Testing a Biochar Filter for Removal of Pesticides at Environmentally Relevant Concentrations

CONCLUSION

Biochar is suitable to remove pesticides from water.

Removal efficiency depends on:

- **chemical properties (i.e. hydrophobicity)**
- **flow rate**
- **properties of the biochar (large BET surface area)**
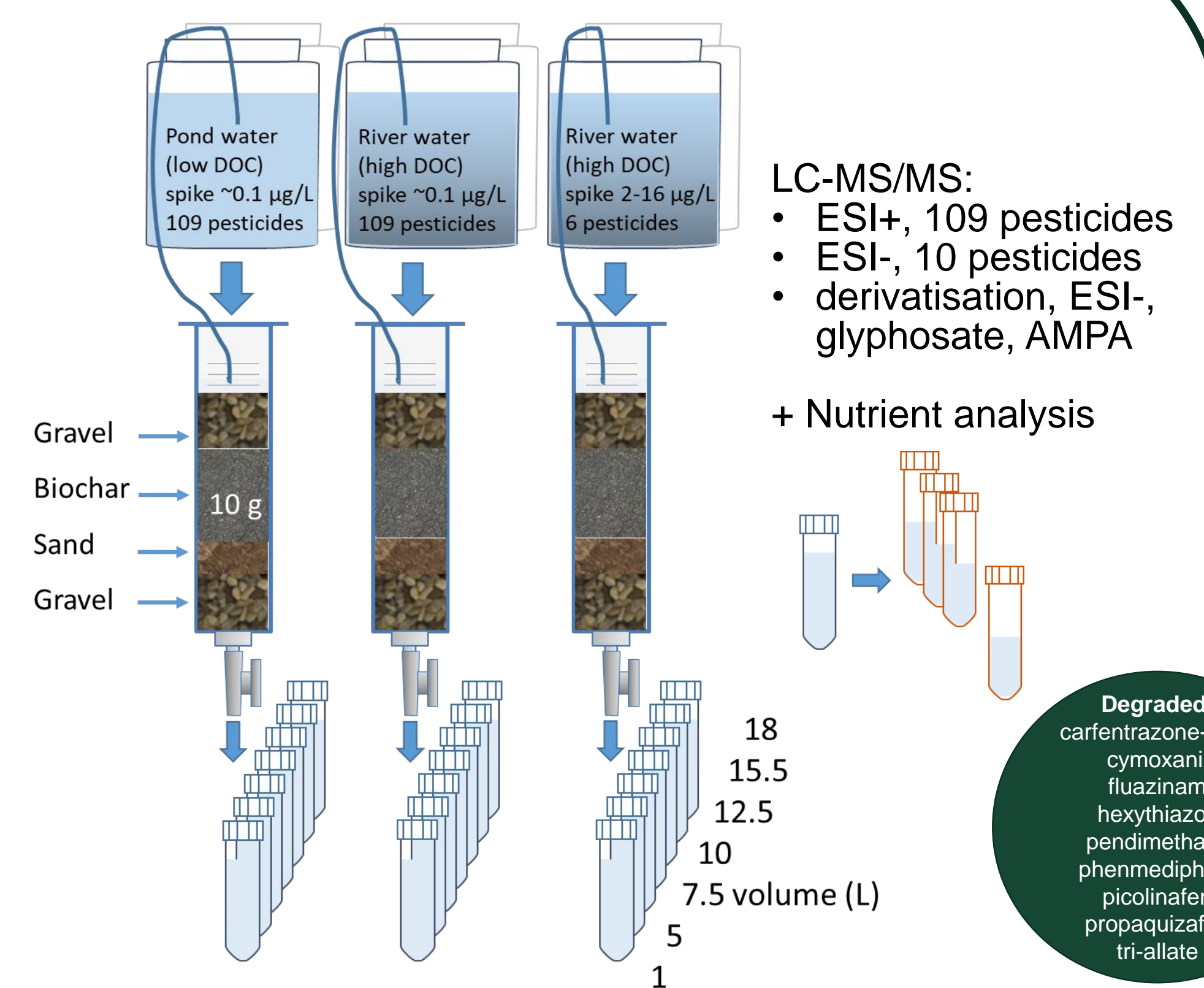- **Dissolved organic carbon (DOC)**

Background

About 47% of Swedish arable land has tile drainage systems, which can transport pesticides. Installing filters in these systems could notably cut pesticide runoff.

Aim

To test removal efficiency of pesticides using a biochar filter.

Biochar facts:
Feedstock: wood pellets
BET surface area (m^2/g): 334.68
Adsorption average pore size (nm): 2.37

Experimental setup

Pond water (low DOC) spike ~0.1 µg/L 109 pesticides

River water (high DOC) spike ~0.1 µg/L 109 pesticides

River water (high DOC) spike 2-16 µg/L 6 pesticides

LC-MS/MS:
- ESI+, 109 pesticides
- ESI-, 10 pesticides
- derivatisation, ESI-, glyphosate, AMPA

+ Nutrient analysis

Gravel
Biochar — 10 g
Sand
Gravel

18
15.5
12.5
10
7.5 volume (L)
5
1

Degraded:
carfentrazone-ethyl
cymoxanil
fluazinam
hexythiazox
pendimethalin
phenmedipham
picolinafen
propaquizafop
tri-allate

A total of 18 L or 981 times the filters pore volume of water were filtered, and collected after specific volumes. Concentrations after filtration were compared to unfiltered water concentrations (reference after 1, 10, and 18 L). Out of 128 spiked pesticides measured, 9 were not quantified due to degradation.

RESULTS

Effective elimination in low DOC water.

Slightly reduced efficiency in high DOC and nutrient-rich river water:

- fungicides 94%
- herbicides 62%
- insecticides 84% median removal after 18 L / 981 pore vol (Fig 1).

High spike experiment (Fig 2):
- Glyphosate and AMPA have low removal rates (low Log P)
- Others > 87% after 18 L

Hydrophobic pesticides (Log P 2 to 5.5) exhibit significantly higher removal rates compared to hydrophilic pesticides (Log P -3 to 2) (Fig. 3, Wilcoxon $p < 0.001$).

Nutrients: Minimal impact observed; concentrations remained relatively stable pre- and post-filtration
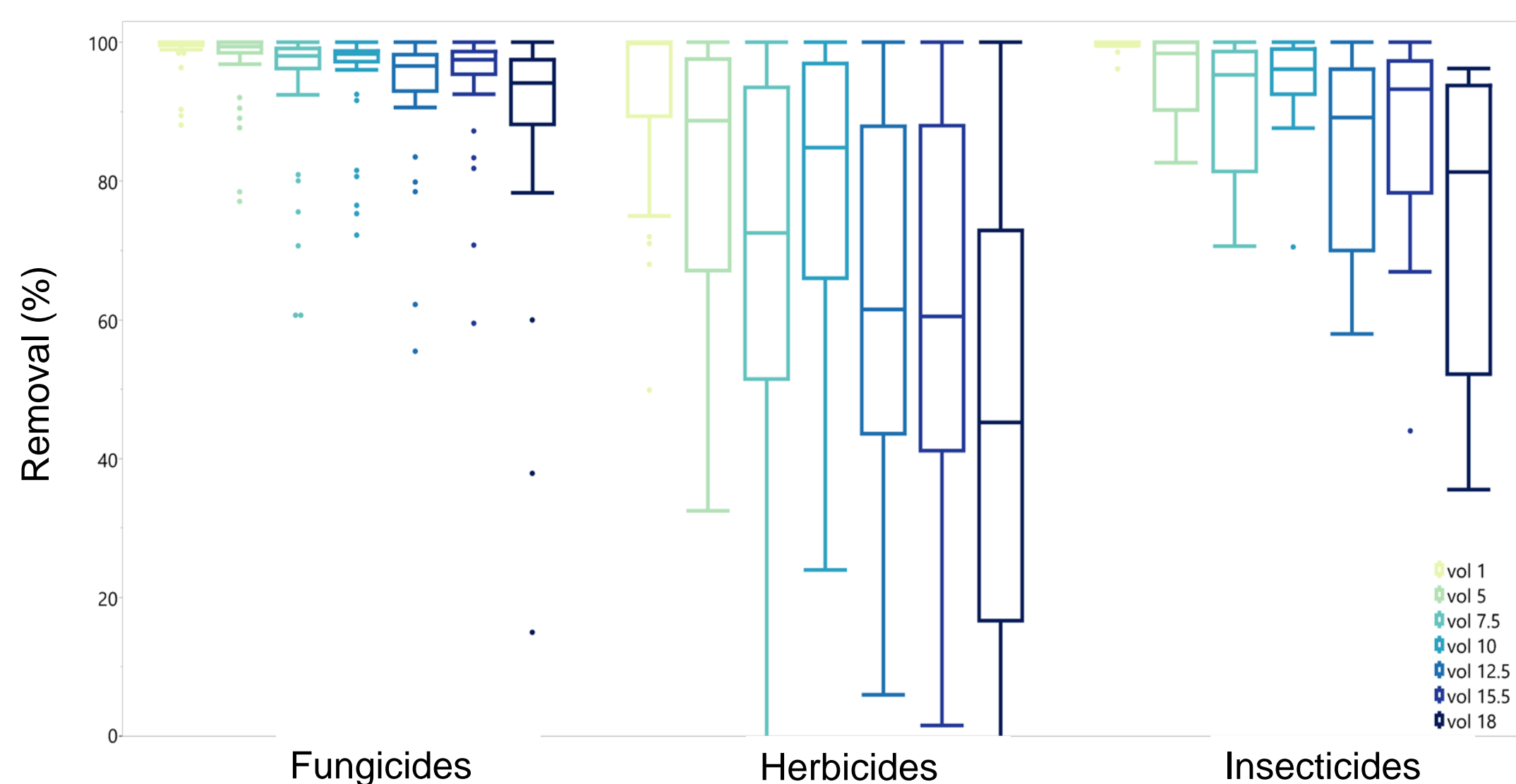

Fig 1. Removal (%) of fungicides (n = 44), herbicides (n = 61), and insecticides (n = 12) across various volumes of river water.

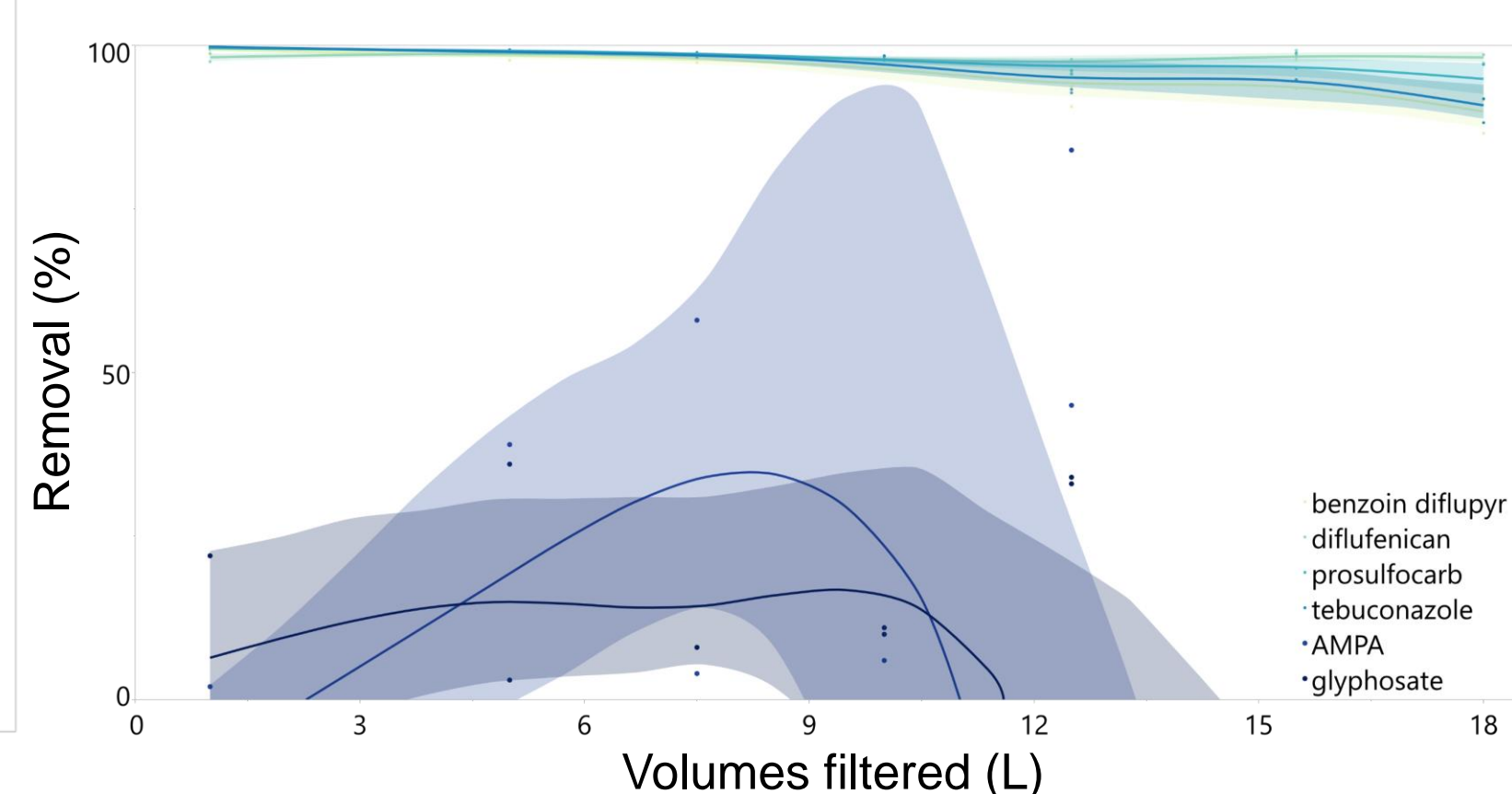Fig 2. Removal (%) of six commonly detected pesticides spiked at high environmental concentrations (2 - 16 µg/L).

Pesticides with high partition to organic phase (hydrophobic)

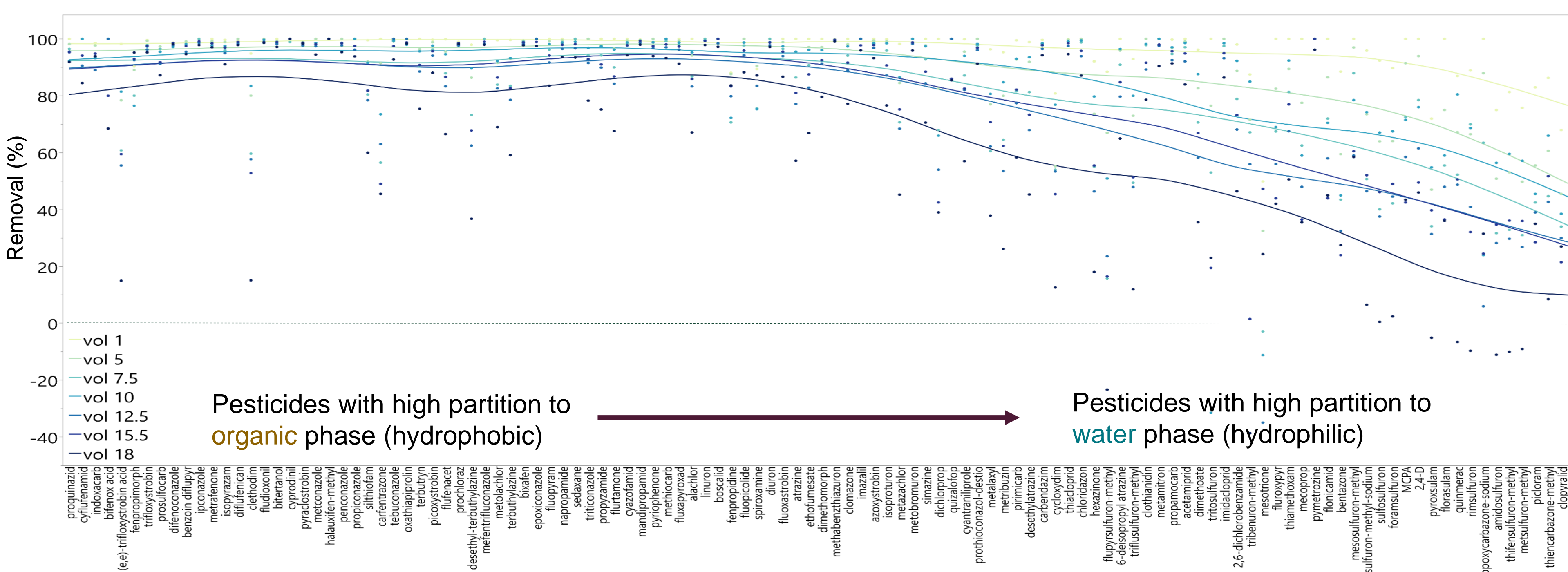Pesticides with high partition to water phase (hydrophilic)

Fig 3. Removal rates (%) of 119 pesticides from river water. Pesticides are shown in order of their octanol-water partition coefficient (Log P) from left to right Log P values range from 5.5 to -3.

Alina Koch (PhD)
Researcher
alina.koch@slu.se

Harald Cederlund (PhD)
Researcher
harald.cederlund@slu.se

Ove Jonsson (PhD)
Chemist
ove.jonsson@slu.se

CENTRE FOR PESTICIDES IN THE ENVIRONMENT