Hydraulic shortcuts: An important but ignored pesticide transport pathway?

Eawag:
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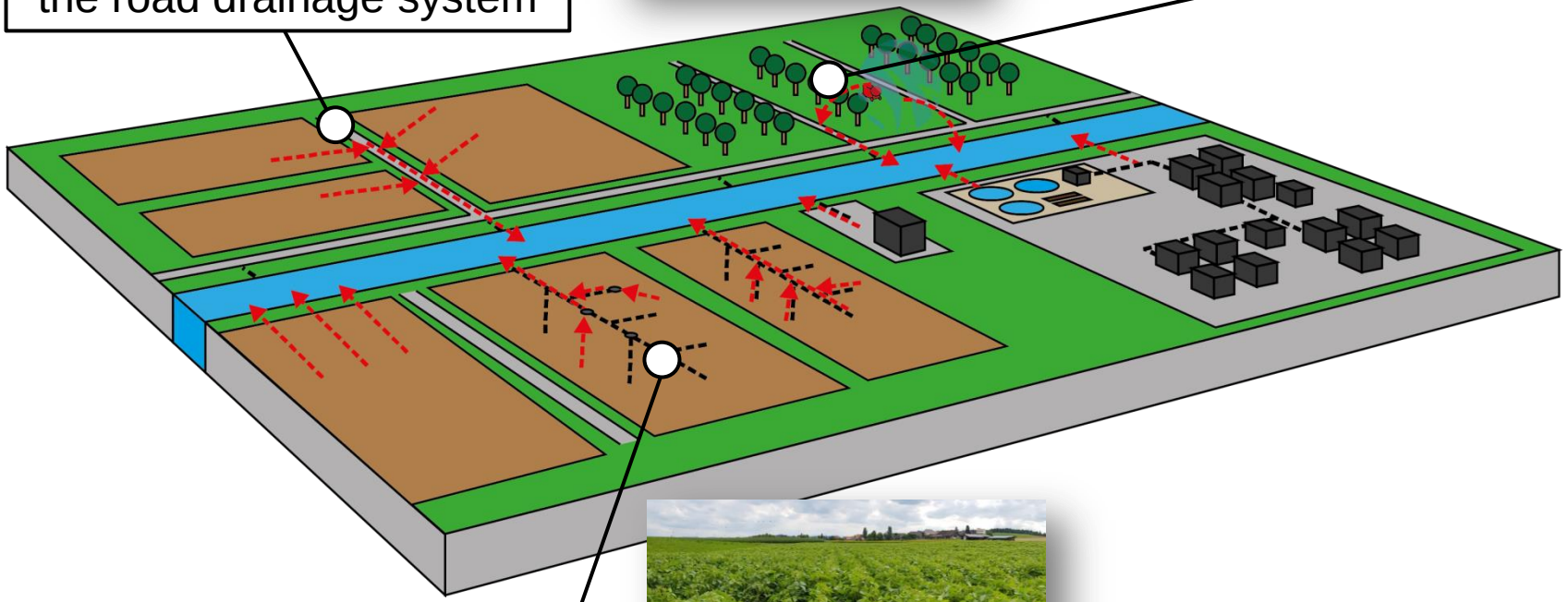
aquatic research

Hydraulic shortcuts

«Indirect» loss paths

Indirect drift via roads & the road drainage system

Surface runoff via roads & the road drainage system



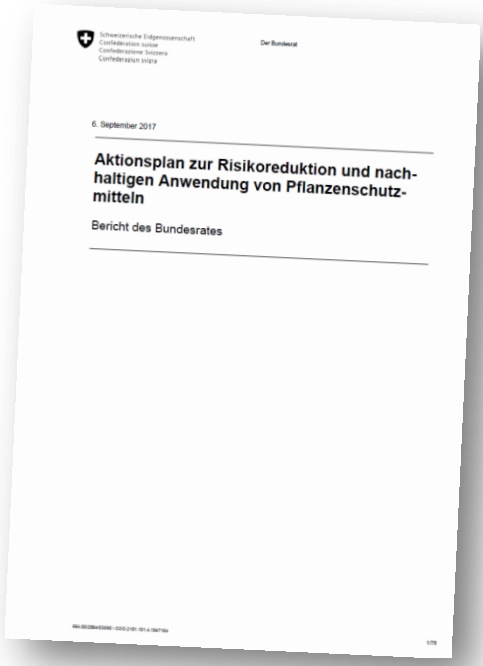
Surface runoff via drainage inlets on the field

Regulatory relevance of Shortcuts

- Studies showed that shortcuts can be a relevant entry path
  (e.g. Doppler, 2012 or Lefrancq, 2013)

- National action plan on pesticide loss reduction:
  investigation of hydraulic shortcuts

→ Decision on:
  - Consideration of shortcuts in pesticide authorisation?
  - Regulations on loss reduction measures


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Der Bundesrat

6. September 2017

Aktionsplan zur Risikoreduktion und nachhaltigen Anwendung von Pflanzenschutzmitteln

Bericht des Bundesrates

Research questions

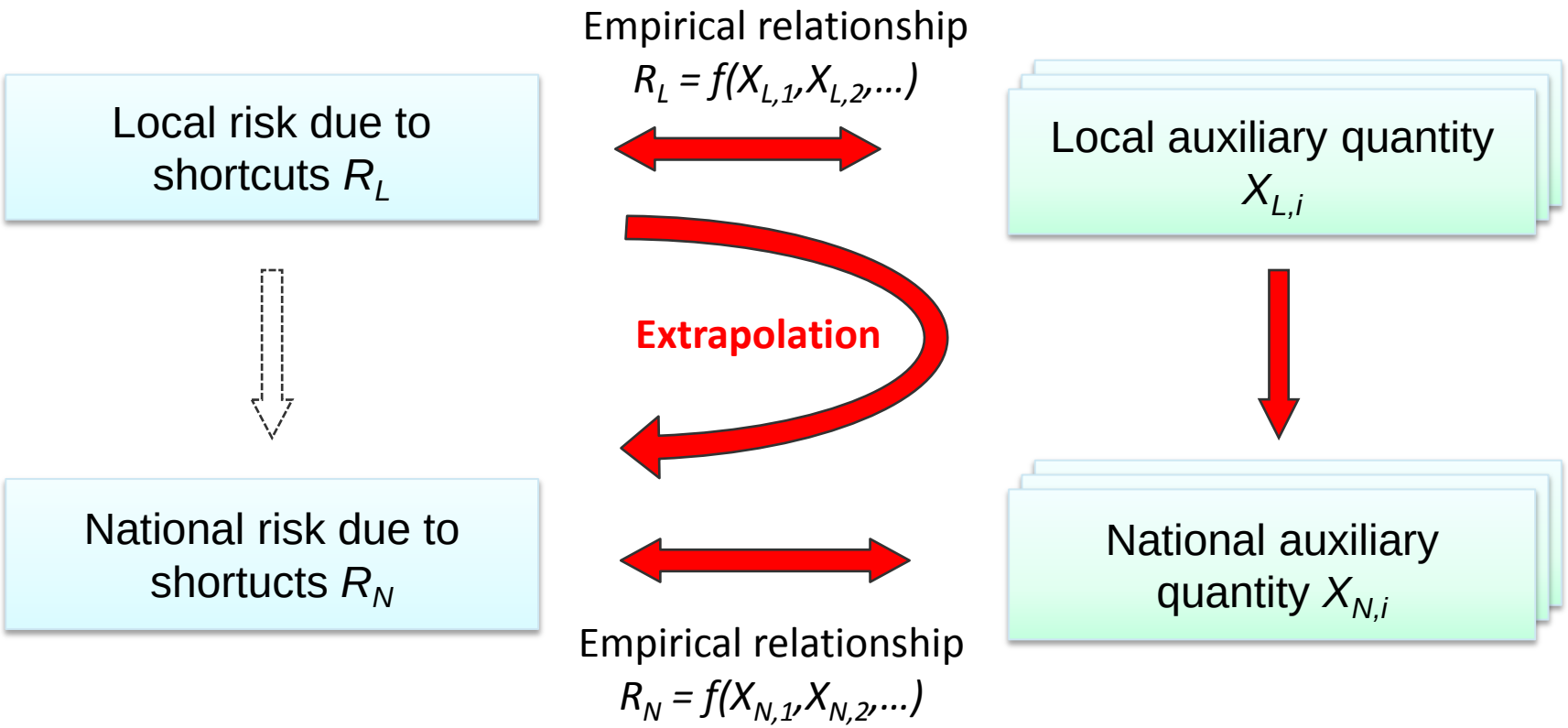
1) How often do shortcuts occur in Switzerland?

2) Which amounts of pesticides are lost via hydraulic shortcuts compared to other pathways?

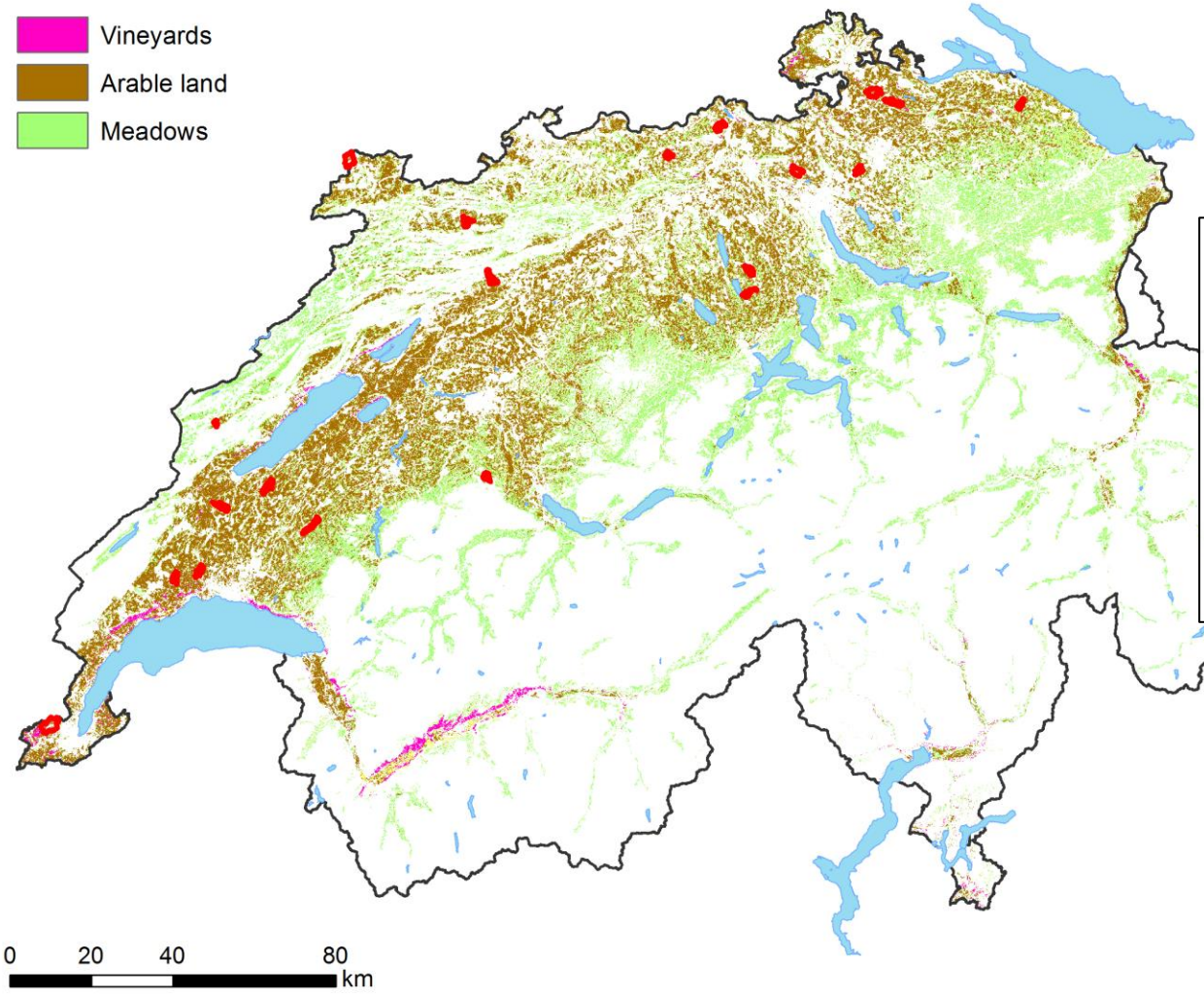
3) What are appropriate measures for a loss reduction?

Determination of national relevance of shortcuts

Method



Random selection of investigation areas



- 20 subcatchments
- Average area: 3.5km^2
- Arable land: 11-75% (Ø 44%)

Mapping of hydraulic shortcuts

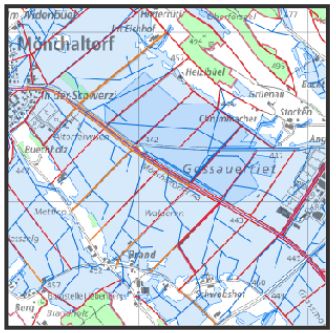
1) How often do shortcuts occur in Switzerland?

Field survey

partial coverage

Leitungs-Kataster/GEP

partial coverage



Tile drainage map

partial coverage

Drone images

full coverage

Map of hydraulic shortcuts for 20 investigation areas

→ 13 of 20 subcatchments: 6000 potential shortcuts

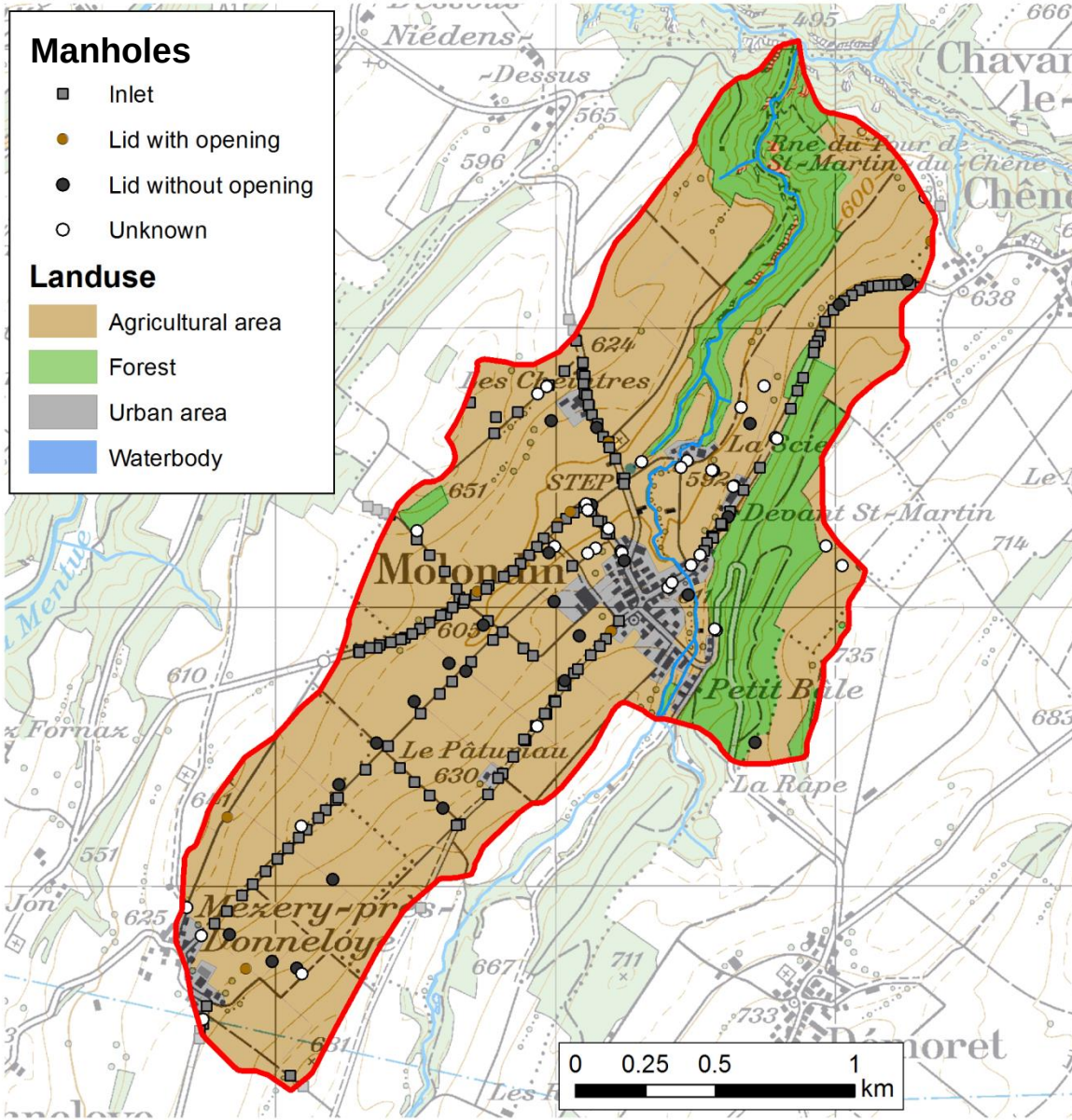
Shortcut map

Results Molondin (VD)

- Area: 4.2km^2
- Agriculture: 74%
  - Arable land: 90%
  - Meadows: 10%

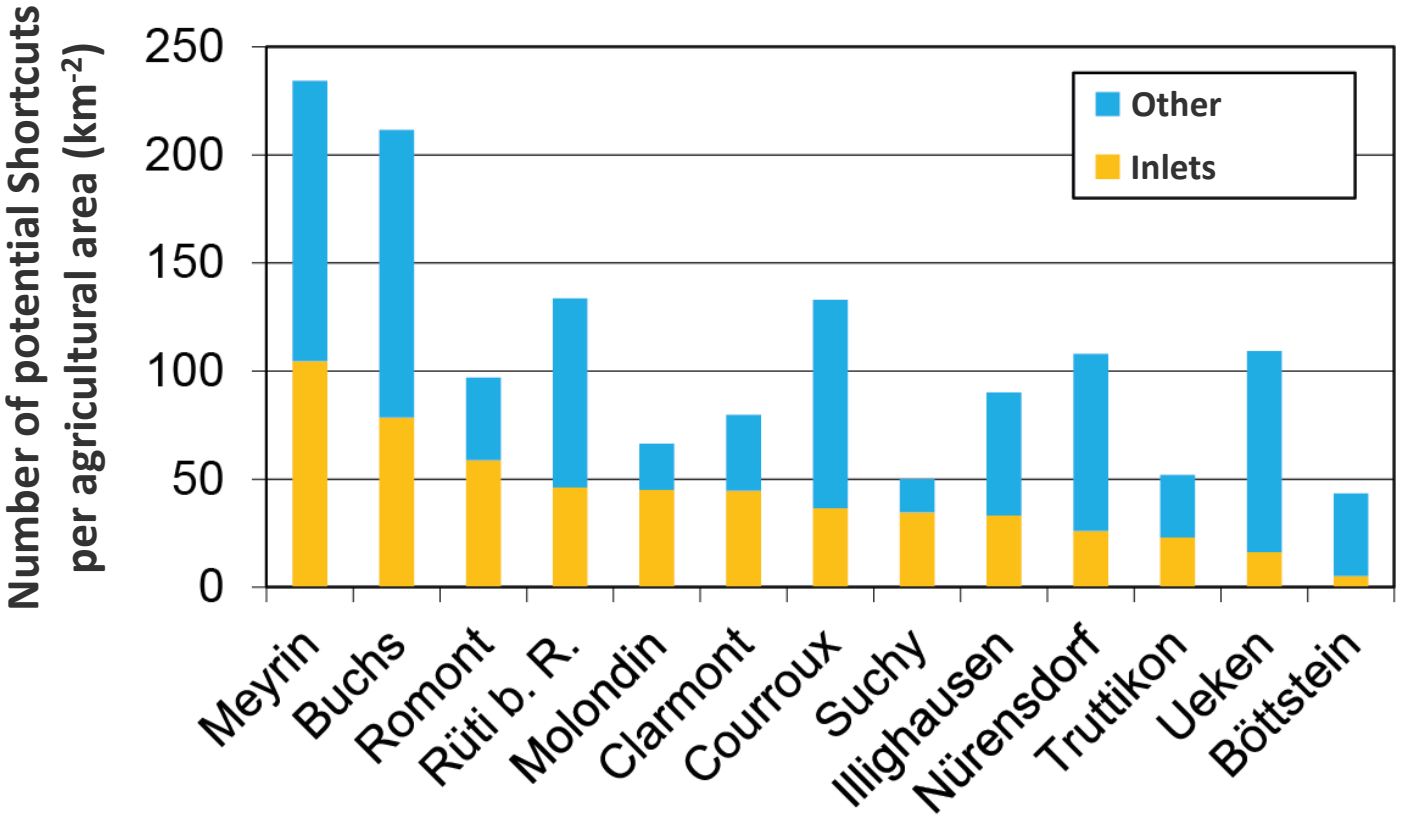
- Potential shortcuts: 280
  - Inlets: 200
  - Other: 80

- Attention: different data sources for different catchment parts



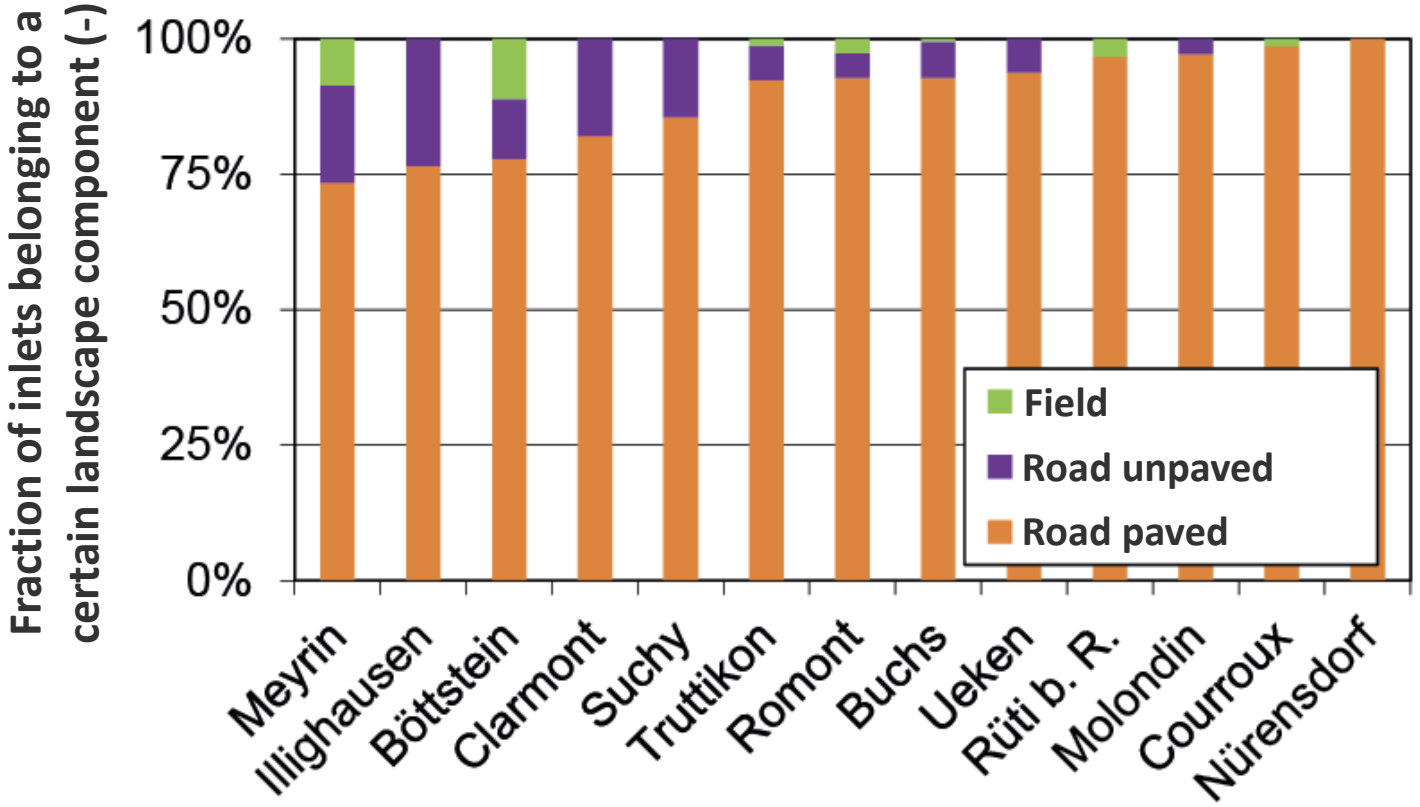
Shortcuts per area of agricultural land

Preliminary results



Inlets belonging to different landscape elements

Preliminary results



→ Most of the inlets in a catchment belong to a road

Amounts of pesticides lost via surface runoff

Methods

Pesticide losses = f(Connectivity,
Amounts applied,
Soil properties,
Rainfall,
Substance properties,
Application methods
…
)

2) Which amounts of pesticides are lost via hydraulic shortcuts compared to other pathways?

→ Relative comparison of these variables for direct and indirect pathways

Connectivity

Methods

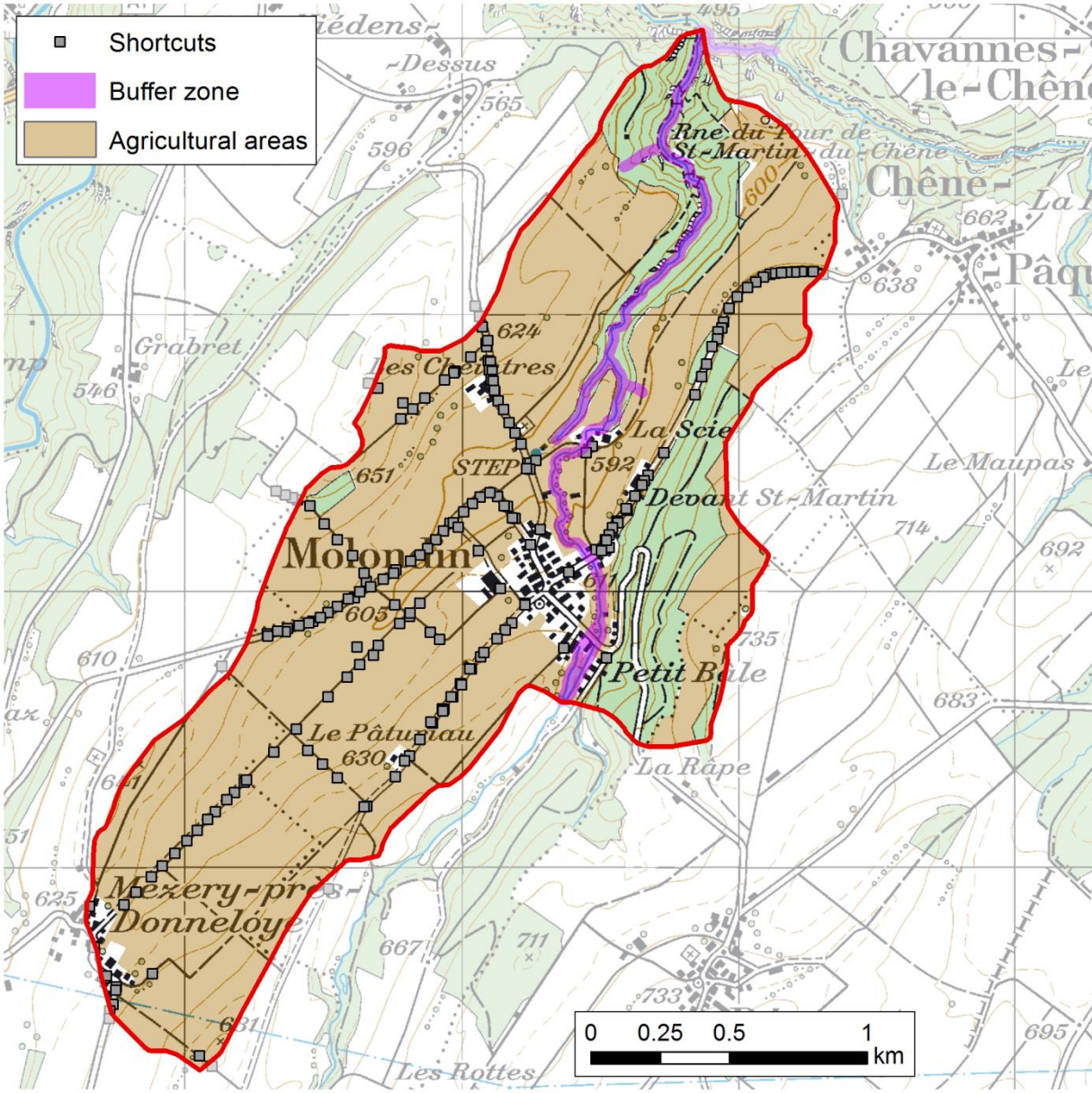
- Modelling of catchments based on topography

- DTM resolution: 2x2m
- D-Infinity algorithm
- Sinks < 1m filled

- Assumption:
  - 100% of inlets connected to surface waters
  - 0% of other manholes connected to surface waters

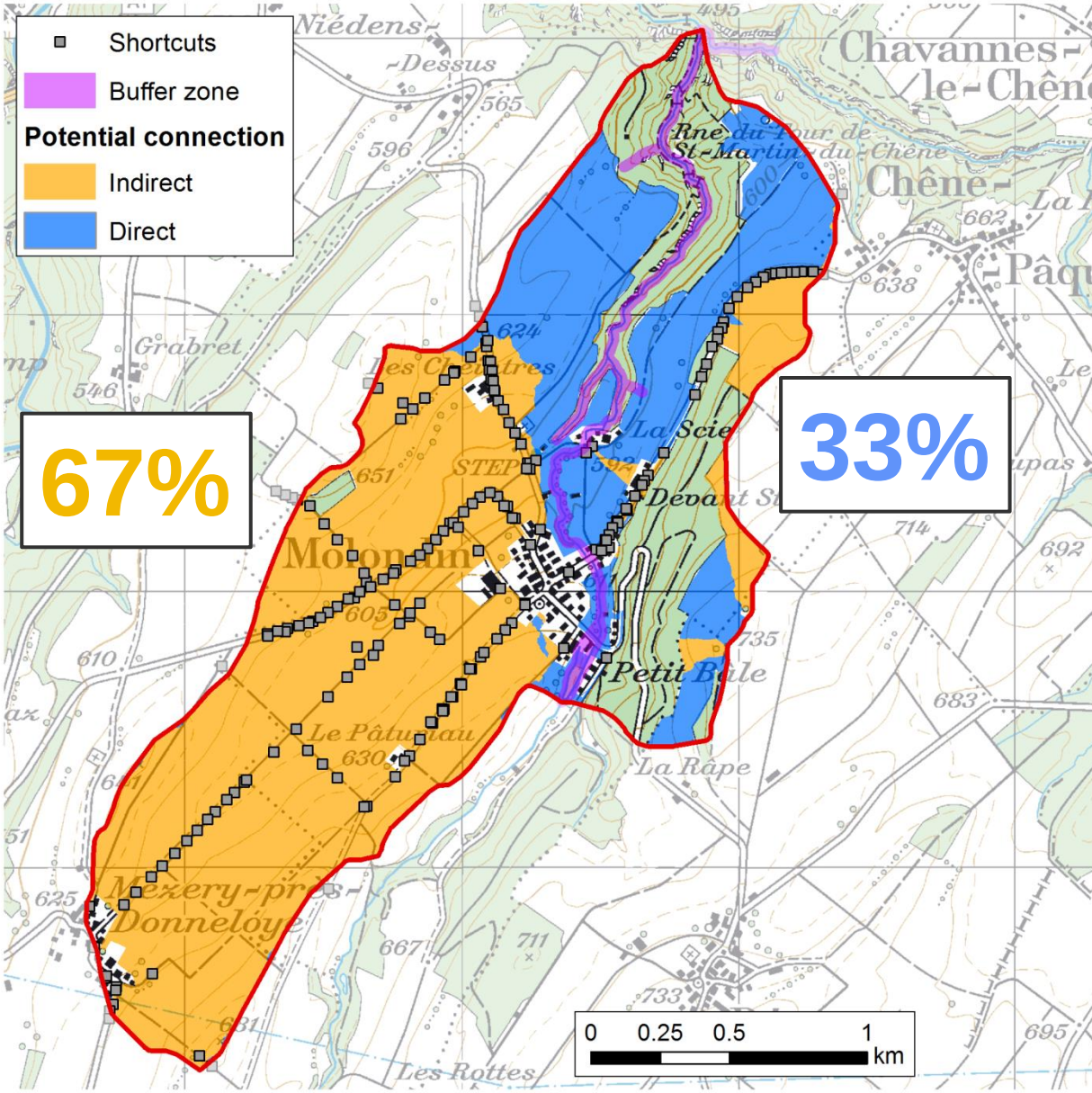
Connectivity

Example
Molondin (VD)



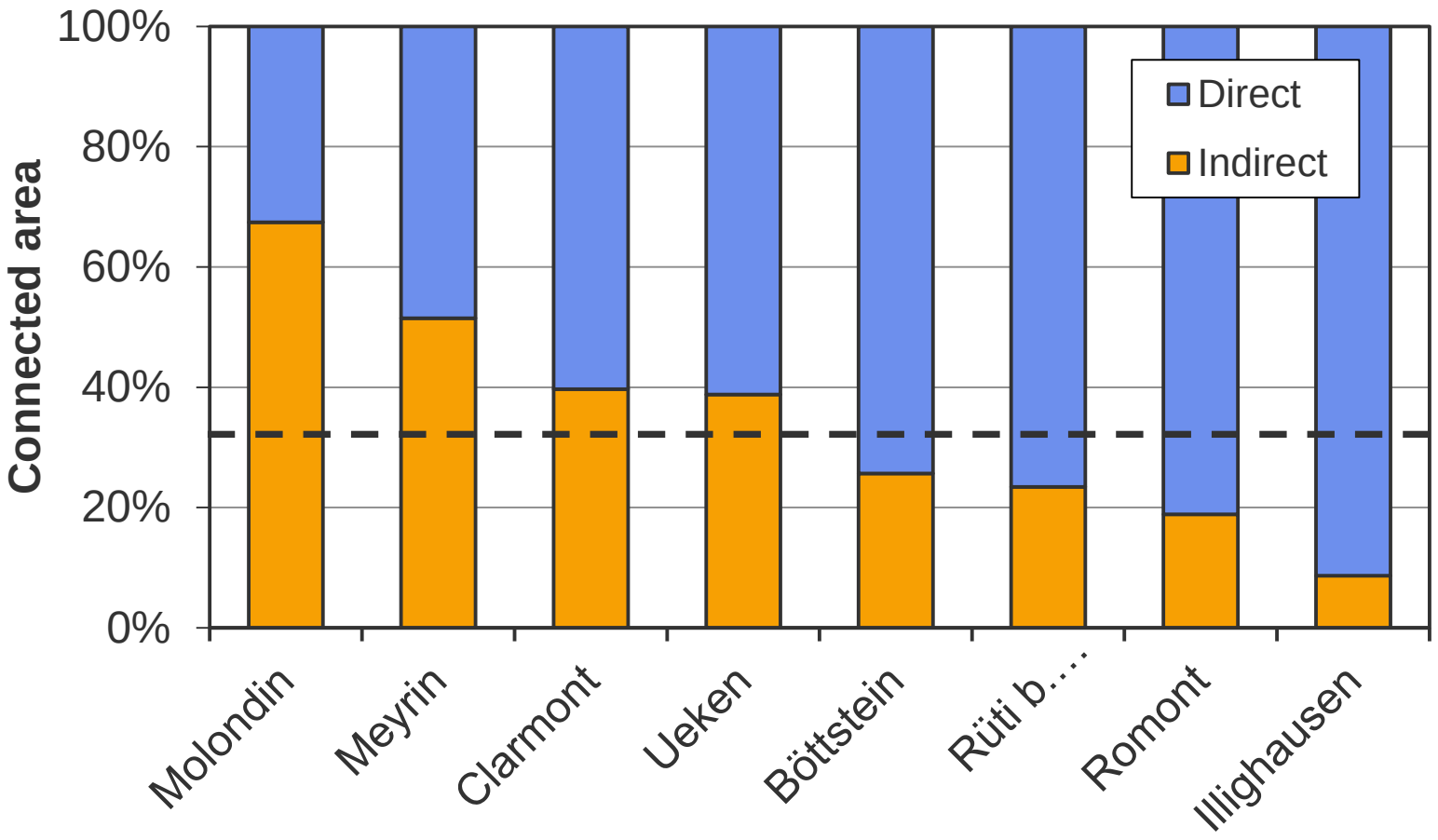
Connectivity: Direct vs. Indirect

Example Molondin (VD)



Connectivity: Direct vs. Indirect

Preliminary results



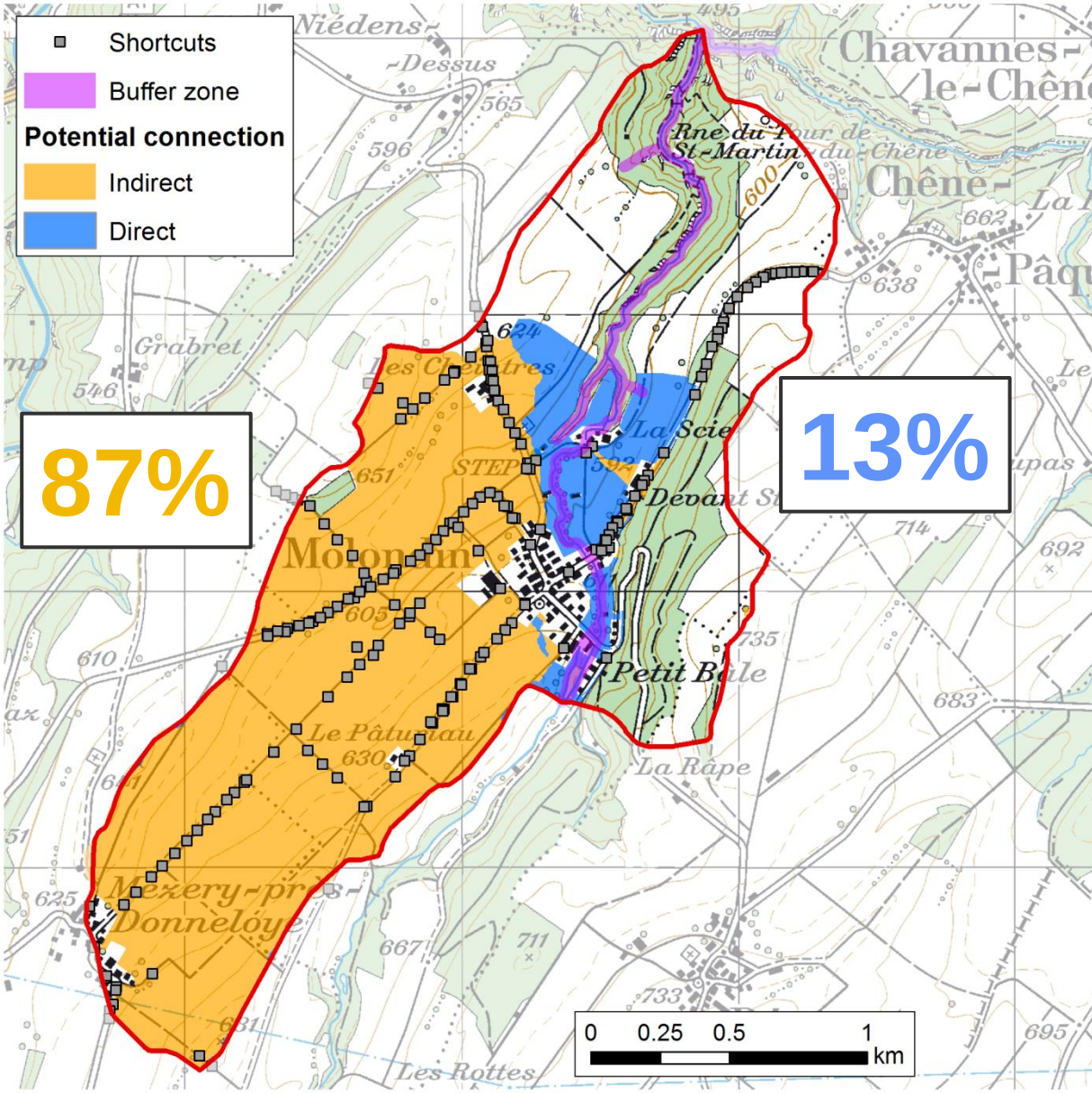
66%

Average

34%

Further model improvements

- Effect of forests & other landscape structures
- Analysis of flow distances instead of catchment areas
- Selection of sink filling methods
- Estimating the fraction of shortcuts connected to surface waters
- Inclusion of field survey results on microstructures



Further steps

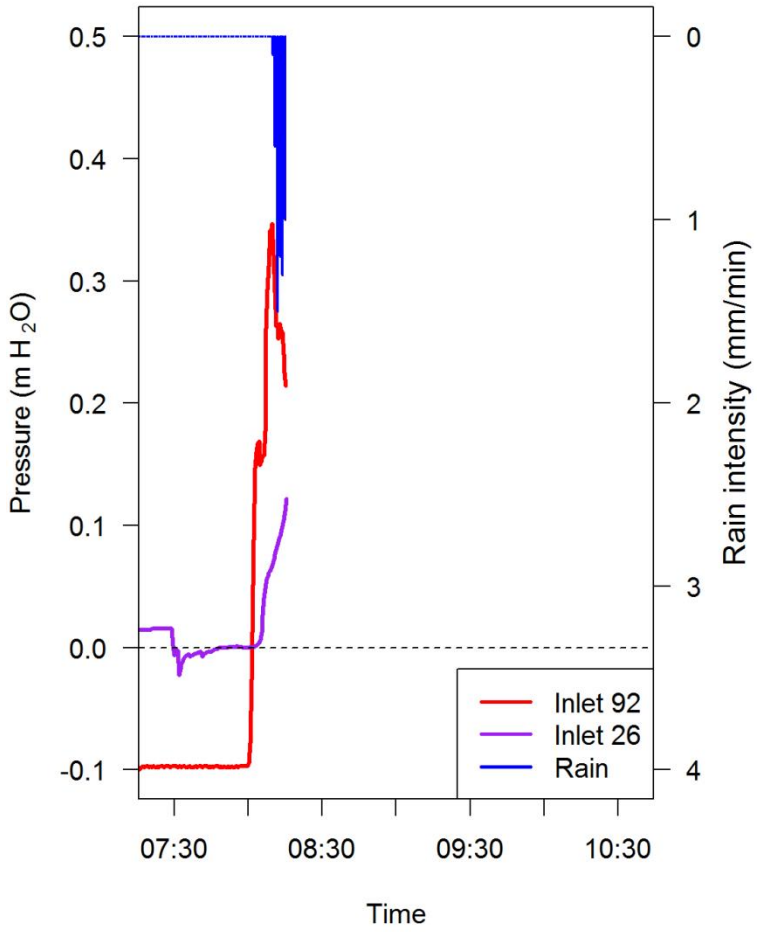
- Modelling of other factors relevant for pesticide losses via surface runoff:

*Pesticide losses = f(***Connectivity***,*
Amounts applied,
Soil properties,
Rainfall,
Substance properties,
Application methods
…
)

- Modelling of spray drift losses via shortcuts

Further steps

Discharge and pesticide measurements in one subcatchment



Conclusions

- Structures that can lead to a hydraulic shortcut are commonly found on Swiss agricultural areas
- Most shortcuts belong to the road drainage system
- On **arable land** large areas are connected to surface waters via shortcuts
  → vineyards?
  → horticulture?
- Although further are steps needed for a final conclusion:
  Shortcuts seem to be loss pathway which should not be neglected in (Swiss) regulations