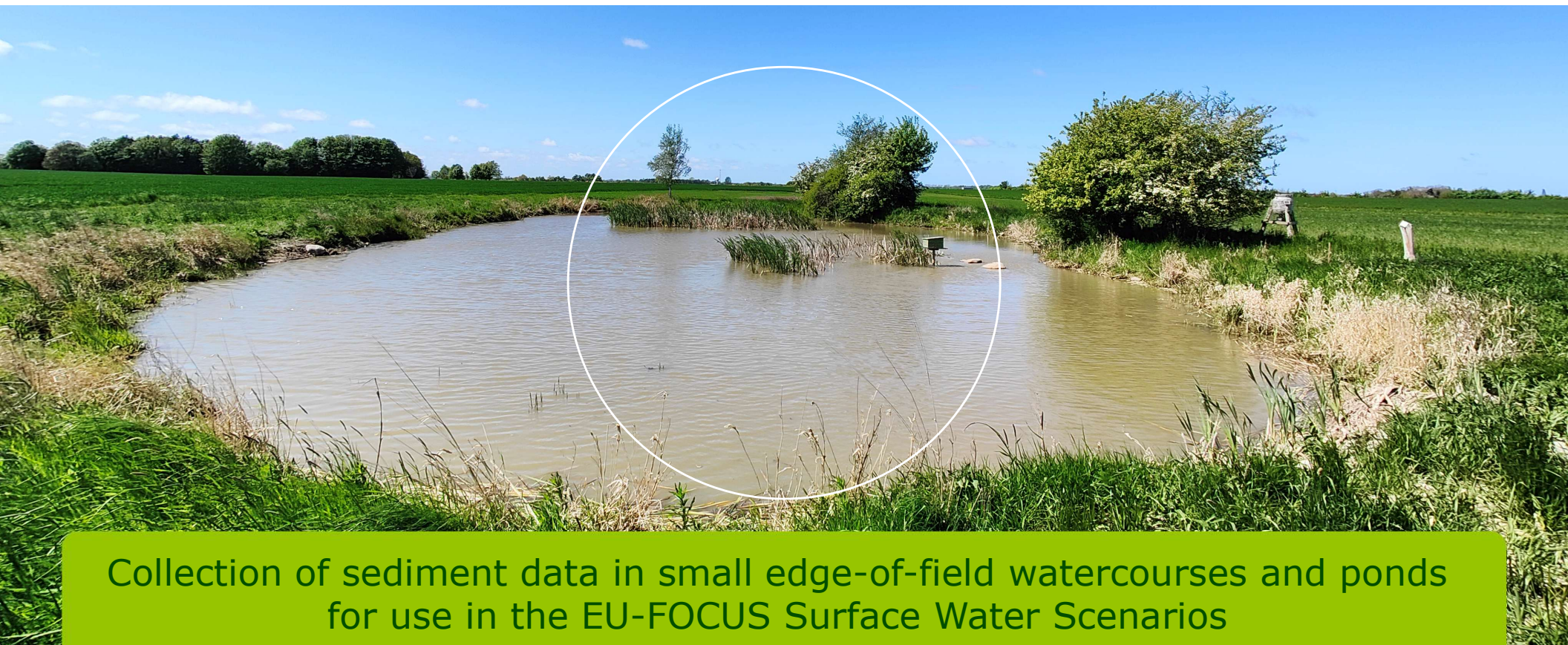




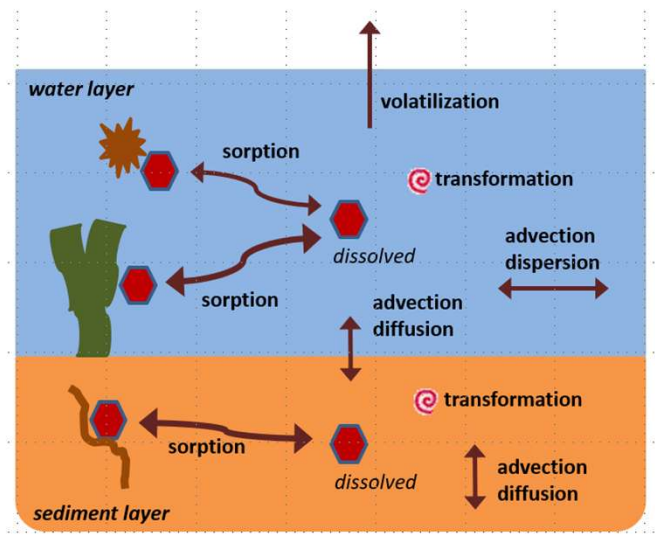
Collection of sediment data in small edge-of-field watercourses and ponds for use in the EU-FOCUS Surface Water Scenarios

Wim Beltman, Kas Swinkels, Sander Mucher, Steven Crum, Martin Knotters, Paulien Adriaanse, Alie Hissink, Arjan Reijneveld, Almir Nunes, Jan Baas

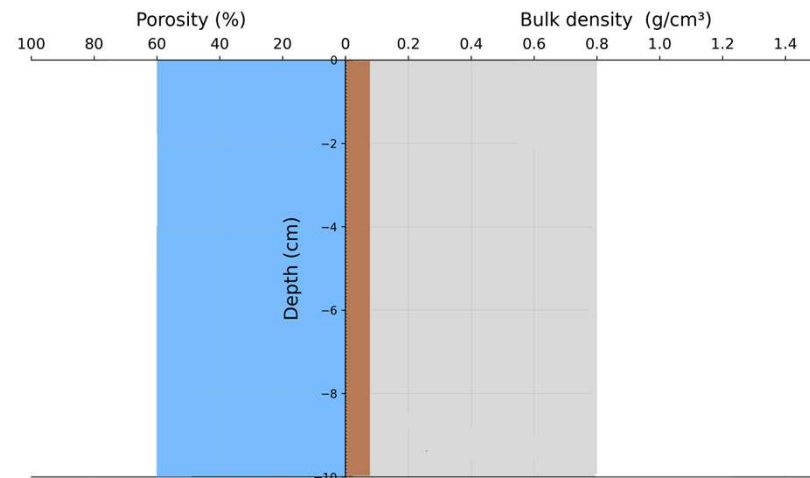
Background

TOXSWA model is used in risk assessment EU to calculate exposure concentrations in water and in sediment for realistic worst case scenarios

Processes in TOXSWA



**Sediment parameterization 10 cm:
porosity 60%, bulk density 0.8 g/cm³,
Organic Matter (OM) 9%**



Current scenarios designed for aquatic exposure, so not for sediment exposure

Sediment exposure

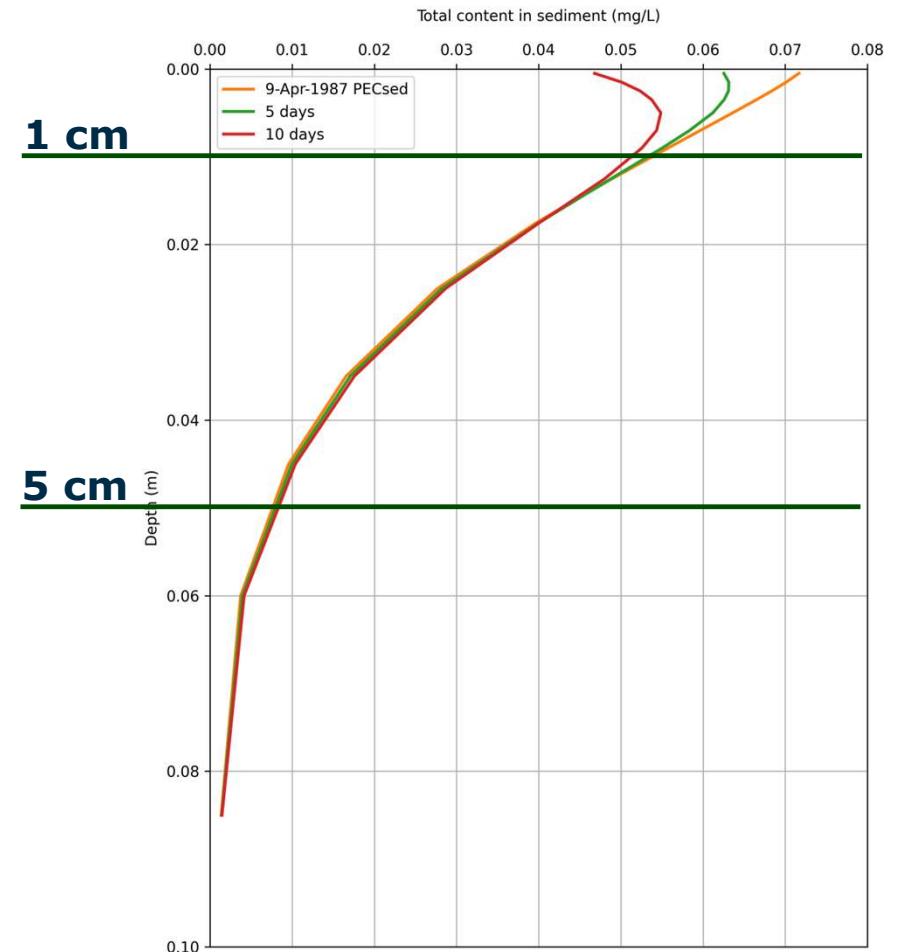
Example calculation

In the risk assessment, exposure

- for sediment dwelling organisms is calculated for the layer 0-1 cm, and
- for rooted macrophytes, exposure in depth 0-5 cm is used.

Current FOCUS sediment, 9% OM

Sorption coefficient $K_{oc} = 100 \text{ L/kg}$



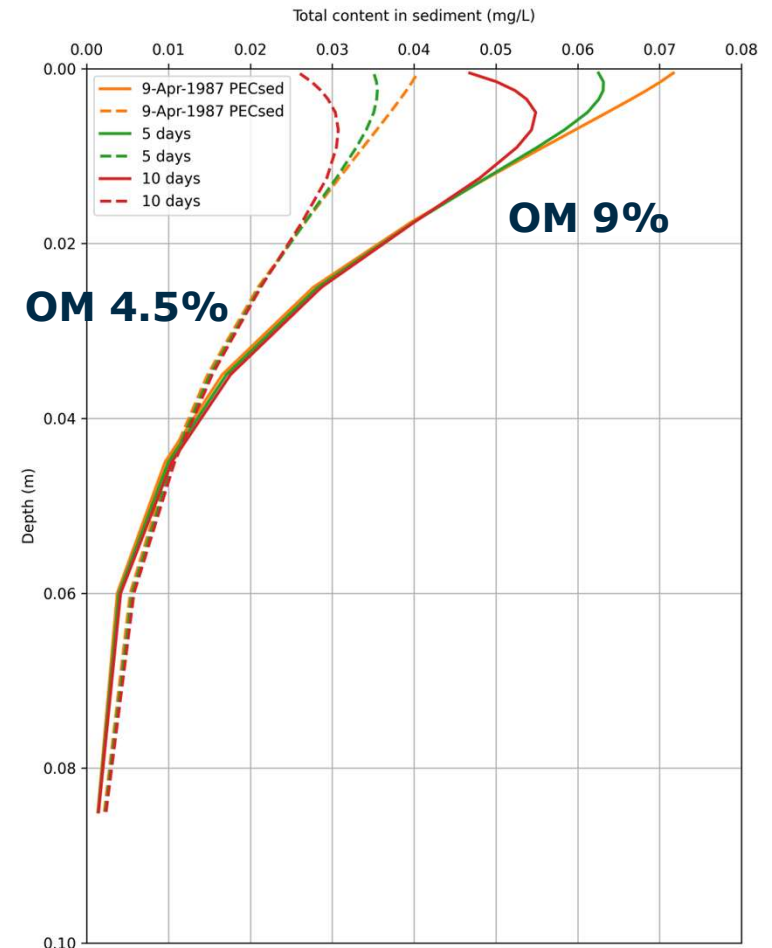
Sediment exposure

Example calculation

- Exposure concentration sensitive for parameterization.
- Parameterization based on limited data, and properties same for whole 10 cm.
- Same parametrization used for all scenarios.

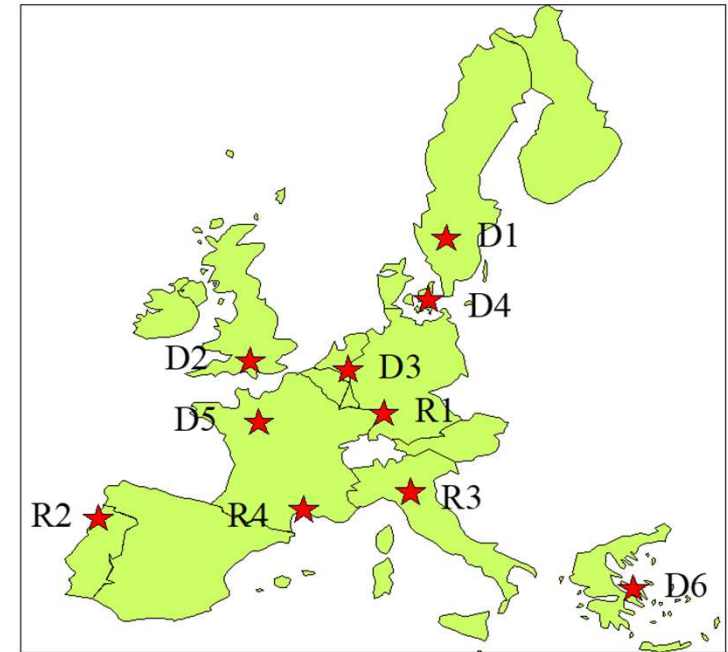
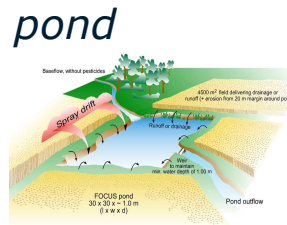
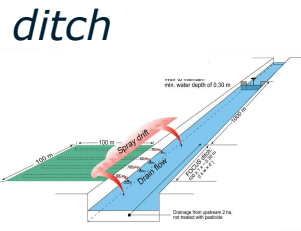
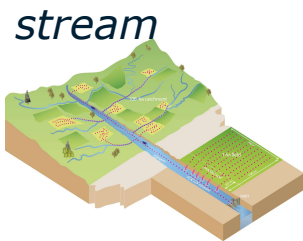
So, need for data:

Porosity, bulk density and OM content as function of depth



Aim of study

Collection and evaluation of existing and new sediment data for the parameterization of scenarios to estimate the exposure of pesticides in small waterbodies adjacent to agricultural fields at the EU level



15 waterbodies - 10 scenario locations,
distributed over Northern, Central and
Southern zone

Targeted literature search

22

studies included

94

unique waterbodies

1997–2023

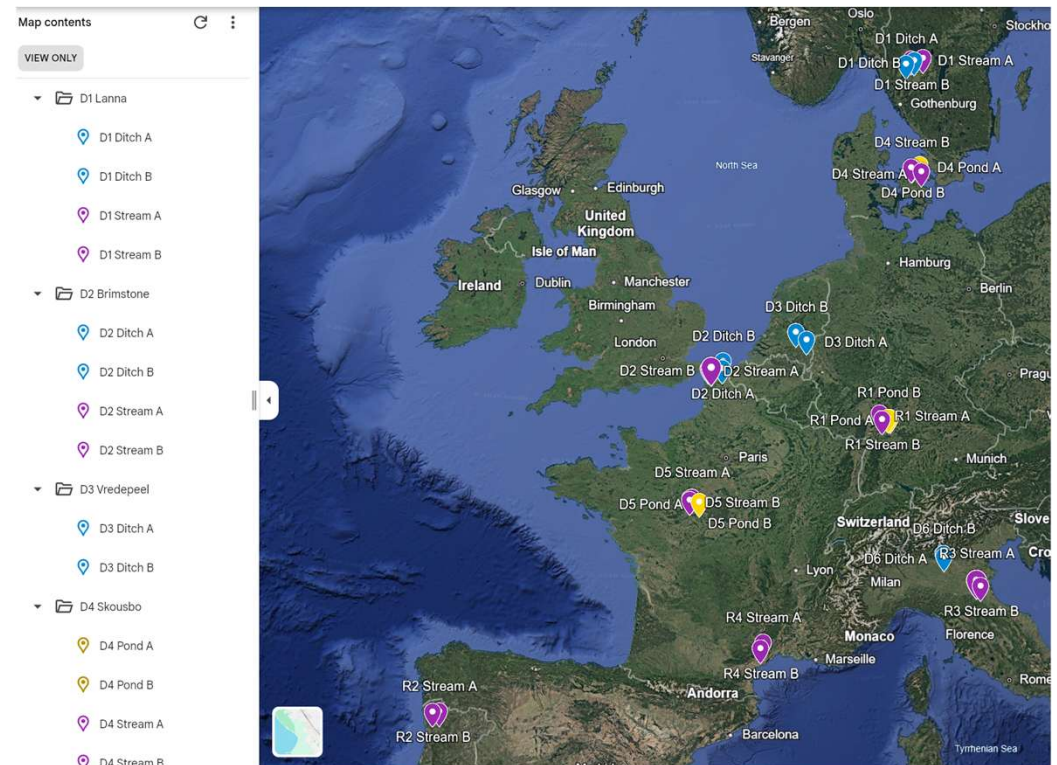
publication period

84 of 94 waterbodies lie in the Central Zone — a strong geographic bias.

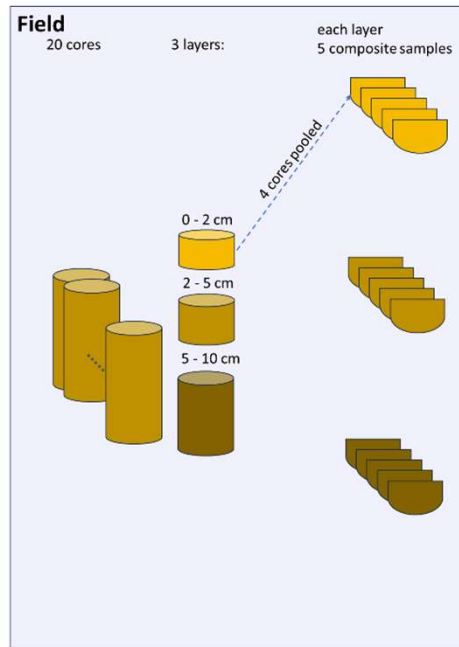
- Many studies report **OM% only, without bulk density** – incomplete for sorption.
- Only **WUR studies in ditches** report both OM and bulk density as a function of depth.
- **Adriaanse et al. (2015)** gives field data (not experimental setups) – the most suitable source for realistic TOXSWA parameterisation.
- In general: **sampling depth** and methods differ widely, so reported values cannot be compared in a meaningful way.

For each location - waterbody type 2 waterbodies selected

- (i) waterbody map of the EESE project
- (ii) arable crop areas from Corine Land Cover and European Union Crop type map
- (iii) FOCUS maps for the areas represented by the scenario



Sampling of waterbodies



Measurements

- porosity, bulk density, OM content in layers 0-2 cm, 2-5 cm and 5-10 cm depth
- Granular composition 5-10 cm layer



Measured sediment properties

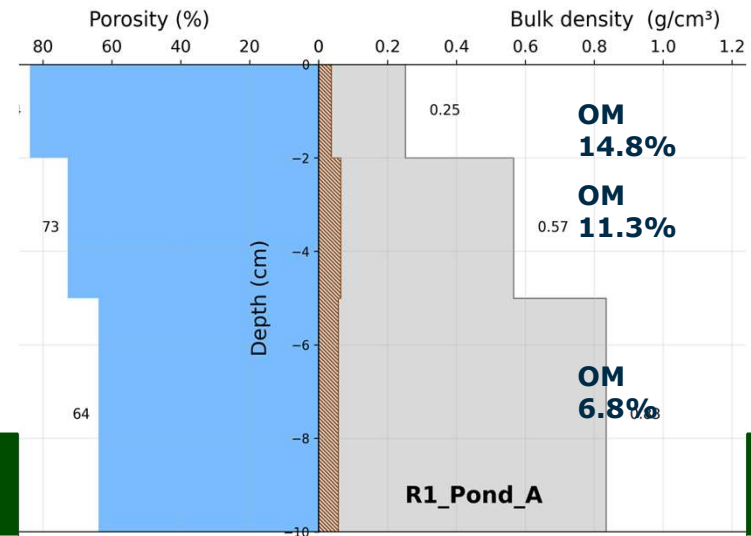
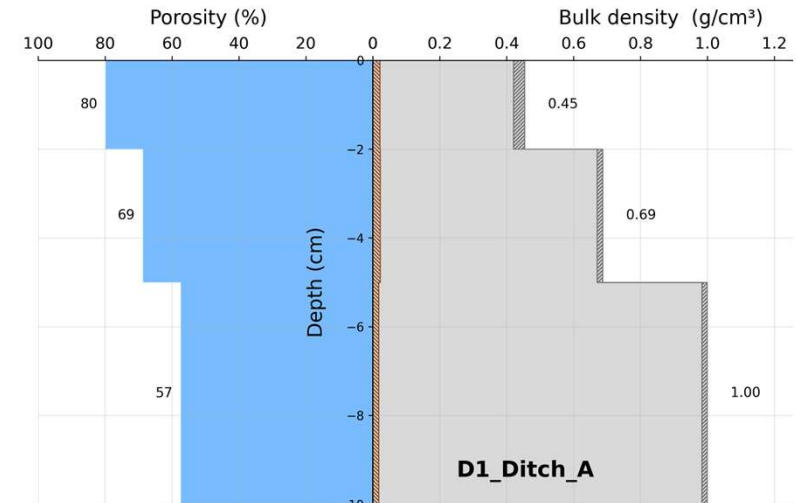
Profile plots: properties as function of depth

Layers, 0-2 cm, 2-5 cm and 5-10 cm.

- Left: porosity (volume %, blue)
- Right (all in g/cm³):
 - bulk OM density (brown),
 - bulk stone density (dark grey)
 - sediment bulk density (sum)

OM content (%) decreases with depth

- but absolute organic matter mass (g/cm³, brown) increases with depth
- Absolute mass OM = OM content x bulk density
define as **bulk OM density** (g/cm³)

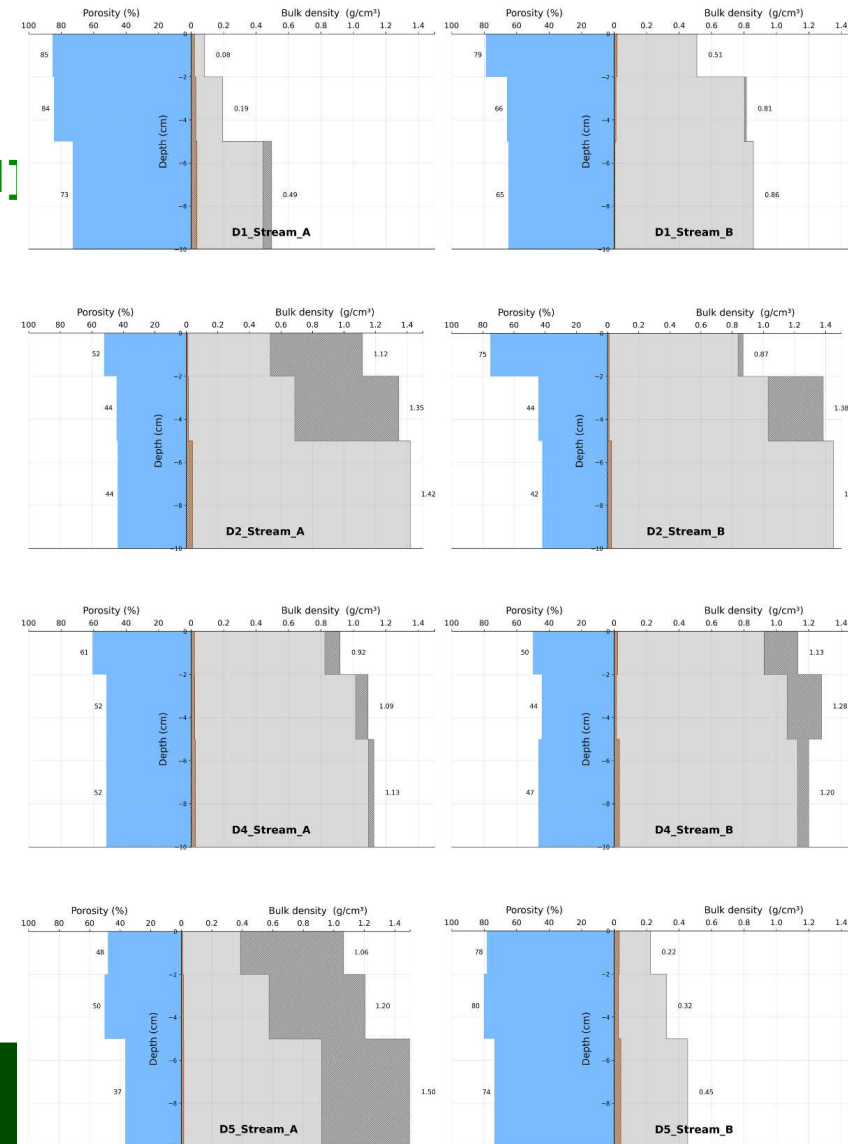


Measured sediment properties

Results 8 D-streams [of 30 waterbodies sampled]

- No substantial decrease porosity (blue) with depth for seven streams.
- Increase of bulk density (total) with depth.
- Increase of bulk OM density (brown) with depth for six streams.
- Seven stream sediments contain stones (dark grey).

Note that presence of stones makes interpretation and parameterization not straightforward because stones are not considered in TOXSWA



TOXSWA sediment calculation

Concentration in sediment

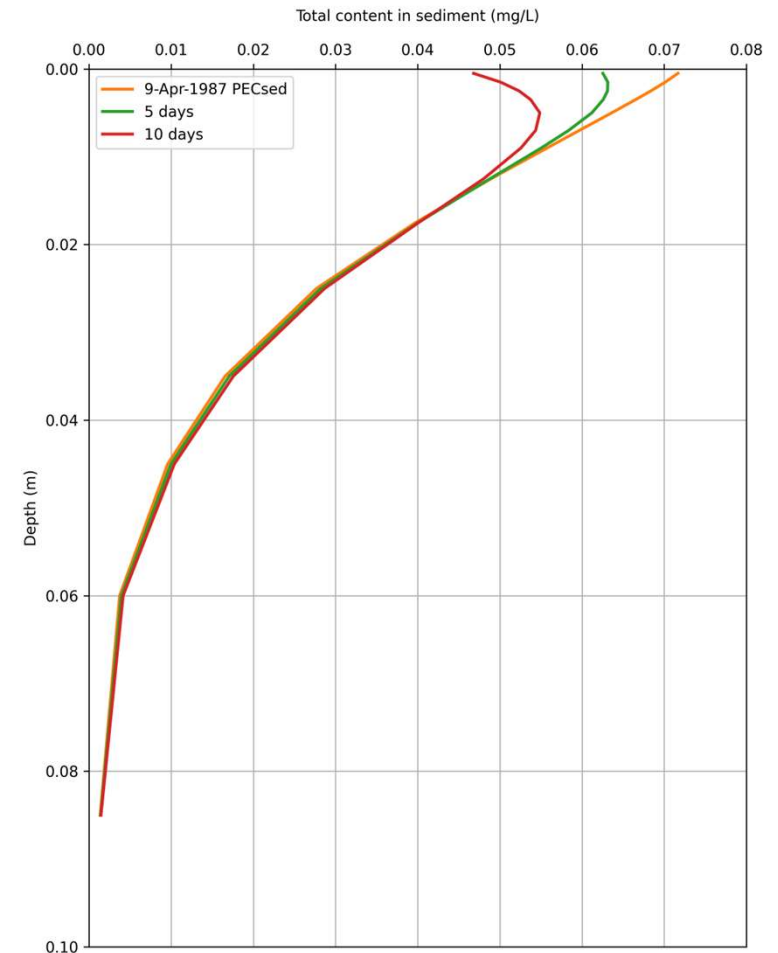
Total concentration in sediment c_{layer}^*

$$c_{layer}^* = \underbrace{\rho_{layer} m_{om,layer}}_{\text{bulk OM density}} K_{Fom} c_r \left(\frac{c_l}{c_r} \right)^N + \underbrace{\epsilon_{layer}}_{\text{porosity}} c_l$$

yellow = sediment properties

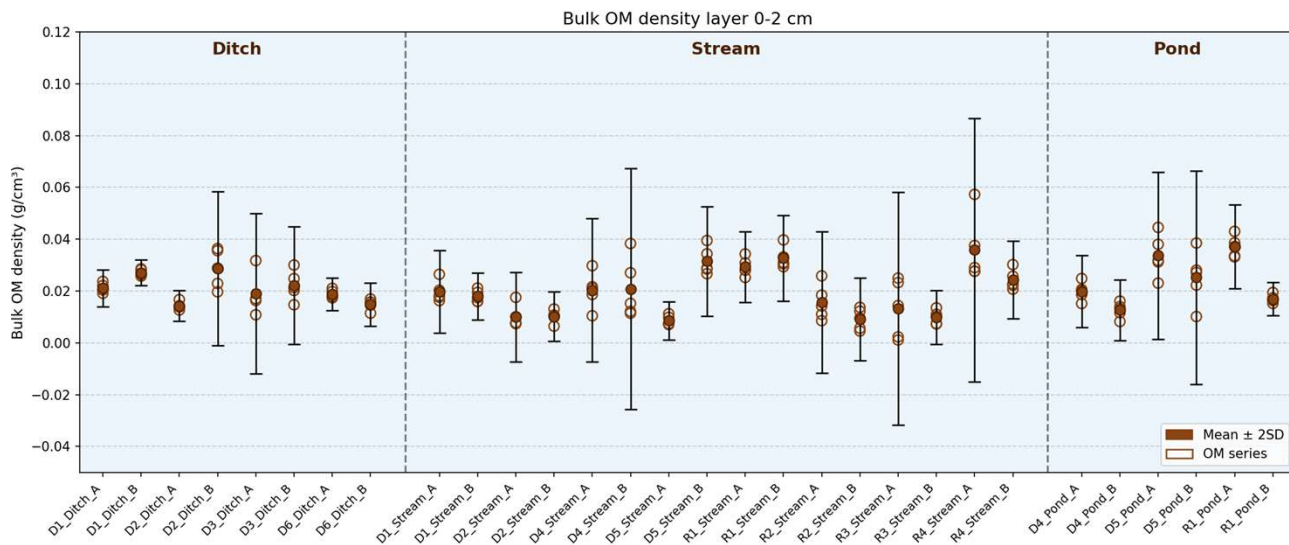
other are concentrations and pesticide properties

Bulk OM density and porosity determine fate in sediment



Parameterization of sediment properties

Use data of layer 0-2 cm depth because most representative for sediment-dwelling organisms and rooted macrophytes



- Bulk OM density between 0.009 and 0.037 g/cm³, within factor 3.5 [OM content: a factor 30]
- Statistically shown no relation of bulk OM density and porosity with waterbody type (ditch, pond, stream), or regulatory zone (North, Central, South)

Conclusions

Literature search and sampling campaign

- Data from literature (22 studies), concerning 94 unique waterbodies not useful for parametrization of TOXSWA.
- Waterbodies selected using a (i) waterbody map, (ii) arable crop areas, and (iii) the FOCUS maps areas. For each waterbody type – location two waterbodies were selected and sampled.
- Bulk OM density (bulk density x OM content) and porosity are the sediment properties determining pesticide fate in sediment
- Stones found in 22 of 30 waterbodies.
- No location-specific, or waterbody type specific, or regulatory zone specific parameterization possible based on 30 sampled waterbodies.



Recommendations

Selection of sediment properties for the FOCUS surface water scenarios



Use properties of the 0-2 cm layer to select a 'realistic worst case' sediment for the PEC_{sw} as well as PEC_{sed}, e.g., the 10th and 90th percentile out of all 30 sampled waterbodies (presuming homogeneous layers with bulk densities, porosities and OM contents averaged over the fine and stone fractions of the layer)



Alternatively, calculate the sediment properties excluding stone mass and volume, so based on fine material.



Do not select sediment properties per location, per waterbody type, or per regulatory zone, because no statistical differences can be shown for the sediment properties.

Thank you

Report in press, and database to be put on Zenodo

Beltman, W.H.J., Baas, J., Crum, S.J.H., Mûcher, C.A., Knotters, M., Swinkels, K.J.L., Nunes, A., Reijneveld, J.A., Adriaanse, P.I. (2026) Collection of data on freshwater sediments from small edge-of-field waterbodies representing the EU-FOCUS scenarios for use in pesticide registration.

