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Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

**Transport of Veterinary Pharmaceuticals in Lowland Catchments:
a Lumped Modelling Approach**
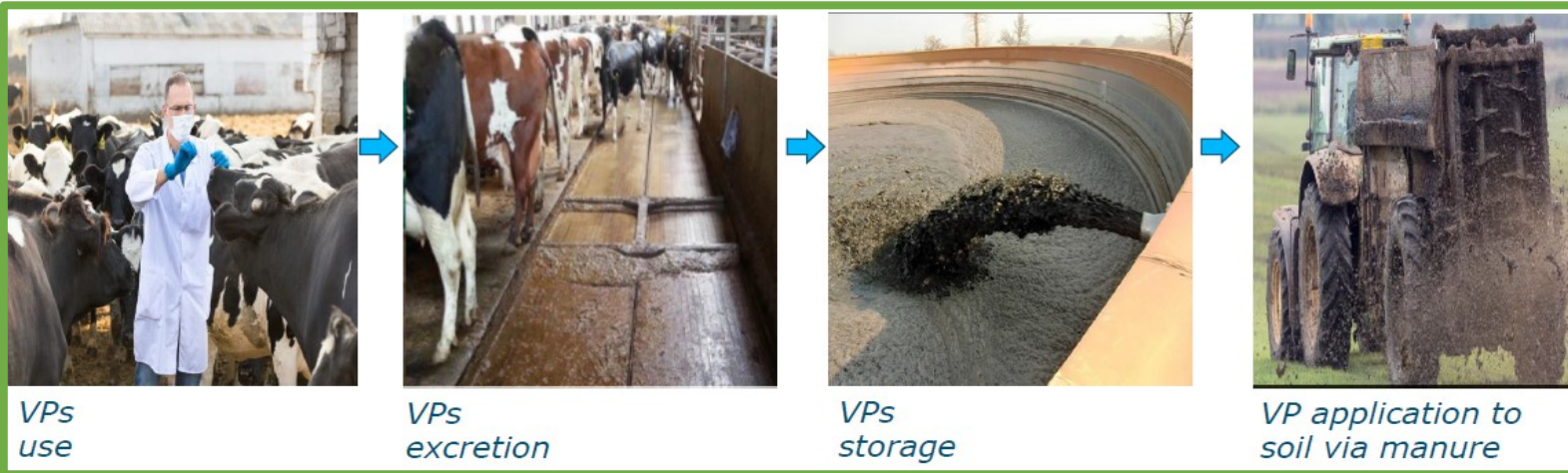
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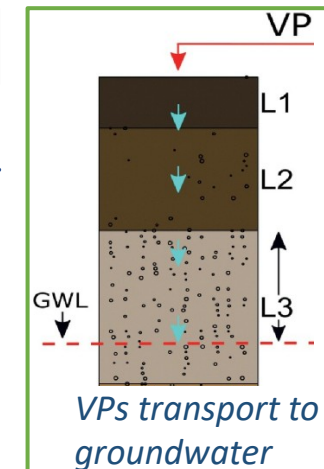Association

Veterinary Pharmaceuticals (VPs)

- VPs are compounds used to treat or prevent animals' illness.

- They are characterized by diffuse and complex hydrogeochemical dynamics, and have potentially negative environmental effects. Classified as CEC.

- So far, environmental monitoring/modelling focus has been mostly on human pharmaceuticals, whereas there is a lack of knowledge for VPs.

- While VPs transport towards groundwater and possible soil/plant contamination has been partly addressed over the past decades, the transport of VPs to and along the stream network has received much less attention. For this reason, it has been highlighted by the European Union Strategic Approach to Pharmaceuticals in the Environment (2019) as one of the research questions which remains to be tackled.
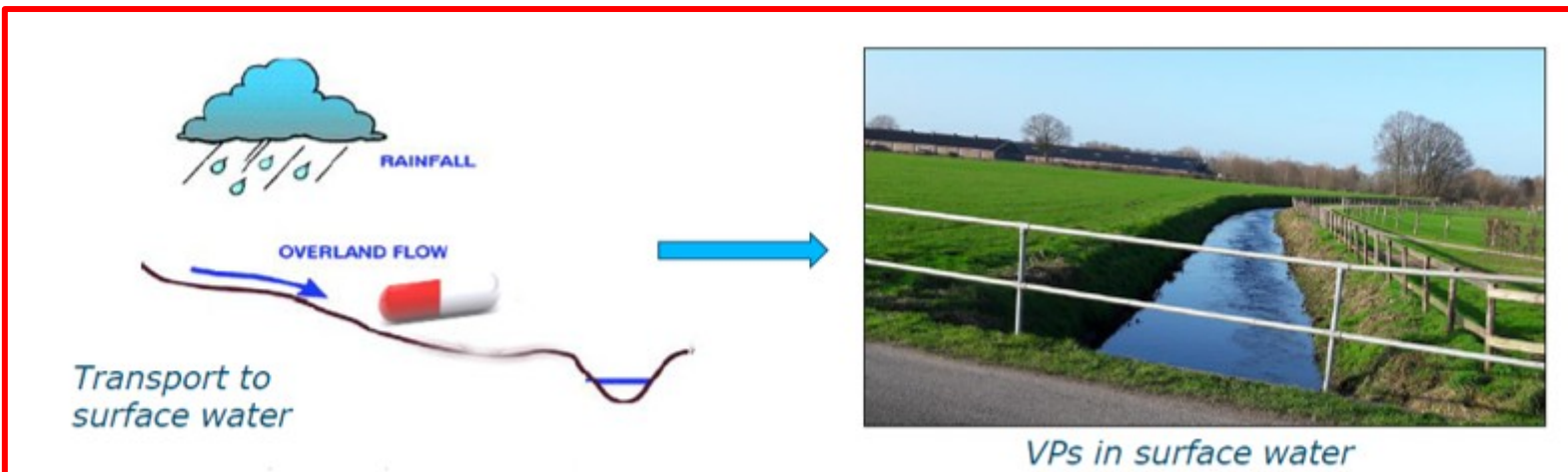
VPs transport

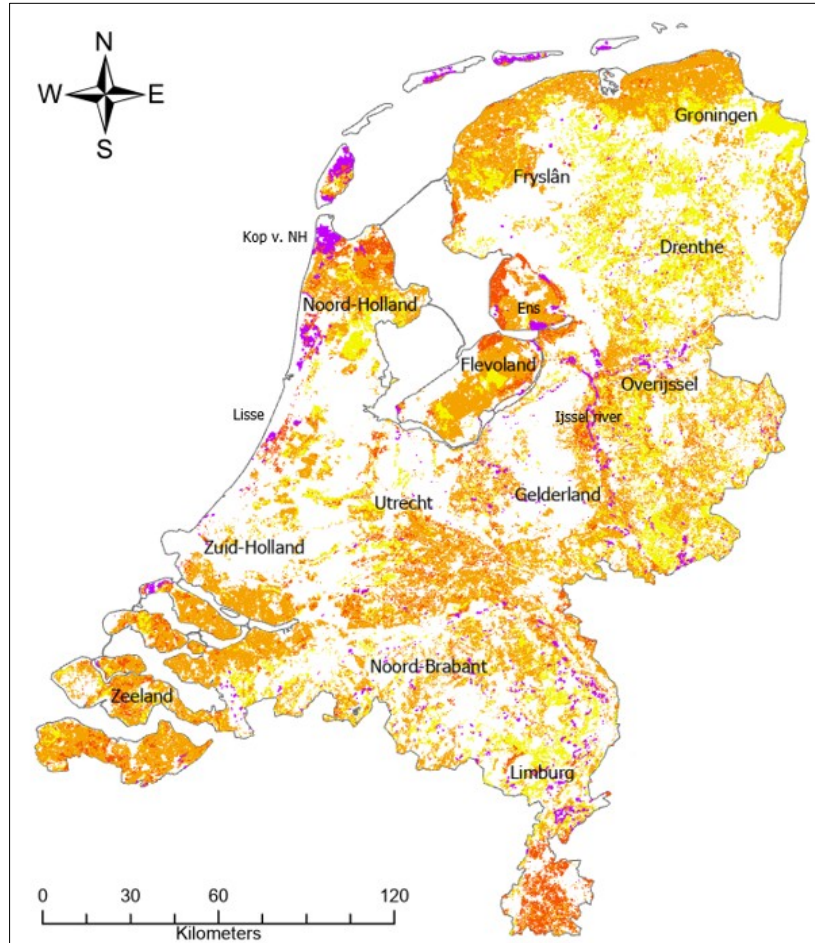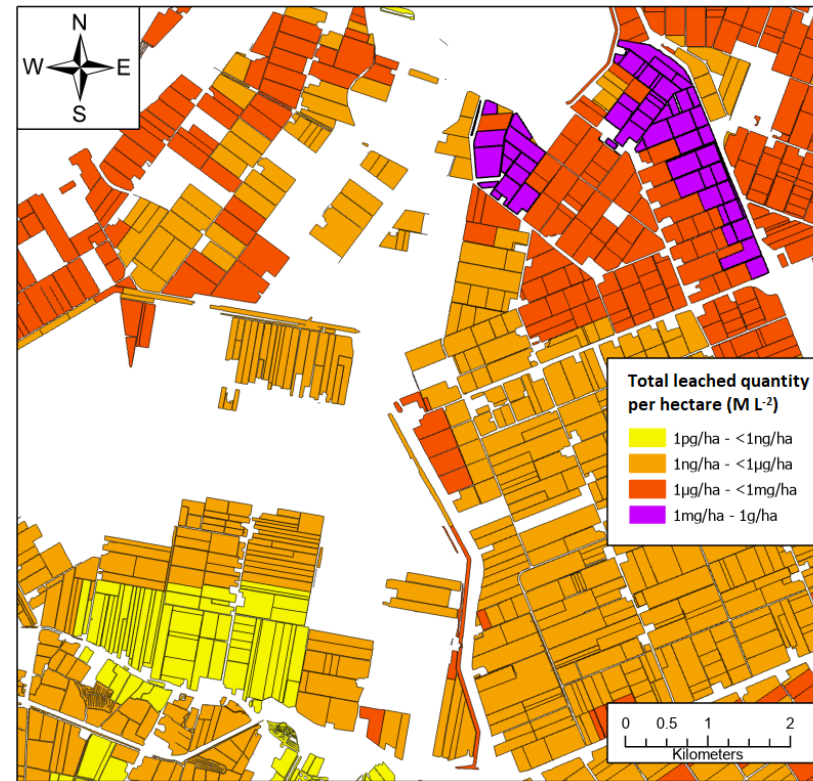**1** VPs use → VPs excretion → VPs storage → VP application to soil via manure

2a VPs transport to groundwater

2b Transport to surface water → VPs in surface water

VPs transport – steps 1 and 2a

National scale model

Local scale

Total leached quantity per hectare (M L⁻²)
- 1pg/ha - <1ng/ha
- 1ng/ha - <1µg/ha
- 1µg/ha - <1mg/ha
- 1mg/ha - 1g/ha

Analyzed more than 1.2 million fields in the Netherlands.

Science of The Total Environment
Volume 815, 1 April 2022, 152938

Emission estimation and prioritization of veterinary pharmaceuticals in manure slurries applied to soil

Nikola Rakonjac [a], Sjoerd E.A.T.M. van der Zee [a], Louise Wipfler [b], Erwin Roex [c], Hans Kros [b]

An analytical framework on the leaching potential of veterinary pharmaceuticals: A case study for the Netherlands

Nikola Rakonjac [a,b], Sjoerd E.A.T.M. van der Zee [a,1], Louise Wipfler [c], Erwin Roex [d], C.A. Faúndez Urbina [e], Leen Hendrik Borgers [f], Coen J. Ritsema [a]

VPs transport to and along the stream network (step 2b)

- This VPs route is indirect, difficult to quantify and may result in the pollution of surface water systems over long distances downstream of the application areas.

- The degree of surface water contamination depends on physical processes occurring during the transport, the way manure is applied to soil (spreading, injection, or incorporation), the distance to surface water, and substance properties (e.g. sorption and degradation).

- In lowland catchments (as typically in the Netherlands), the mentioned processes and their simultaneous interactions become even more relevant since the effect of terrain slope on the transport is diminished.

Challenges and research questions

- Translation from field scale to catchment scale where surface and subsurface contributions mix in the stream.

- How are VPs transported to the river network?

- How quickly can this transport occur?

- How much are they degraded/transformed along the way?
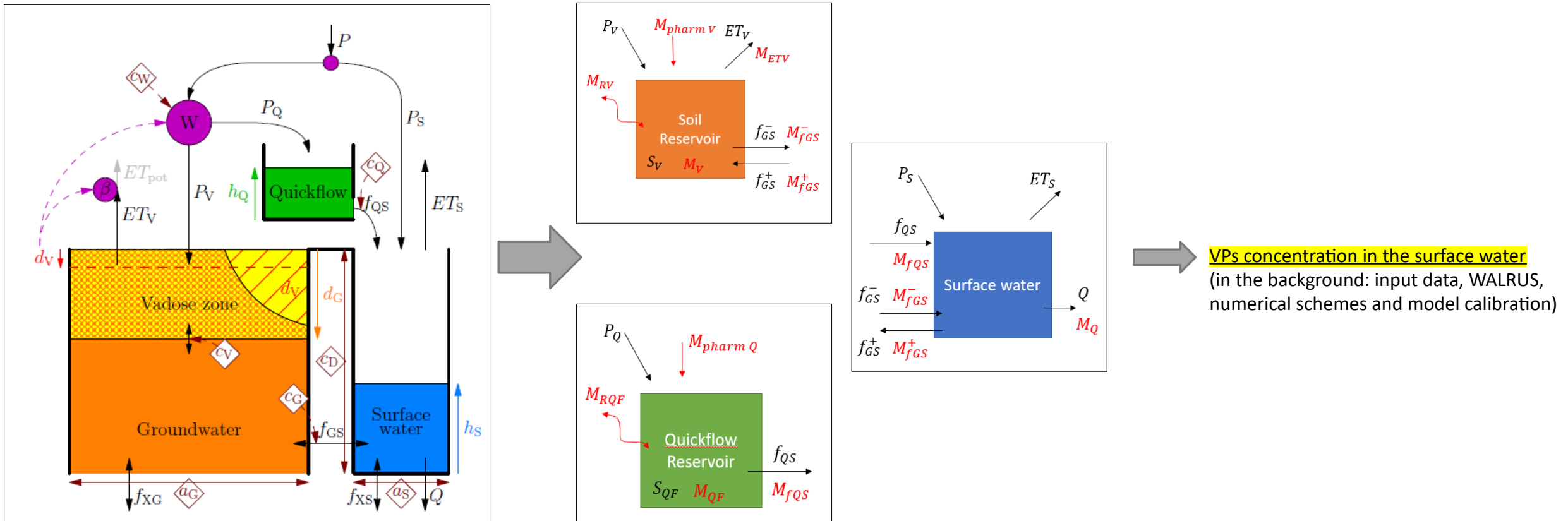
- Can we validate our predictions?

Our approach – area and input data

- Agricultural catchment (26 km^2) with intensive livestock sector.

- Mostly sandy soil and maize.

-Relevant VPs are selected together with the local water authorities.

- Estimation has been done for: VPs concentrations in manure, manure application patterns (soil and crop types), VPs characteristics, and hydrometeorological conditions.
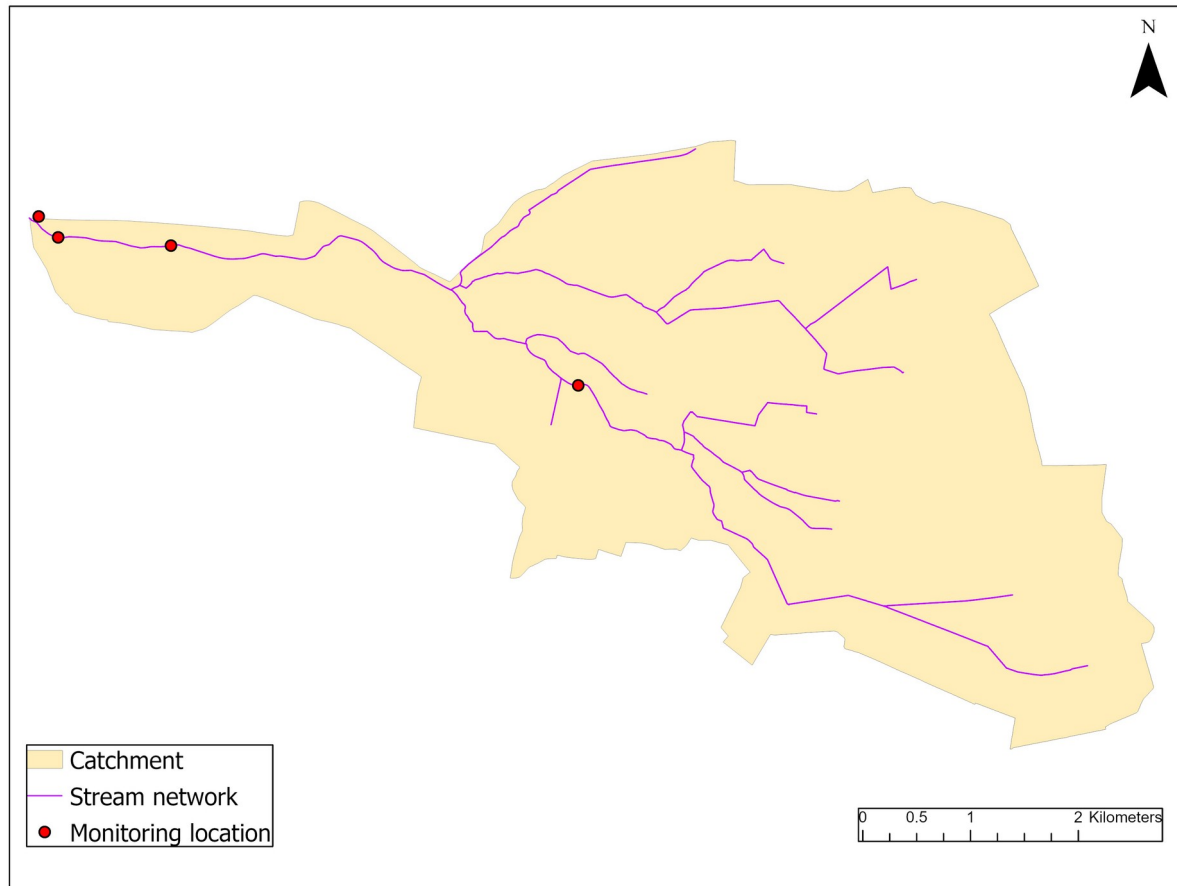

Catchment
Stream network

0   0.5   1   2 Kilometers
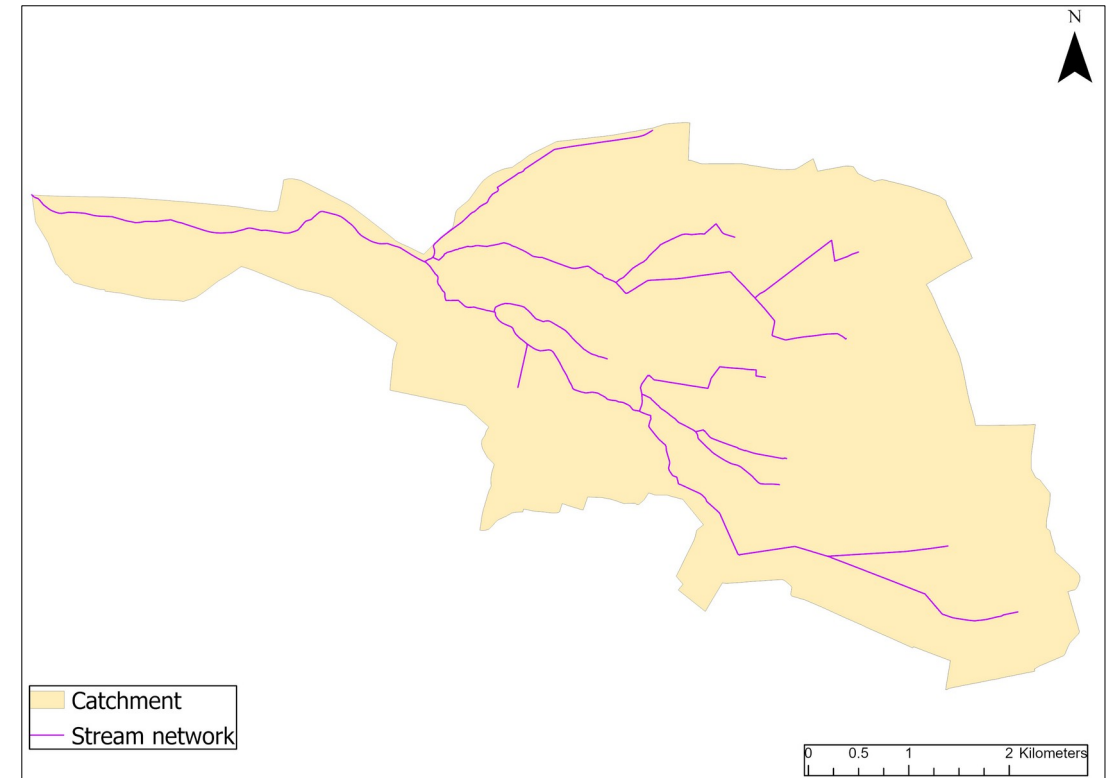
Our approach – model development

- We use an existing rainfall-runoff model (WALRUS) to predict relevant water fluxes. Then we add VP transport.

VPs concentration in the surface water (in the background: input data, WALRUS, numerical schemes and model calibration)

Validation

Catchment
Stream network
Monitoring location

- 4 monitoring locations (selected together with the local water authorities).

- 46 targeted VPs (some will be used for validation).

Passive sampler

Summary

- Our contribution illustrates a modelling approach to investigate the temporal dynamics of VPs in lowland surface waters.

- The approach combines an existing rainfall-runoff model (WALRUS) with data on soil-applied VPs to build a comprehensive VPs transport model.

- In addition, our results provide an insight into the most dominant transport routes towards surface water and VPs mass loss occurring during the transport.

- As the model specifically addresses VPs residence times in surface waters, it helps us understand the interactions between water quality and agriculture, and it allows us to identify suspected risks and suggest (regional) policy improvement.