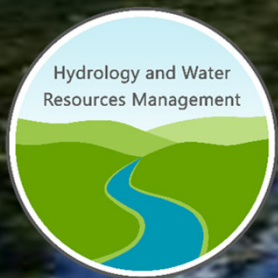


Input of plant protection products into groundwater via bank filtration: - a review -



U. Ulrich, L. Loose, A. Wendell, N. Fohrer

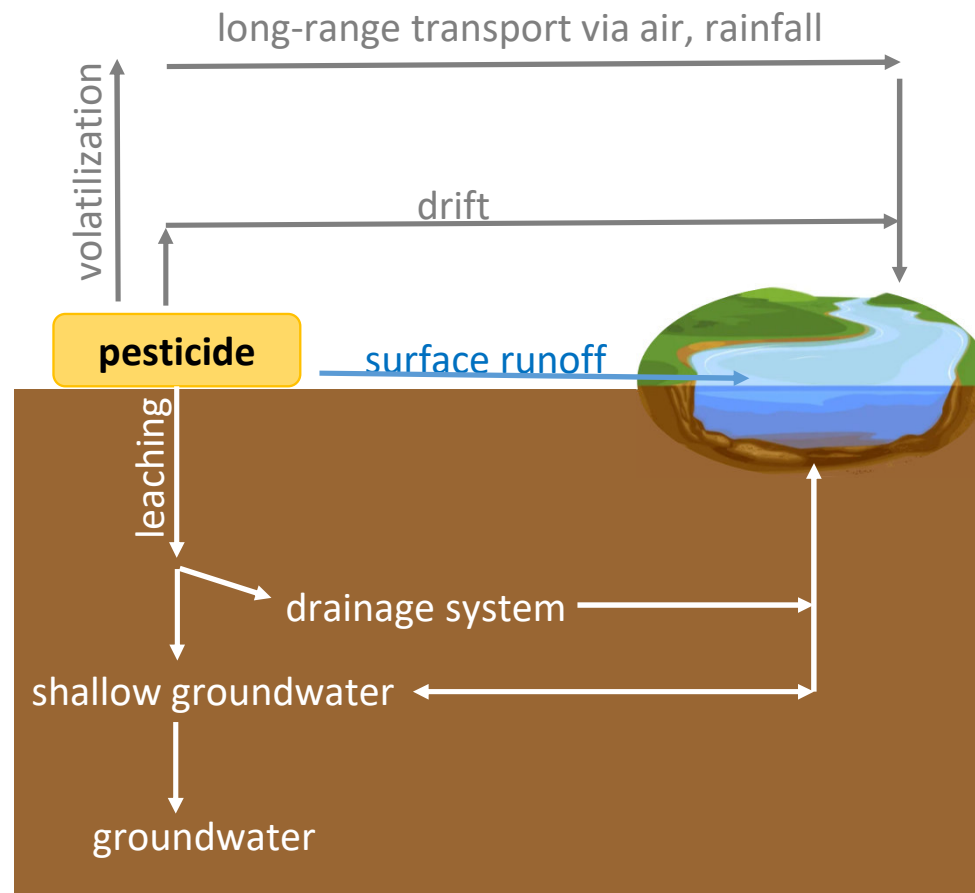
Dept. Hydrology & Water Resources Management, Kiel University/Germany

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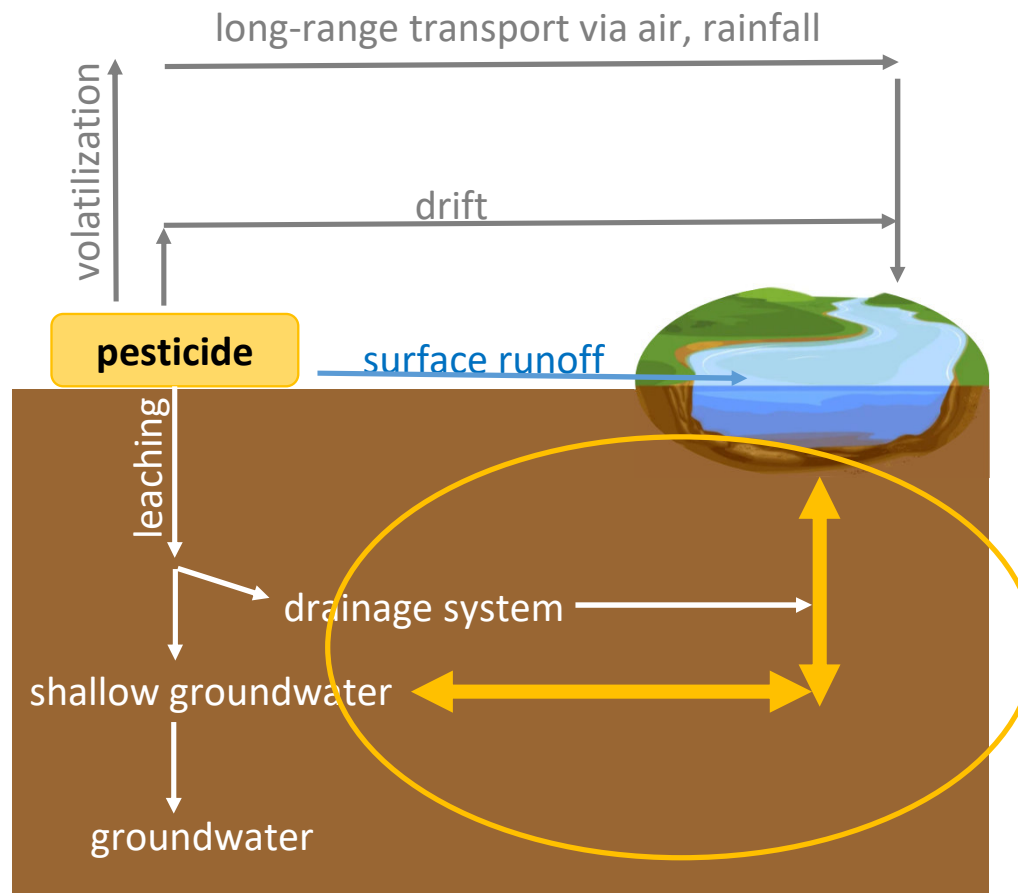
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Introduction



Introduction



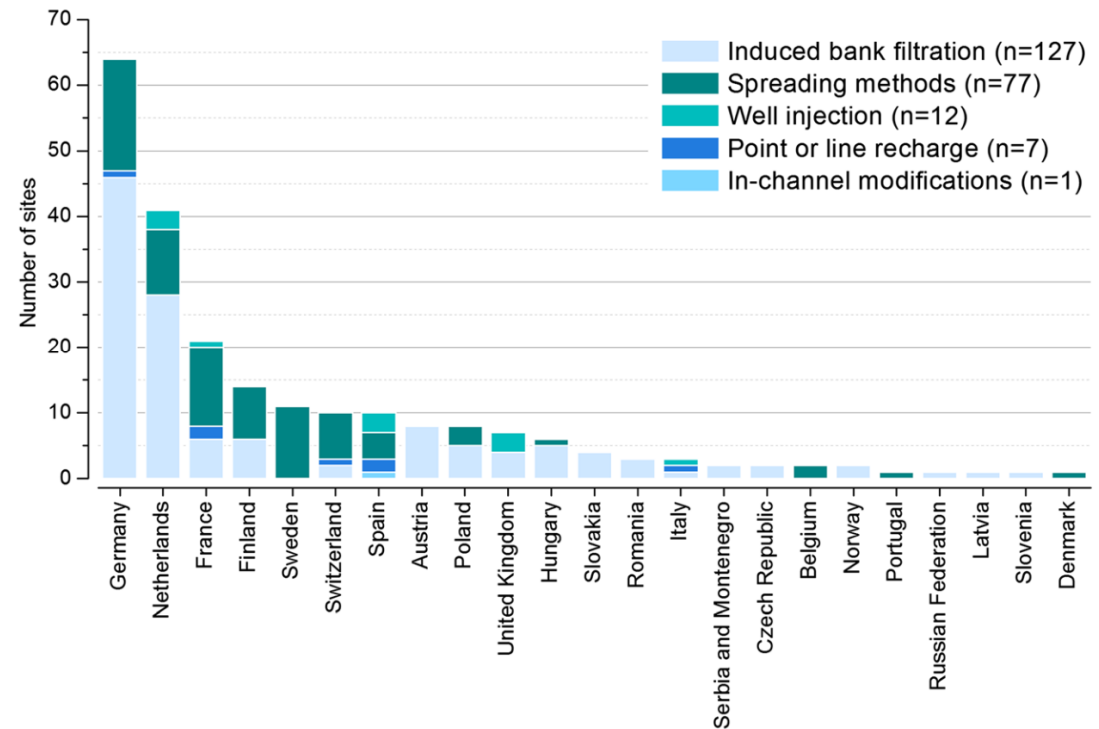
Bank filtration (BF): transport of water, along with dissolved or particulate matter, from a surface water body through the riverbed and subsurface passage into the groundwater (GW), excluding percolating (DIN 4049-3: 1994)

Application



Technically induced BF for raw water provision

- Common in Europe
- High volume withdrawn at limited numbers of sites



Sprengr et al. 2017

Objectives & Approach



- summarize the evidence on PPP transport via bank filtration (BF) in agricultural landscapes
- identify factors influencing retention
- compile reported bank filtration rates (BFRs)

- Literature review 2000-2025
- WoS, Google Scholar, EDS, and grey literature
- Synonyms of bank filtration and PPP
-

EDS=Environmental Discovery System



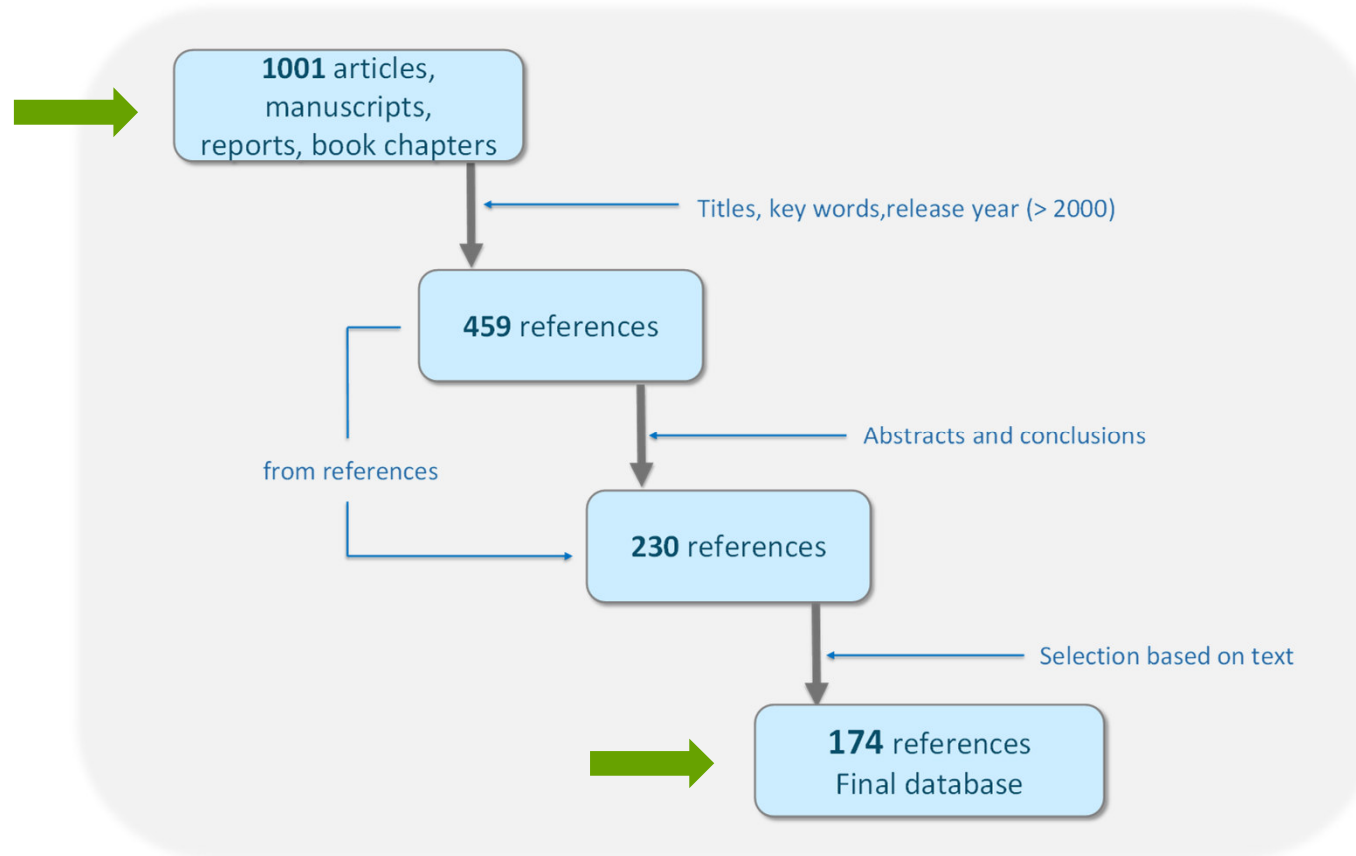
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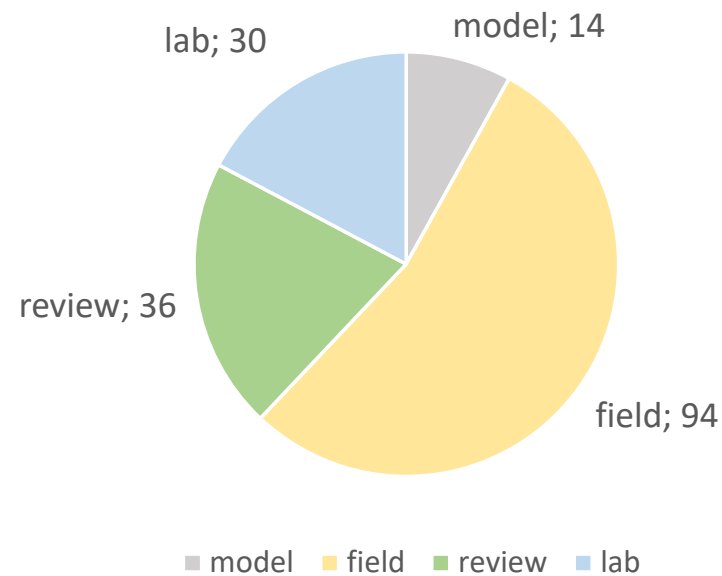
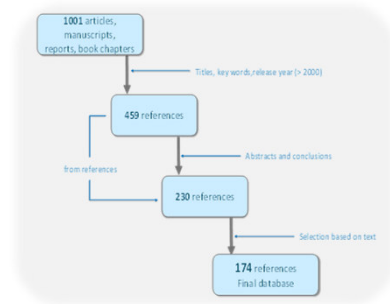
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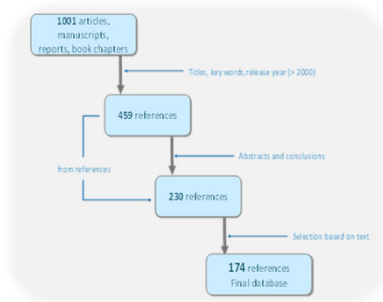
Review Process



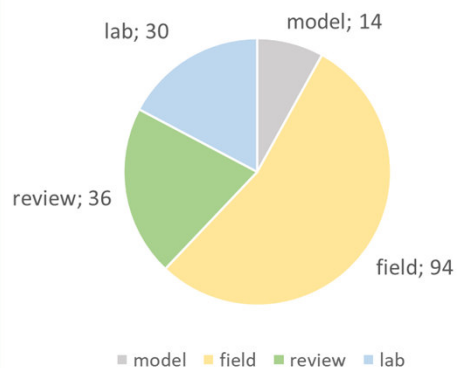
Types of studies



Review Process



- Only 2 studies with **natural** BF
→ 1 with PPP
- 124 pharmas : 91 PPP
- Most studies focused on compounds/residues from waste water treatment plants
- Bank filtrate often used as raw water in densely populated areas, more attention on pharmas



Process of bank filtration



Infiltration

- Temporal transport
- Hydraulic gradient towards ground-water (GW)
- Hyporheic zone to riparian areas
- Spatial variation

Transport

- Potential gradient
- Permeability of aquifer
- Distribution by dispersion
- Travel time $\leftrightarrow$ distance

Sorption

- Highest potential in hyporheic zone
- Hydrophobic sorption
- Ionic sorption
- Decreases with distance to riverbed

Microbial degradation

- Highest potential in hyporheic zone
- Biocenotic interaction
- Extreme interaction between microorganisms and environment



Investigated parameters

Field studies (n=101)

- Retention time & flow distance
- Redox conditions
- Subsurface properties
- Temperature

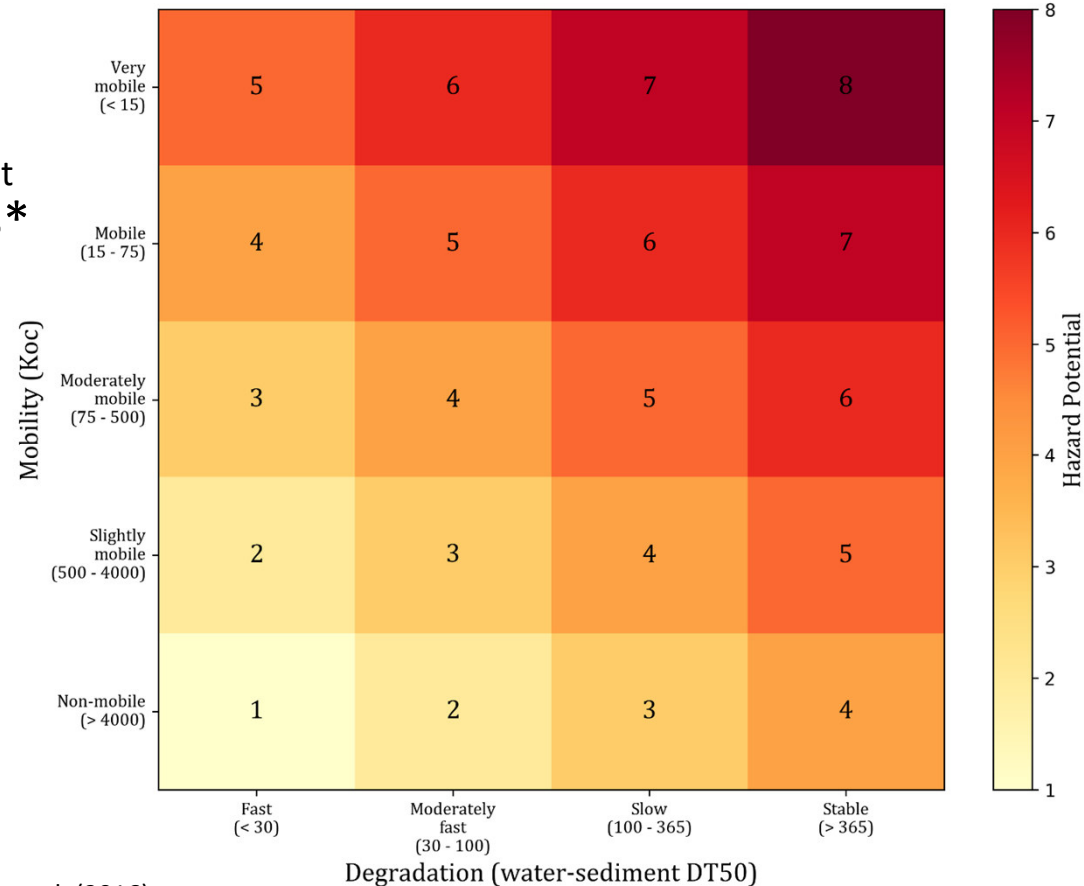
Laboratory studies (n=59)

- Microbial activity
- Compound properties
- Subsurface properties
- Redox conditions



GW hazard potential classification

K_{oc}/DT_{50} water-sediment
according to PPDB*
classification

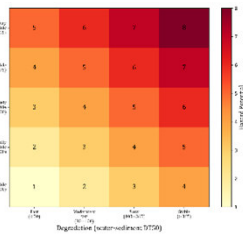


Hazard Potential	Hazard Potential classes [BFR%]
1	>87.5–100 %
2	>75–87.5 %
3	>62.5–75 %
4	>50–62.5 %
5	>37.5–50 %
6	>25–37.5 %
7	>12.5–25 %
8	0-12.5 %

*Pesticide Property Data Base: Lewis et al. (2016)



GW hazard potential classification



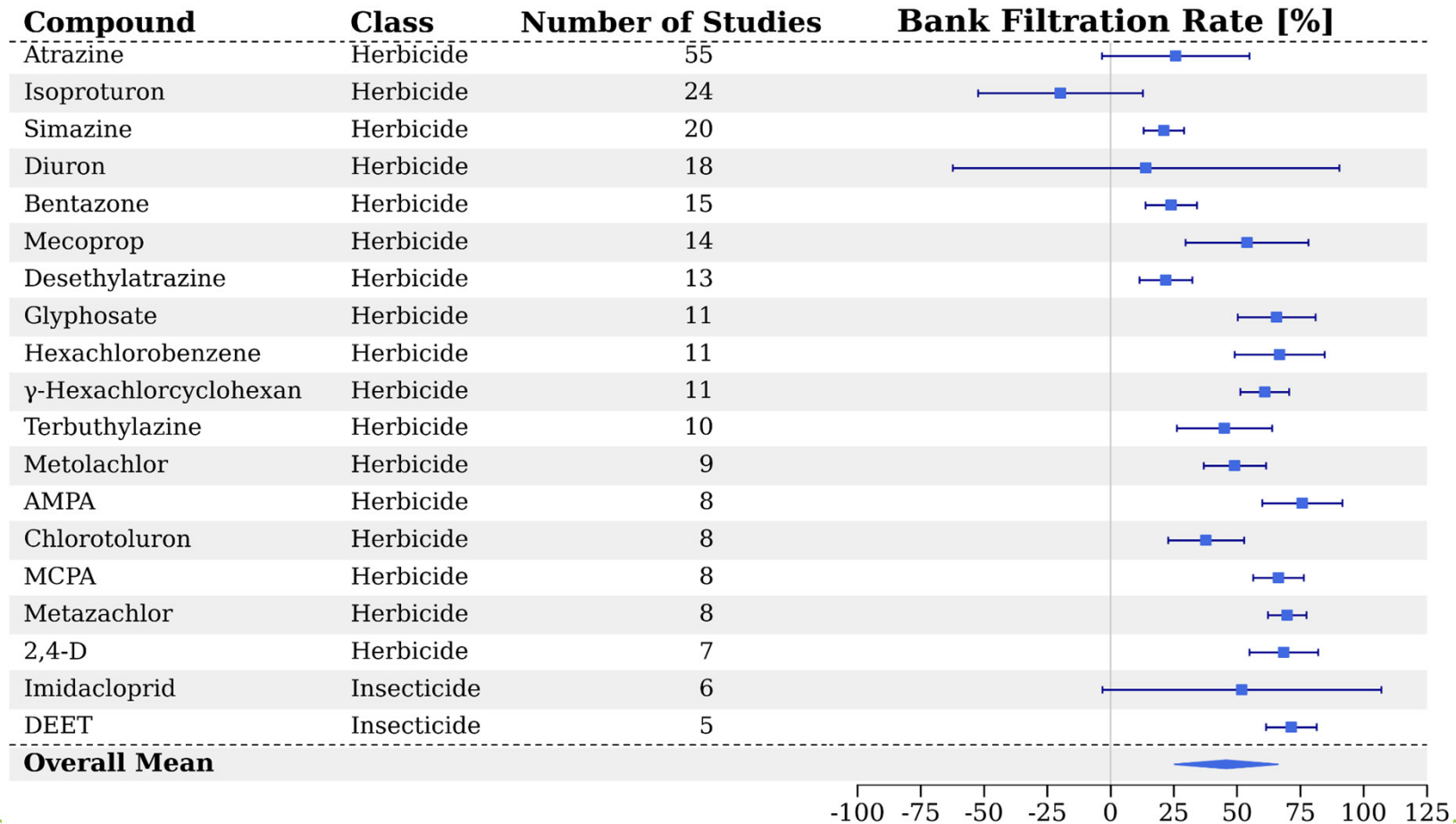
PPP	Hazard Potential <u>PPDB</u>	Hazard Potential classes <u>[BFR%]</u>
Glyphosate	1	3
Diuron	3	8
Atrazine	4	6
Simazine	4	7
MCPA	4	3
Mecoprop	5	4
Metolachlor	5	4
Bentazone	7	7



Bank filtration cannot
be explained only by
 $K_{oc}/DT_{50\text{water-sediment}}$
→ More complex



Bank filtration rates (mean values)



Relevance of BF for contamination risk of GW



Different perspectives



Hydrological context:

- Limited to certain hydrologic
- Occurs across landscape
- Share on water balance?

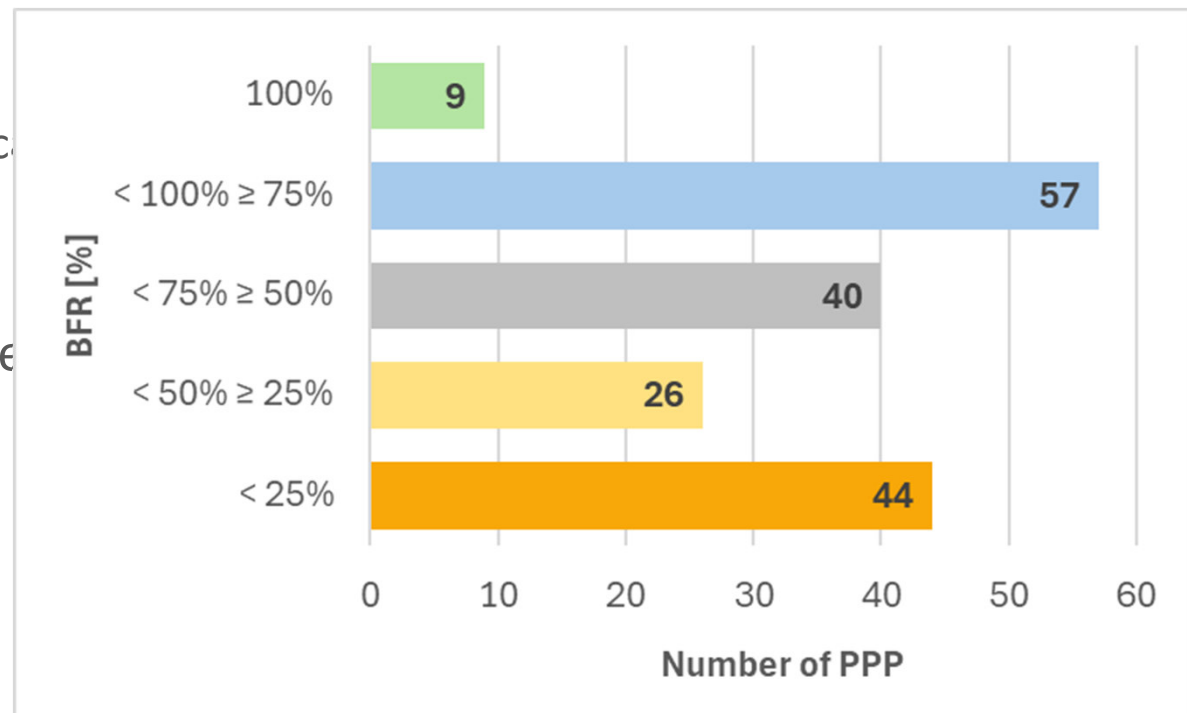


Specific protection of GW re

- Plant Protection Regulation
- Groundwater Directive
- Drinking Water Directive



Risk of GW contamination



Challenges assessing the BFR



- Data scarcity of PPP (91)
- Data scarcity of natural bank filtration studies (1)
- Often qualitative statements
- Not standardized study design (parameters, intervals, compounds)
- Most studies in lab
 - with different parameter/process
 - with parameter ranges only partially corresponding to natural conditions
- Several parameters interconnected → complex

High variability of BFR for the same compound



Conclusion

- Limited data base leaving many questions open
- Mean BFR 30-70% for all PPP,
- high variability for same compound
- Compounds seldom fully retained
- Crucial, considering the precautionary principle* and groundwater's value
- Several influencing factors complexly connected with each other
- Not one or two main factors but composition/interplay
- Hyporheic zone is hot spot for retention

*in Art. 1(4) Reg. (EC) No 1107/2009; Art. 191(2) TFEU



Looking forward to your questions

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