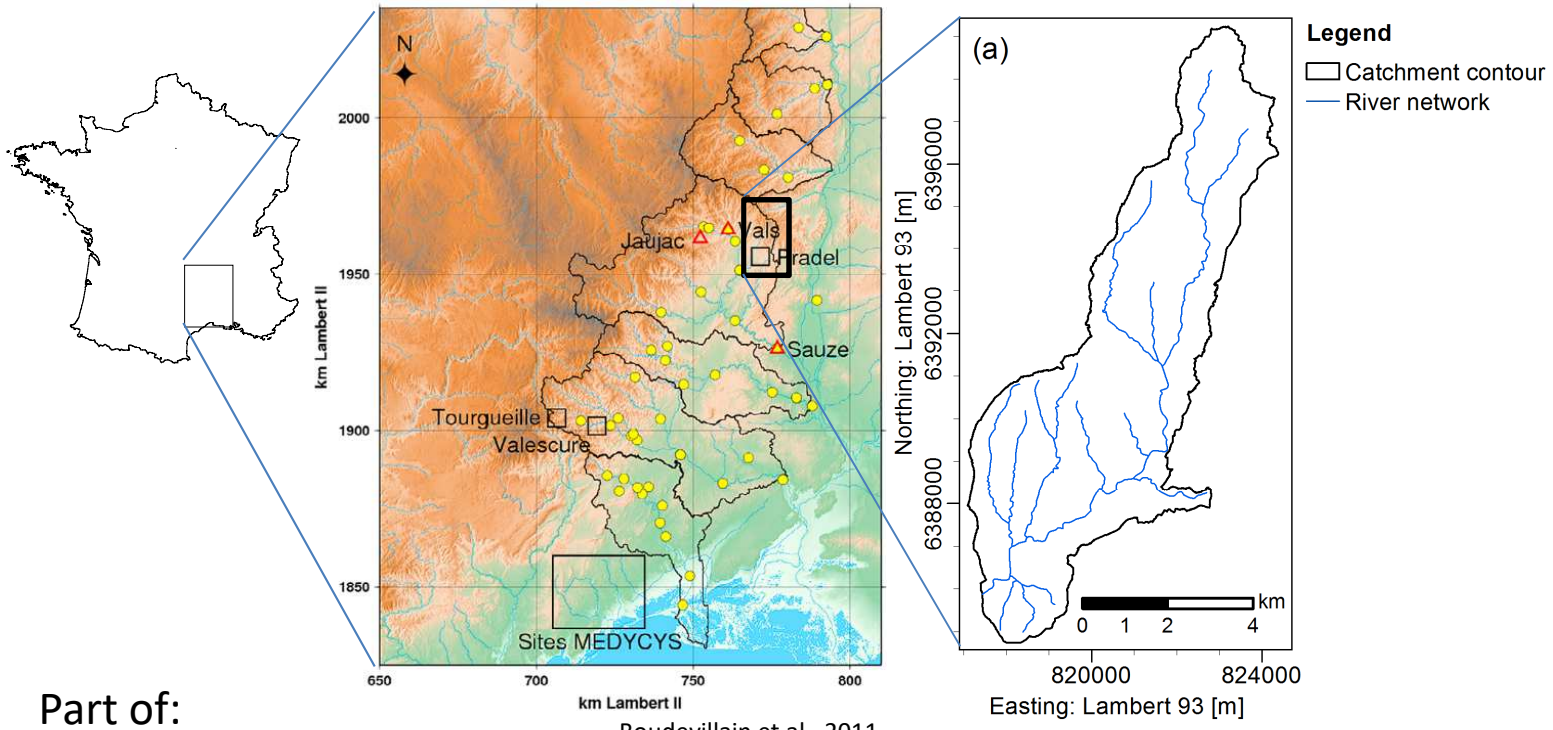
Low-cost sediment fingerprinting

Numerical modelling

The Cladužgne catchment

Cévennes-Vivarais Mediterranean Hydrometeorological Observatory

Surface: 42 km^2



Boudevillain et al., 2011

Part of:

Nord et al., 2017

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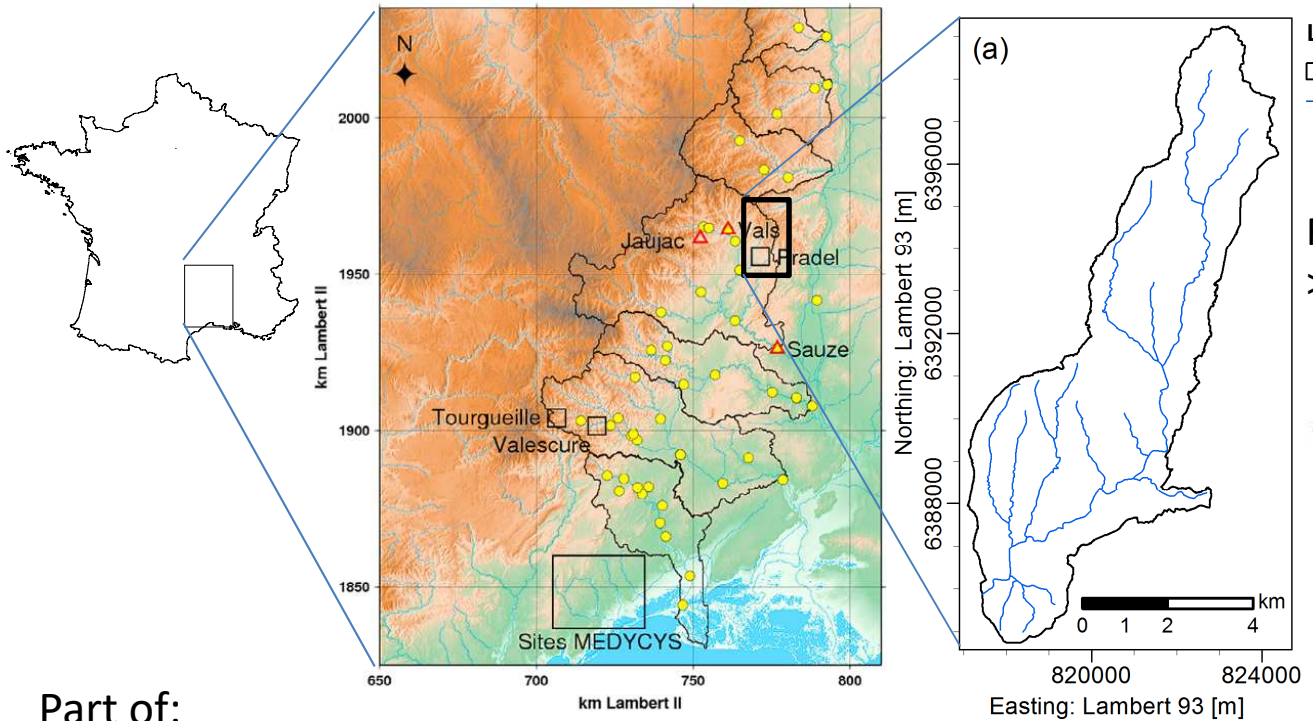
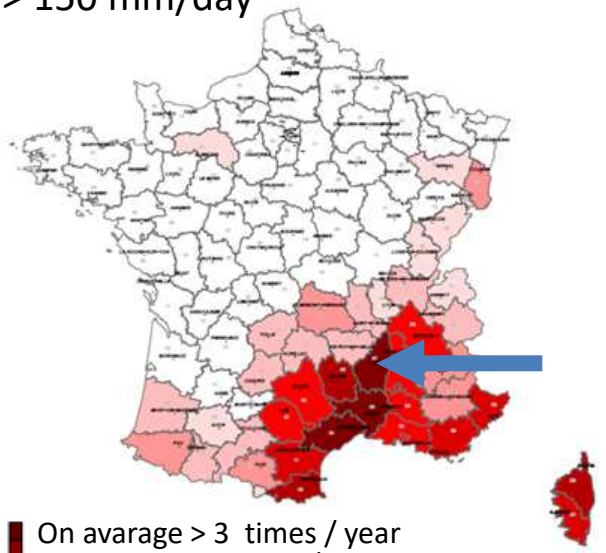


Legend
- Catchment contour
- River network

Boudevillain et al., 2011

Rain events per year with > 150 mm/day



- On avarage > 3 times / year
- On avarage > times / year
- On avarage once every 2 -5 years
- On avarage once every 10 -25 years
- No occurrence

METEO FRANCE

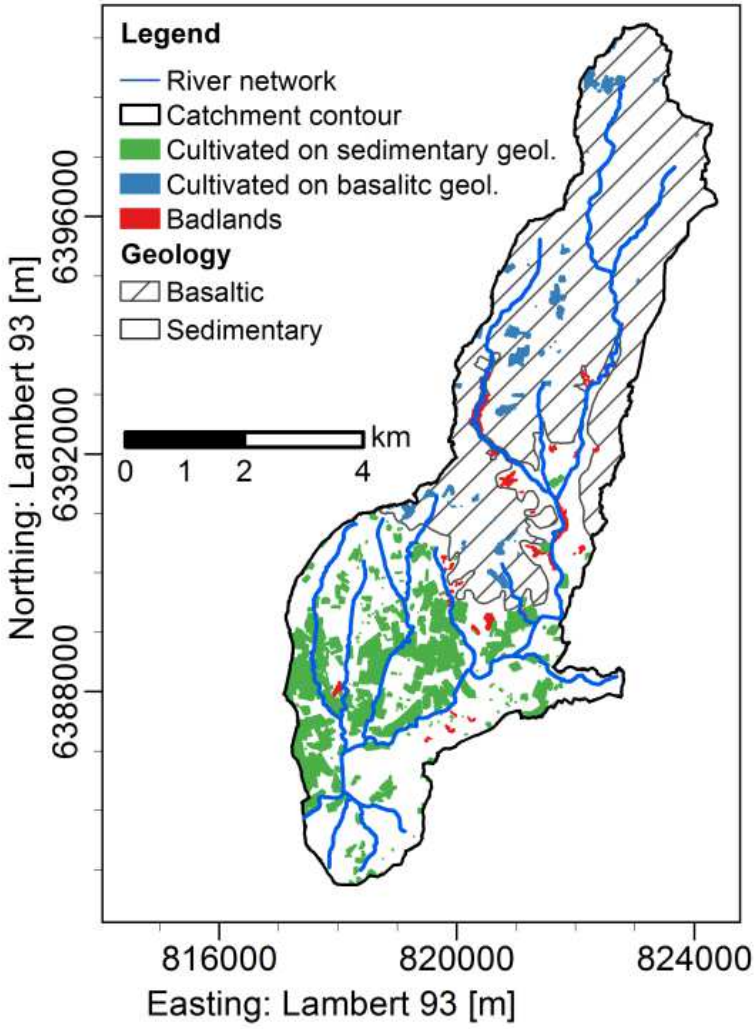
Part of:

OZCAR

Observatoire Hydro-météorologique Méditerranéen Cévennes Vivarais

Nord et al., 2017

The Cladugne catchment



3 Potential sediment sources:

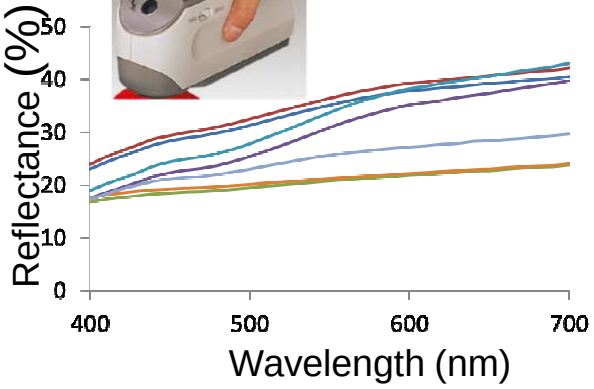
Badlands

Cultivated soils on basaltic geology

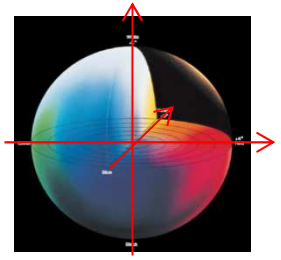
Cultivated soils on sedimentary geology

Tracer measurements

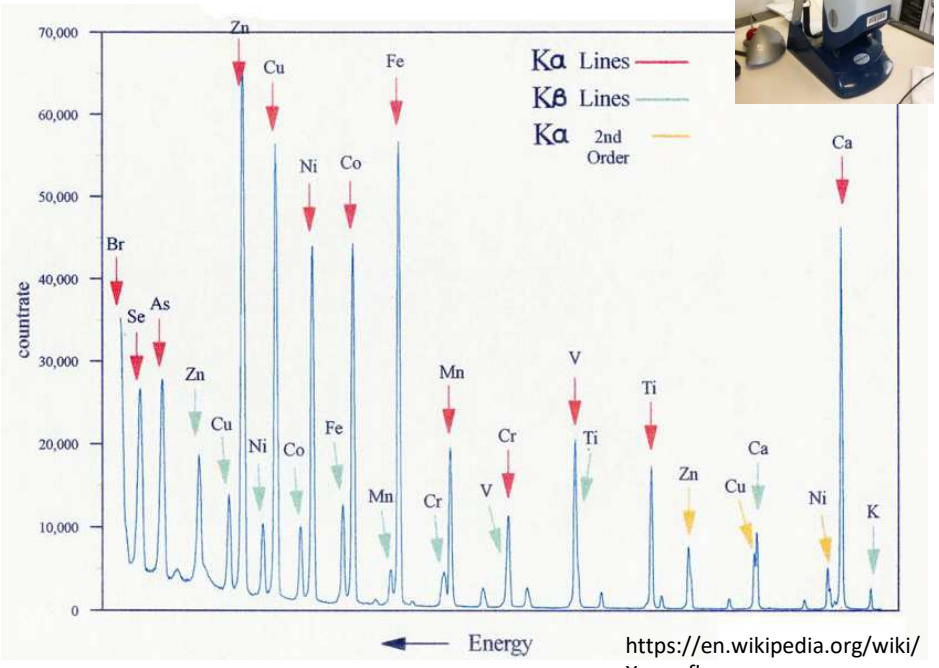
- Spectrocolorimetry



-> 15 Color parameter,
e.g. L*, a*, b*



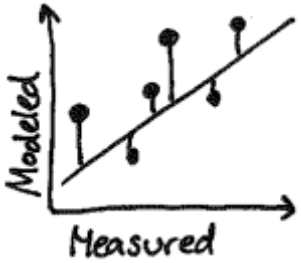
- X-ray fluorescence



https://en.wikipedia.org/wiki/X-ray_fluorescence

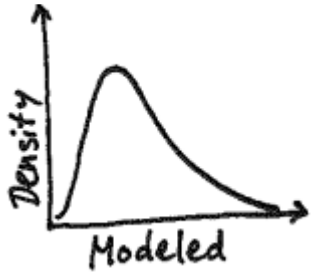
-> 16 element concentrations,
e.g. Al, Si, Ca, Fe

3 Mixing models



Non-negative least squares (NNLS)

Lawson and Hanson, 1974



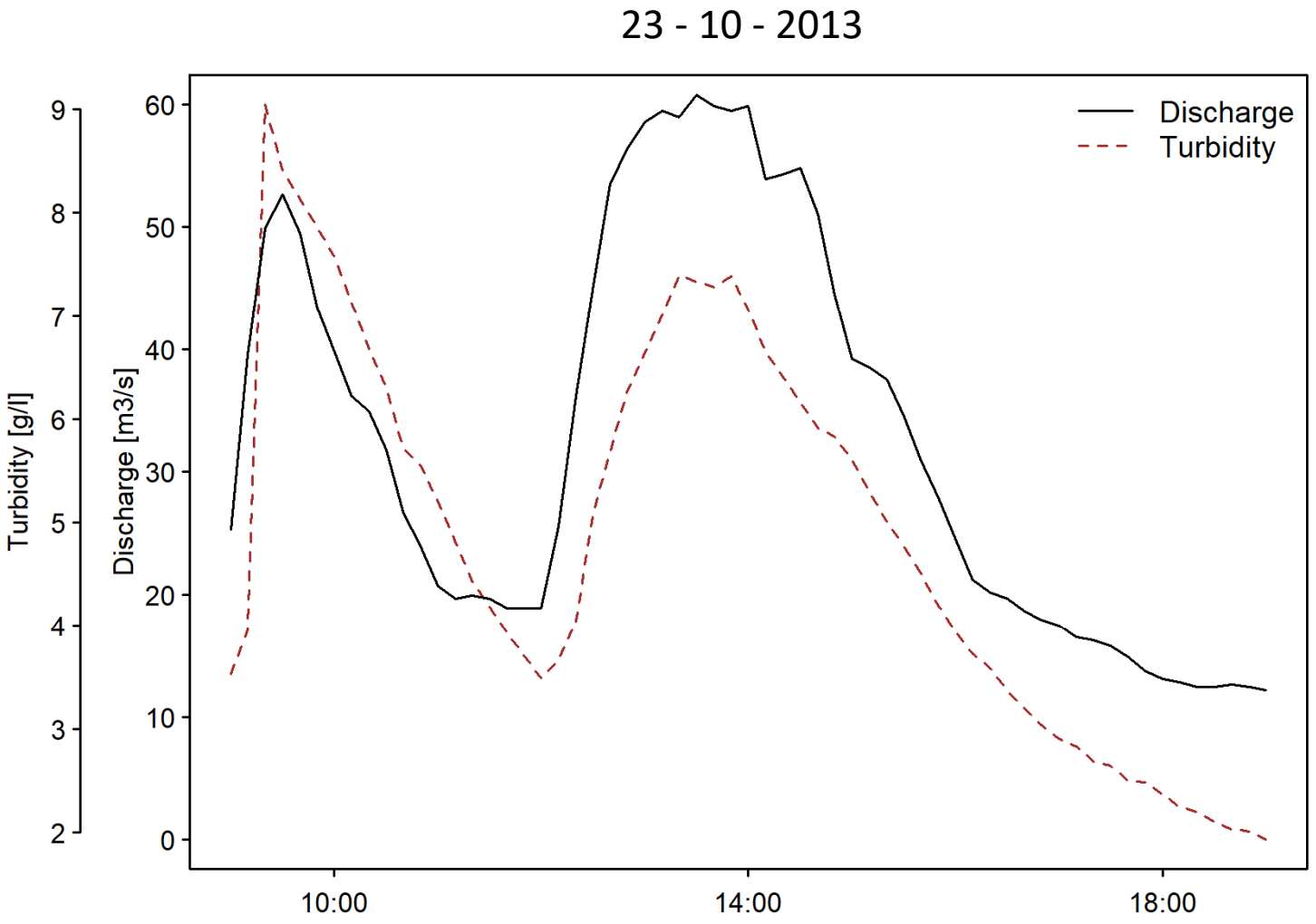
Bayesian mixing model SIMMR

Parnell et al., 2010, 2013

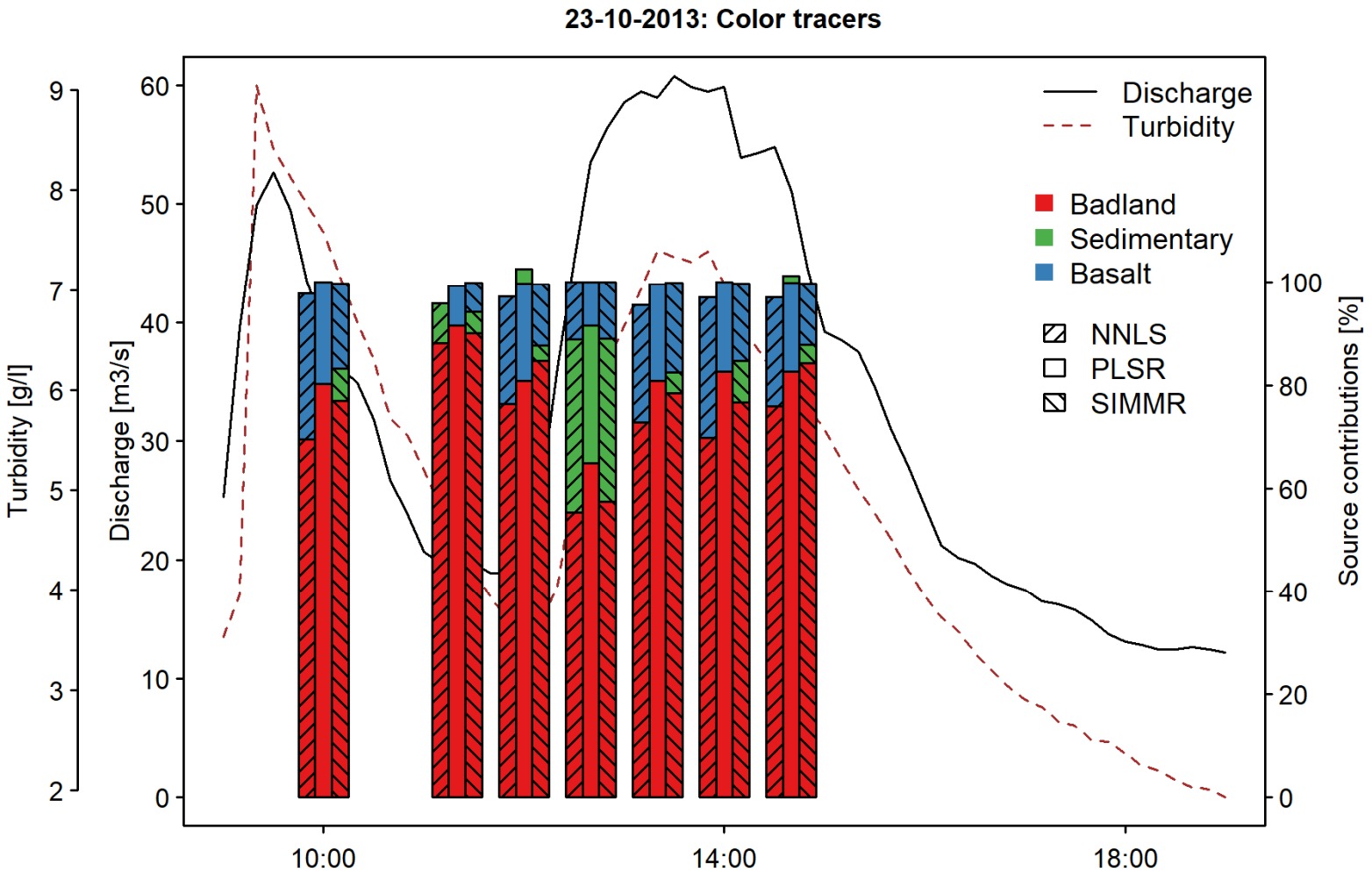
Partial least squares regression (PLSR)

Wold et al., 2001

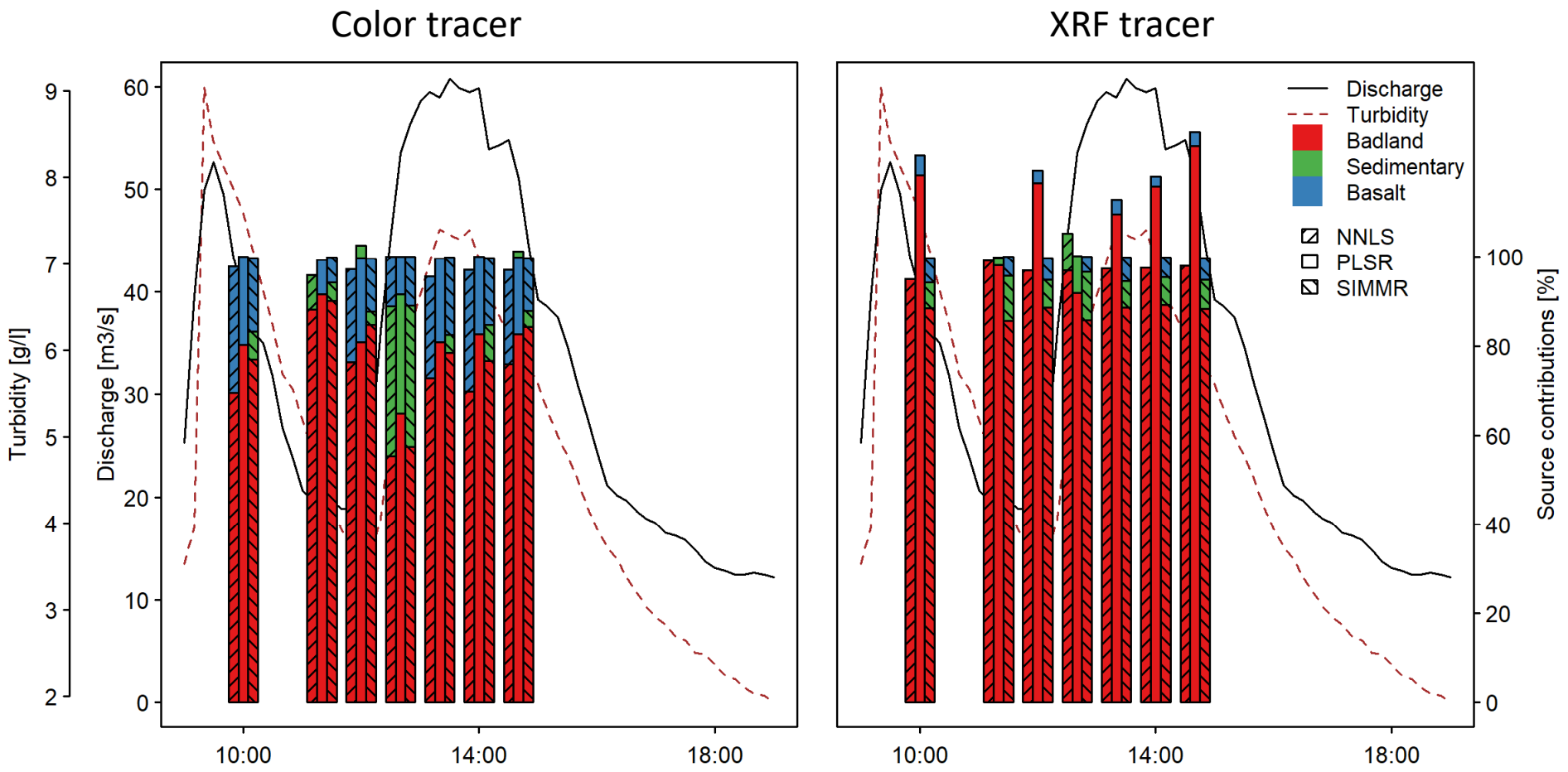
Results


23 - 10 - 2013
Discharge
Turbidity
Turbidity [g/l]
Discharge [m3/s]
9
8
7
6
5
4
3
2
60
50
40
30
20
10
0
10:00
14:00
18:00

Results


23-10-2013: Color tracers
Turbidity [g/l]
Discharge [m3/s]
Source contributions [%]
Discharge
Turbidity
Badland
Sedimentary
Basalt
NNLS
PLSR
SIMMR
10:00
14:00
18:00

Results

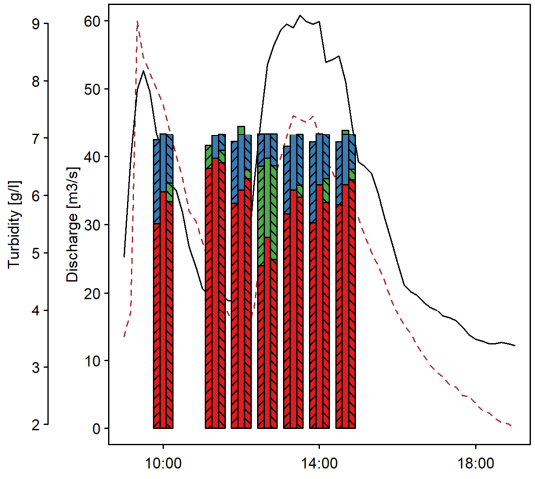

Color tracer
XRF tracer
Turbidity [g/l]
Discharge [m3/s]
Source contributions [%]
Discharge
Turbidity
Badland
Sedimentary
Basalt
NNLS
PLSR
SIMMR
10:00
14:00
18:00

Multi-model-multi-tracer mean

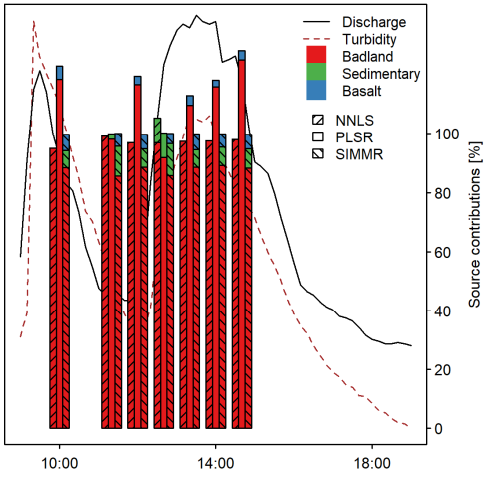
- Differences between tracers and models

-> Multi-model-multi-tracer mean more robust estimator of source contributions

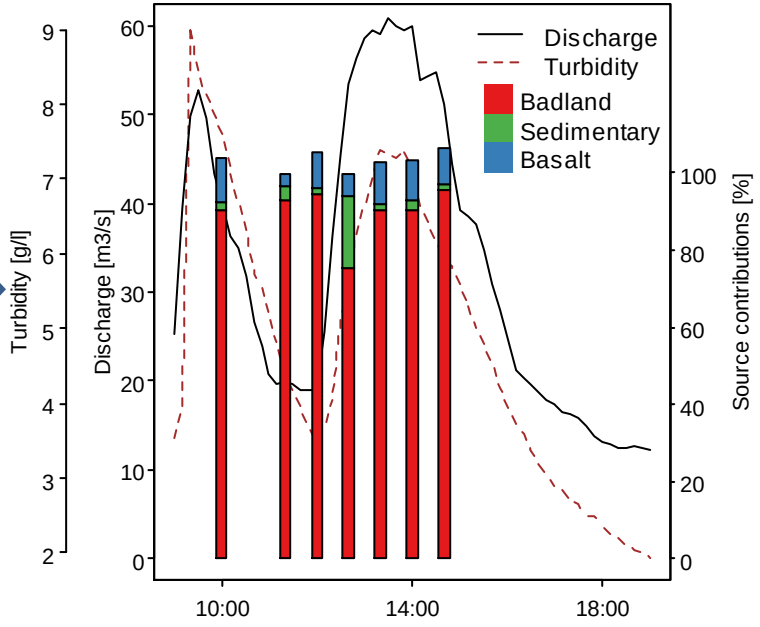
Color tracers



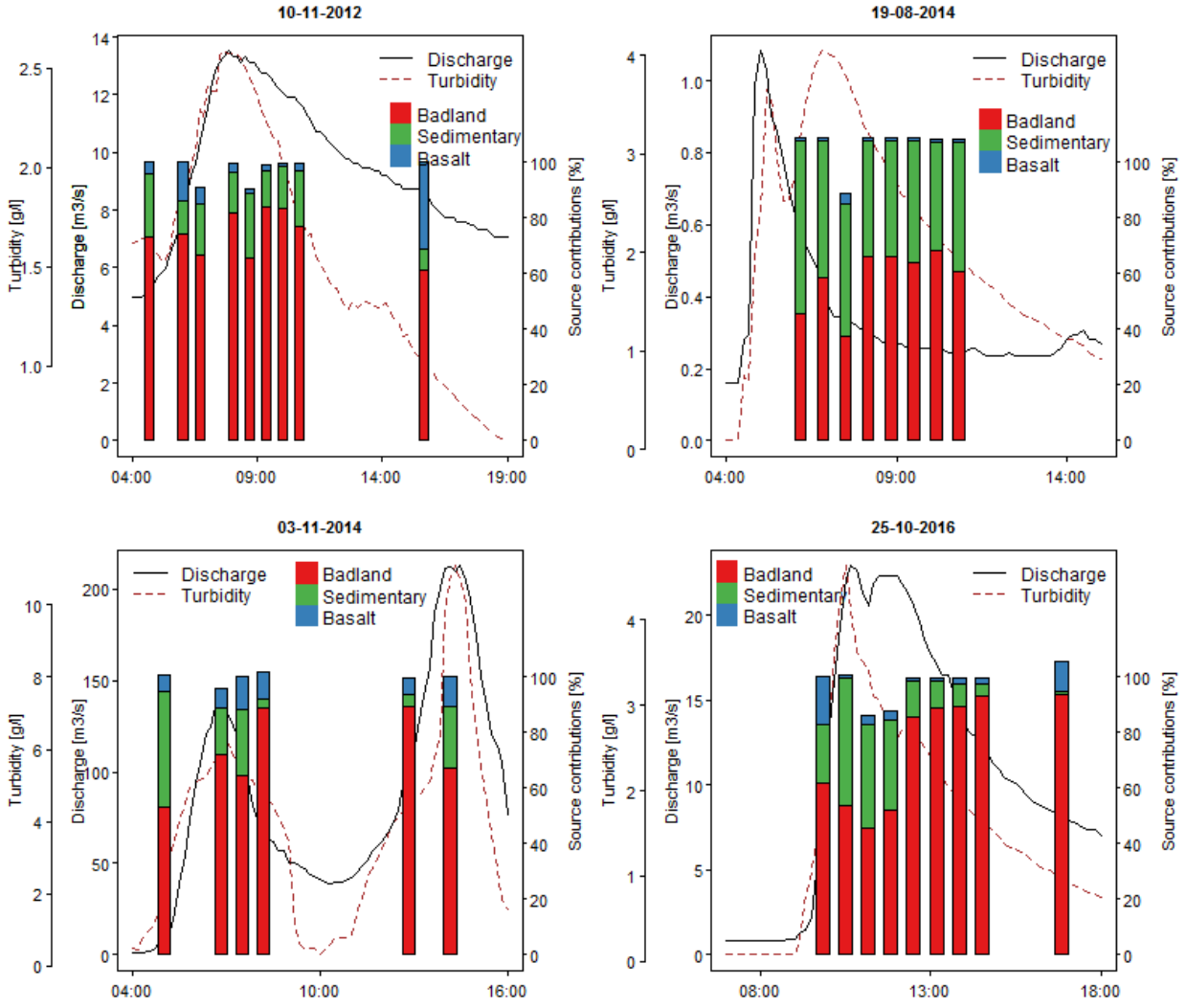
XRF tracers



Multi-model-multi-tracer mean

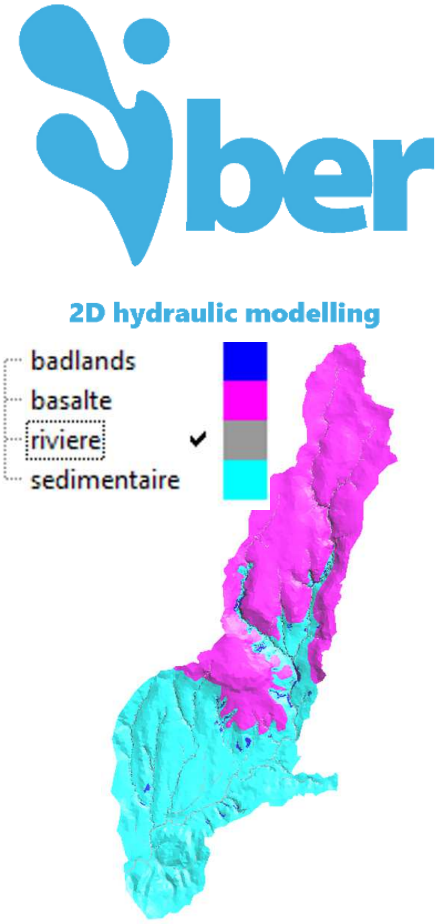


Variability in sediment source contributions



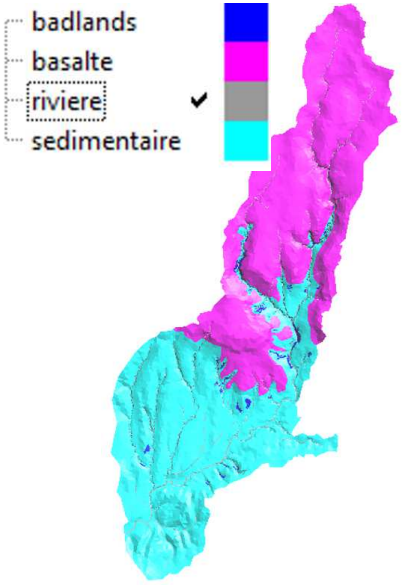
Ongoing work

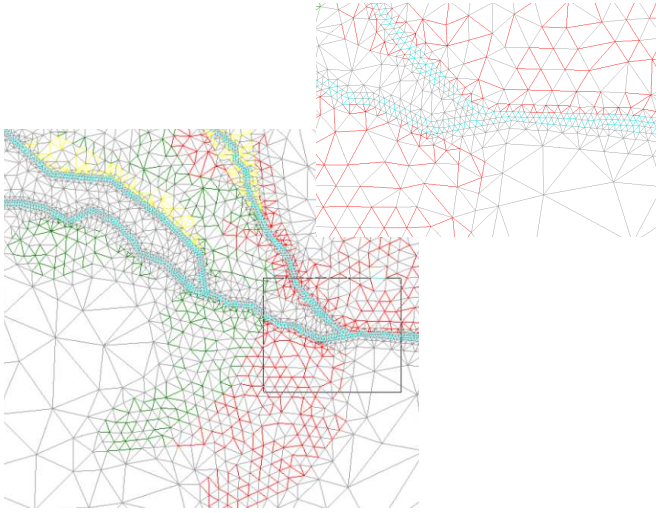
- What are the reasons for the observed between- and within event variability?
- Iber
  - Distributed
  - Physically-based
  - Event-scale



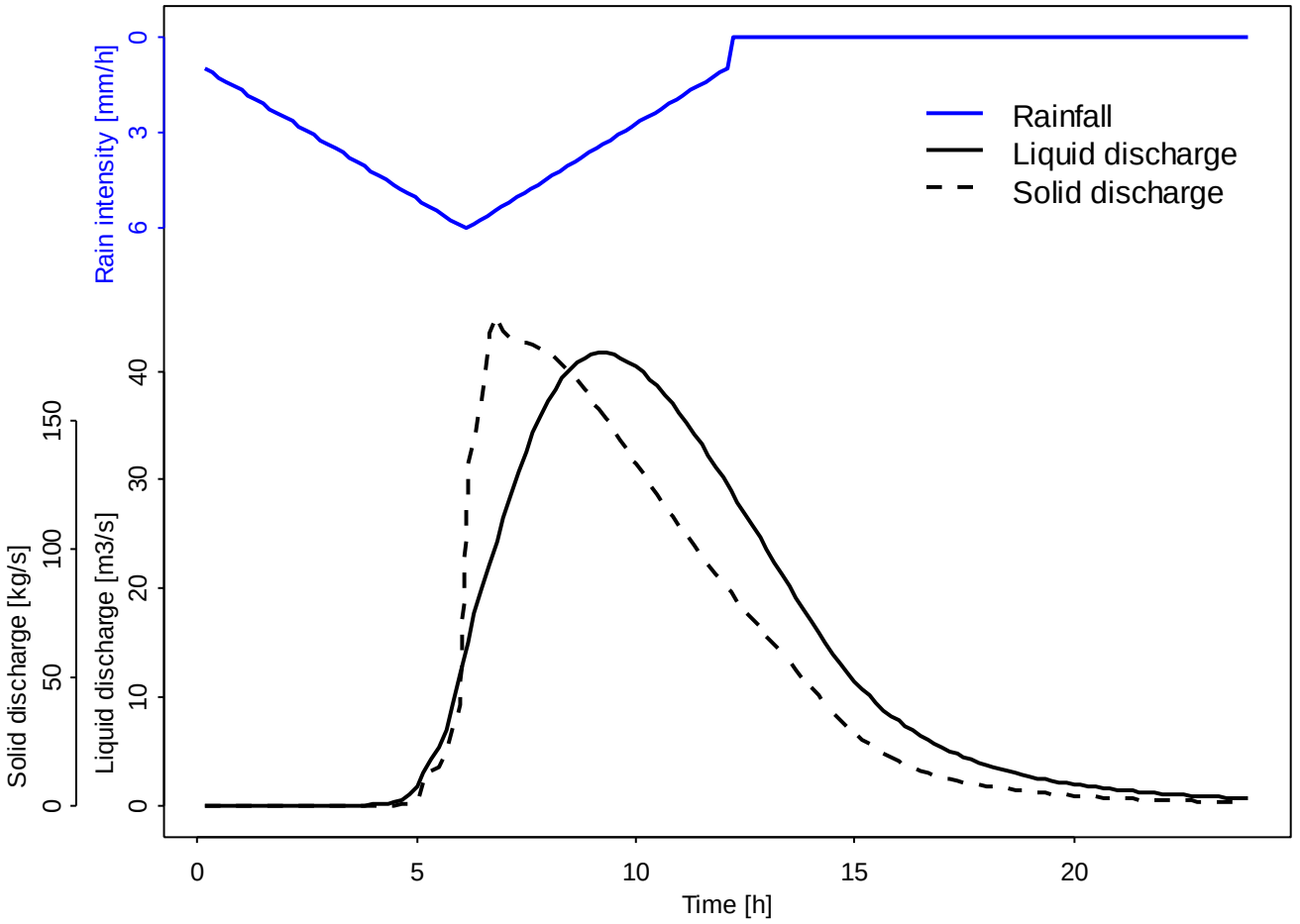
Ongoing work: Numerical modelling

- 2D hydrodynamic model
- Representation of the hydrological processes
- Rainfall-runoff soil erosion module (Cea et al., 2015)
- Numeric modelling units:
  - Triangular mesh, irregular
  - Variable size:
    - River 5 m
    - Erosion zones 20 m
    - Hillslopes 100 m
- Parameterization:
  - Infiltration
  - Manning‘s n
  - Erodibility

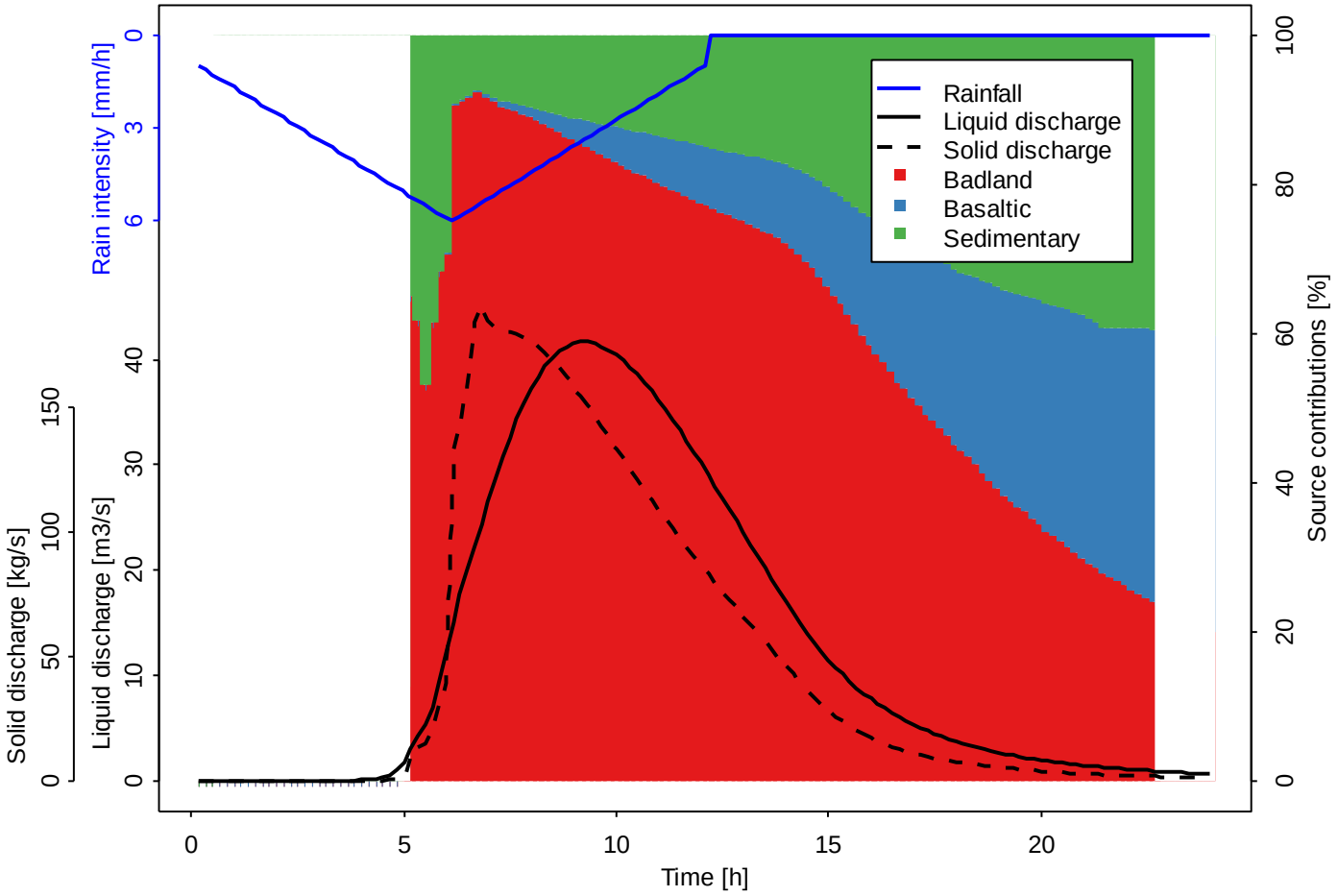




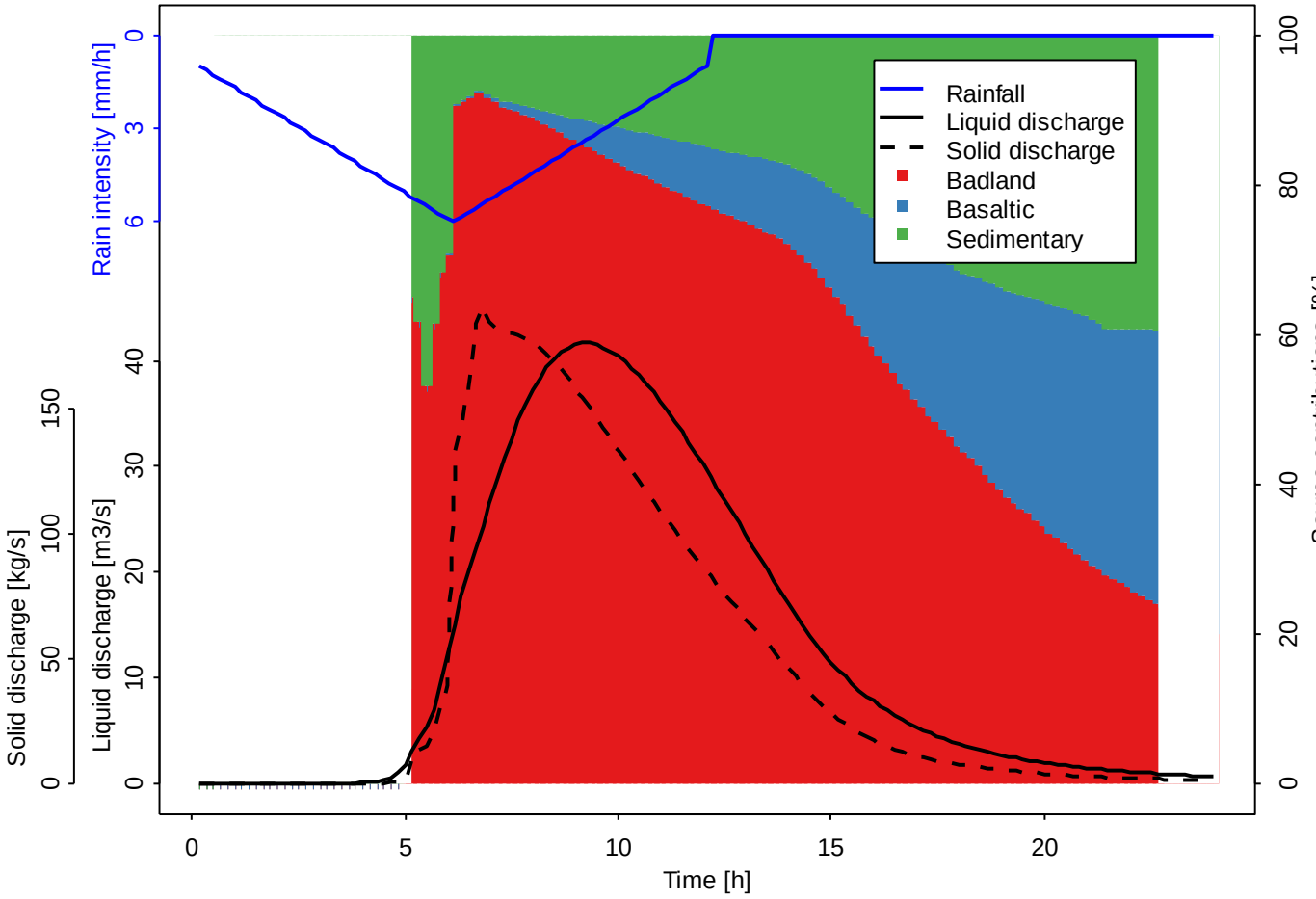
First results

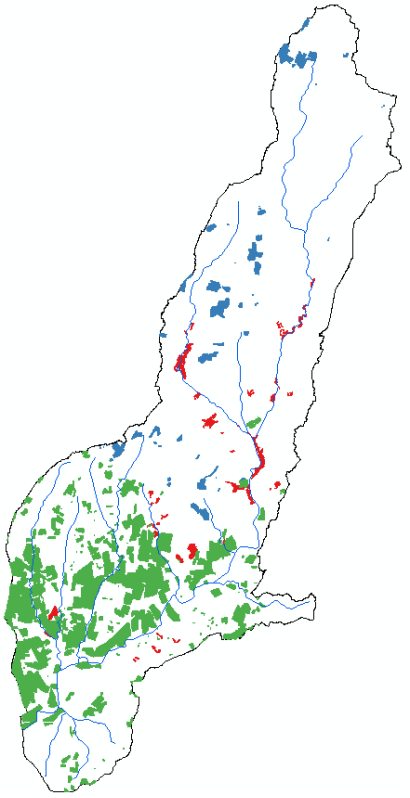


First results

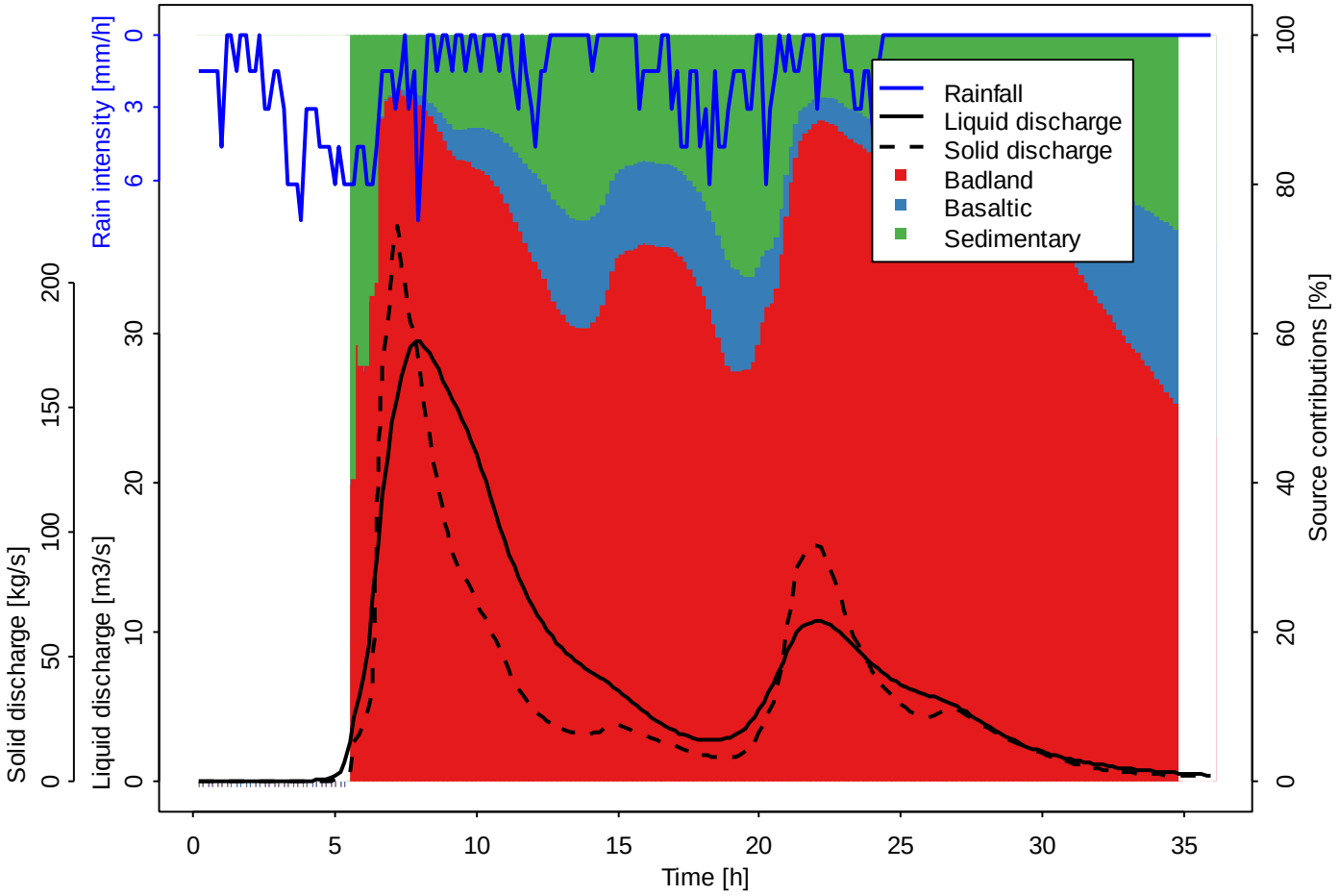


First results

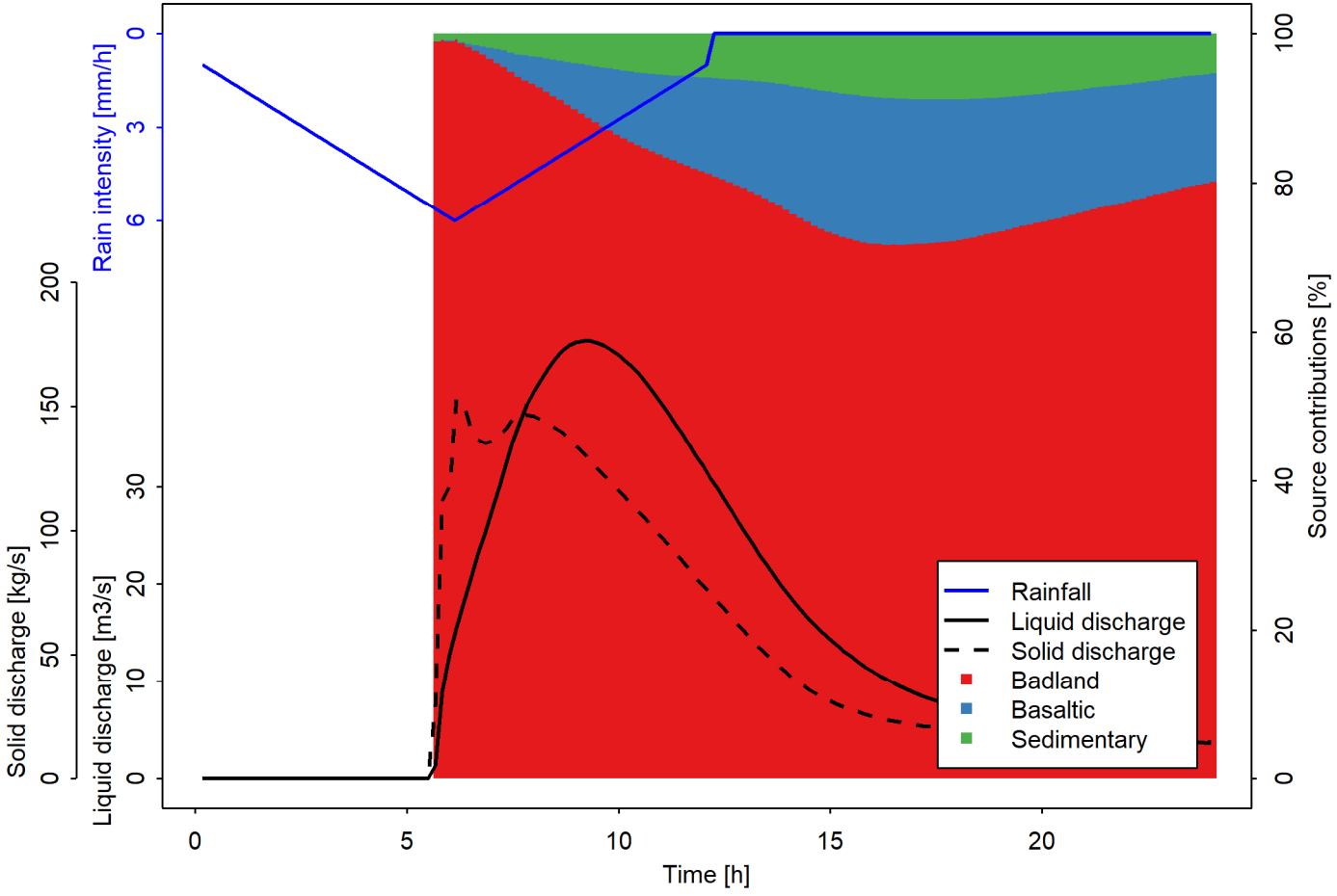




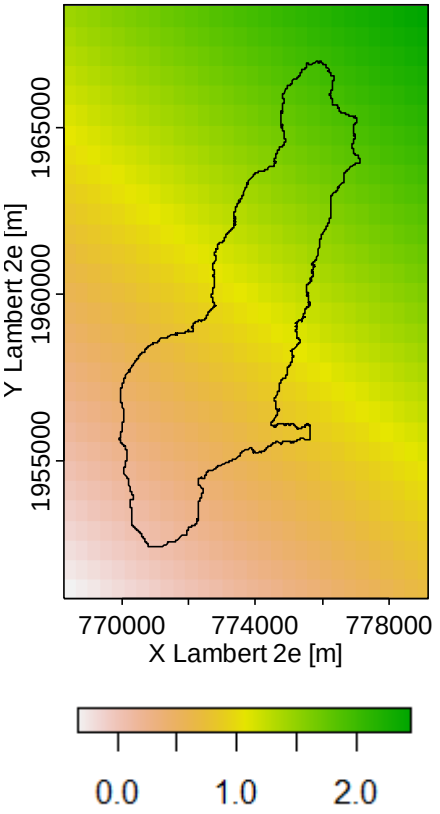
First results



First results

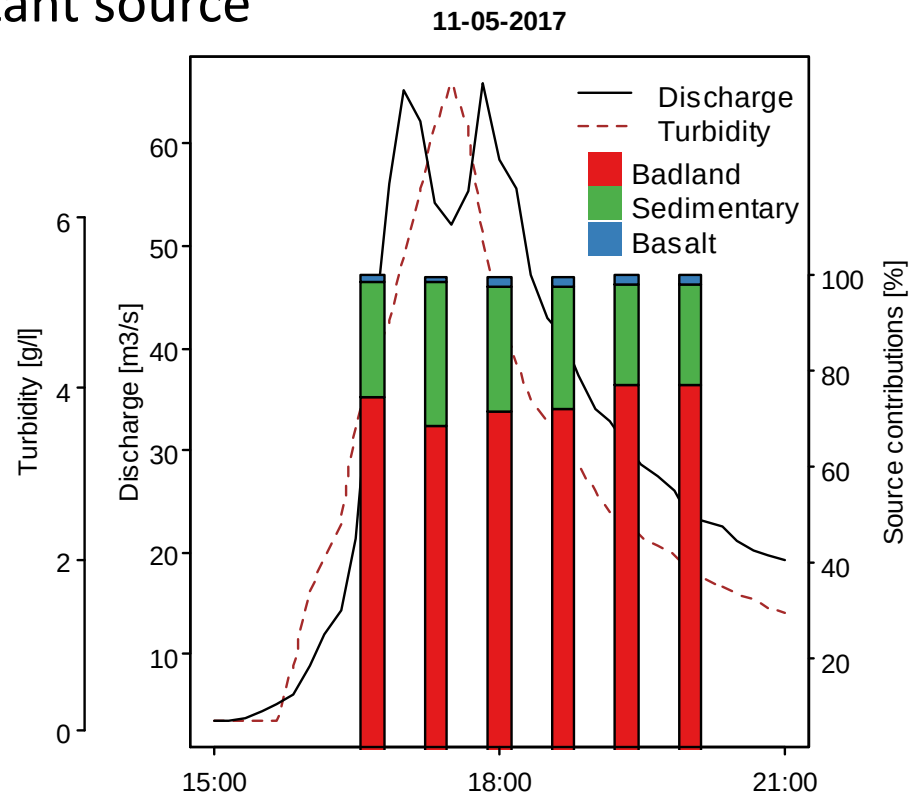


Rainfall gradient
North -South



Perspectives

- Open questions:
  - What kind of events cause which pattern?
  - What about events with constant source contributions?



Thank you very much for your attention!

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SEDIMENT FINGERPRINTING IN THE CRITICAL ZONE

Comparing alternative tracing measurements and mixing models to fingerprint suspended sediment sources in a mesoscale Mediterranean catchment

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