Improving ecotoxicity assessment results by splitting species sensitivity distributions (SSDs)

Susan Anyango Oginah[1], Leo Posthuma[2,3], Michael Hauschild[1], Peter Fantke[1]

[1]Quantitative Sustainability Assessment, Department of Environmental and Resource Engineering, Technical University of Denmark, Produktionstorvet 424, 2800 Kgs. Lyngby, Denmark

[2]RIVM, Centre for Sustainability, Environment and Health, Bilthoven, the Netherlands

[3]Radboud University, Department of Environmental Science, Nijmegen, the Netherlands

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Introduction

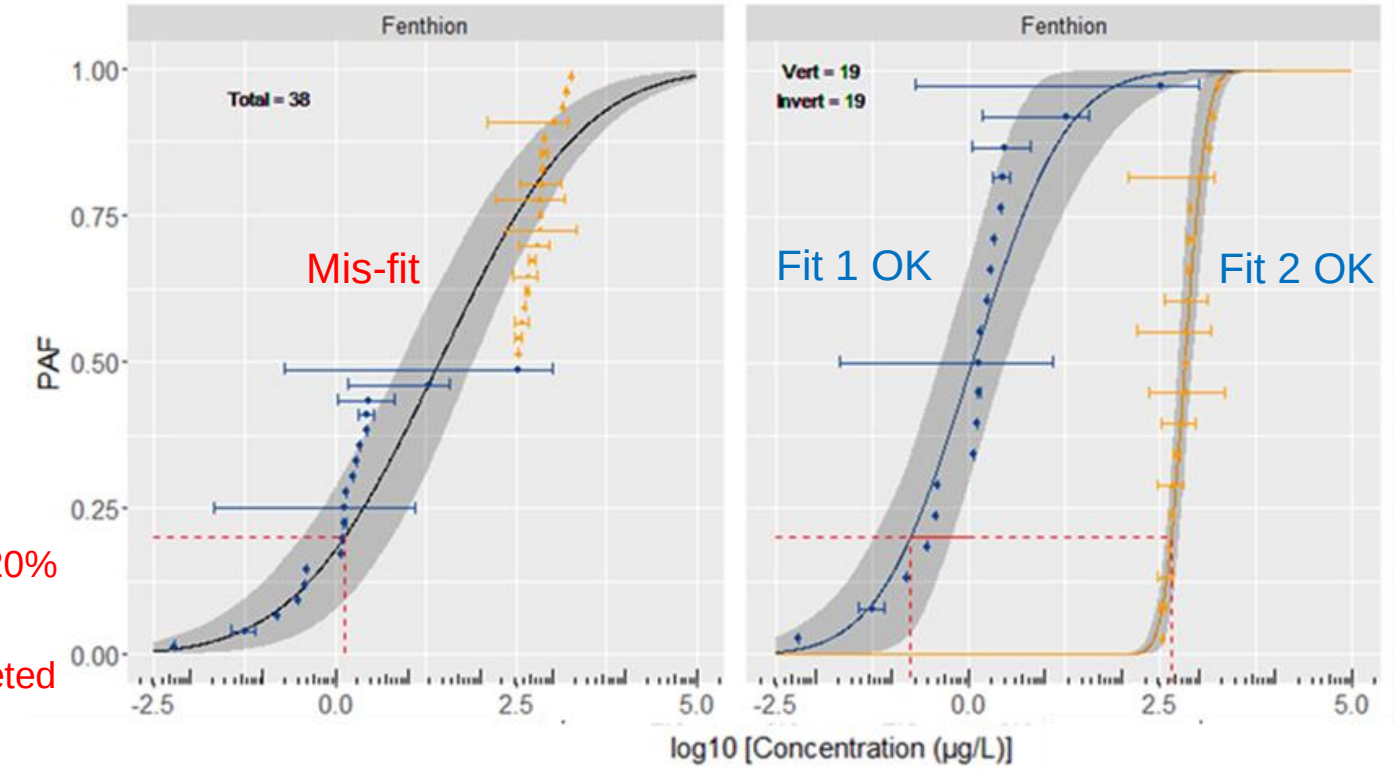
- Species sensitivity distributions (SSDs) describe variation in sensitivity across multiple species
- SSDs provide input for ecological risk assessment, LCA and regulatory purposes
- Current SSDs treat all species groups equally, neglecting modes of action targeting specifically sensitive species groups (e.g., insecticides targeting invertebrates)
- This leads in such cases to mis-fit of the SSD to the data (bi- or multi-modality)
- There is latitude to improve assessment outcome quality
  - theoretically *justified*: by splitting multi-modal data sets
  - practically *limited*: by considering uncertainties due to limited # of data

Objectives

- Introduce a systematic approach for linking chemicals to effects on specific species groups via:
  - Mapping chemicals to chemical classes, modes of action, and target species groups
  - Combining mapping results with quantified species sensitivity distributions for specific species groups
- Derive generalizable rules for splitting SSDs to address more vulnerable species groups and improve the accuracy of ecotoxicity effect factors in support of regulatory decision making for chemical safety

Working hypothesis

- Misfit occurs, e.g., in an all-species SSD with insects as sensitive
  --> impact of pollution (X) on Potentially Affected Fraction (Y) poorly estimated
- Split into Mode of Action driven subgroup: improved net fit, improved Y

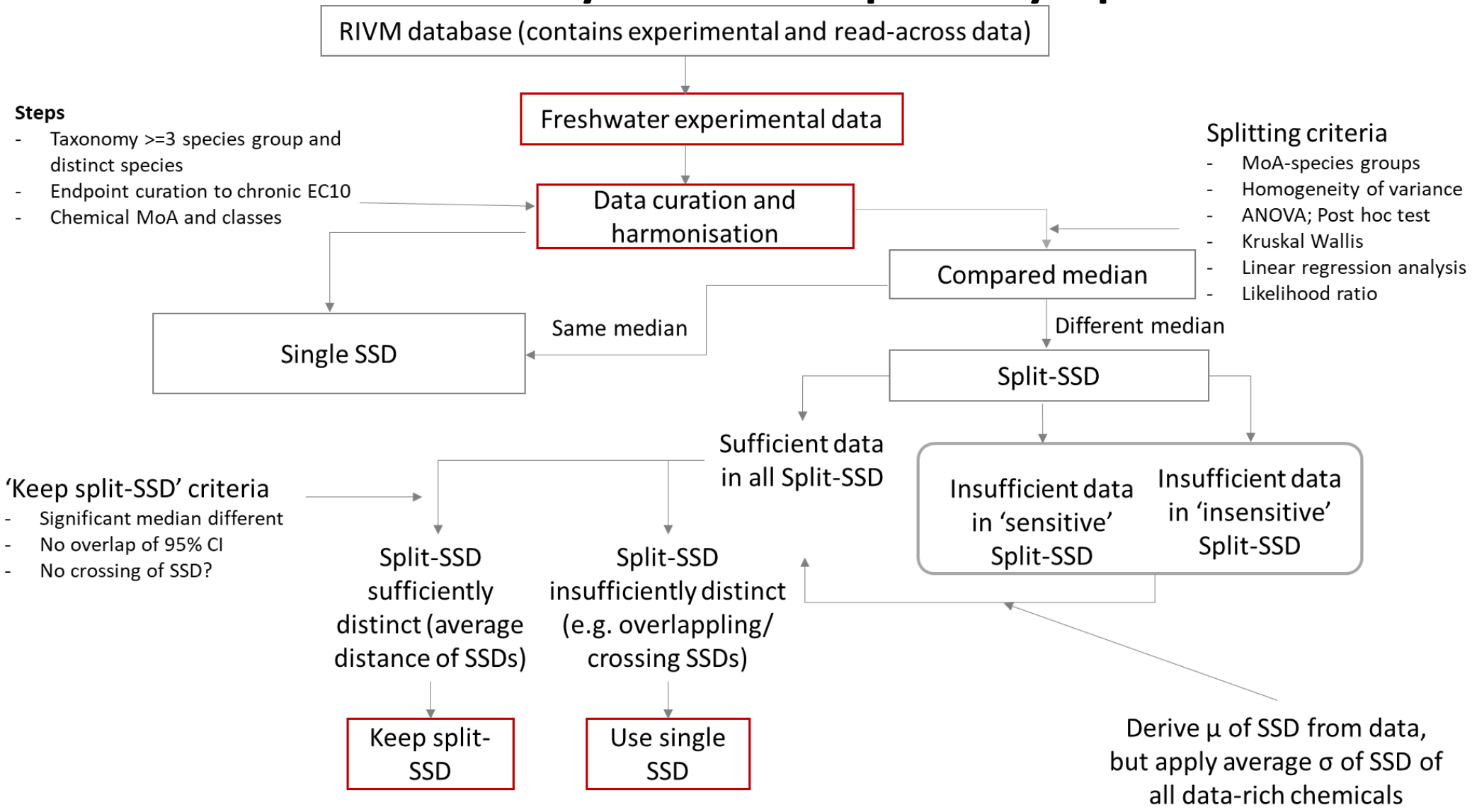


- Based on Fit-1
- Sensitive sub-group

PAF assemblage: 20%
- can be calculated
- but poorly interpreted

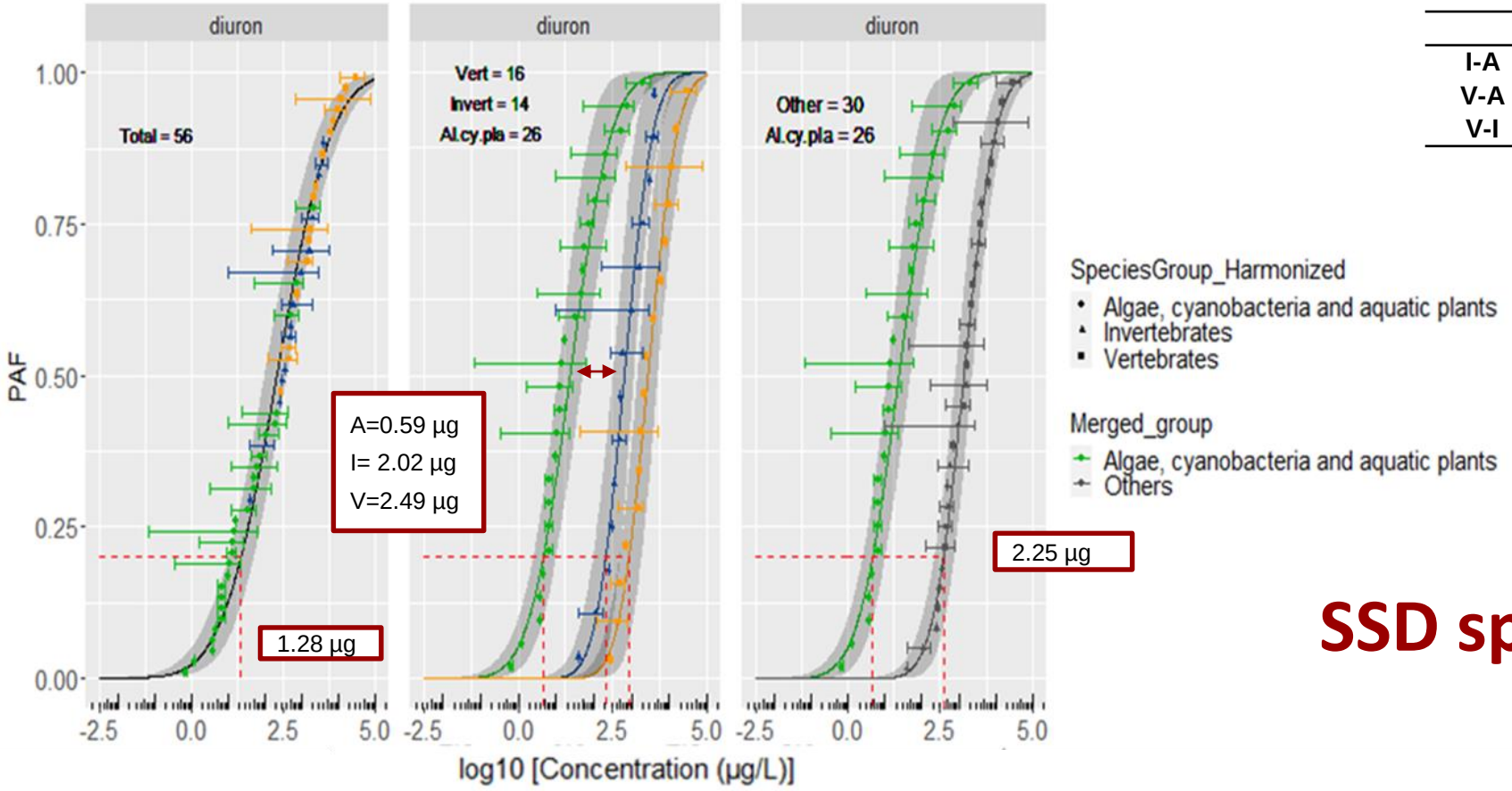
- Based on Fit-2
- Less sensitive sub-group

Methods: from ecotoxicity data to 'responsibly' split-SSDs



Results: Diuron (photosynthesis inhibiting herbicide, #data 56)

a. Non-overlapping uncertainty 95% confidence interval (CI) at μ (red arrow)



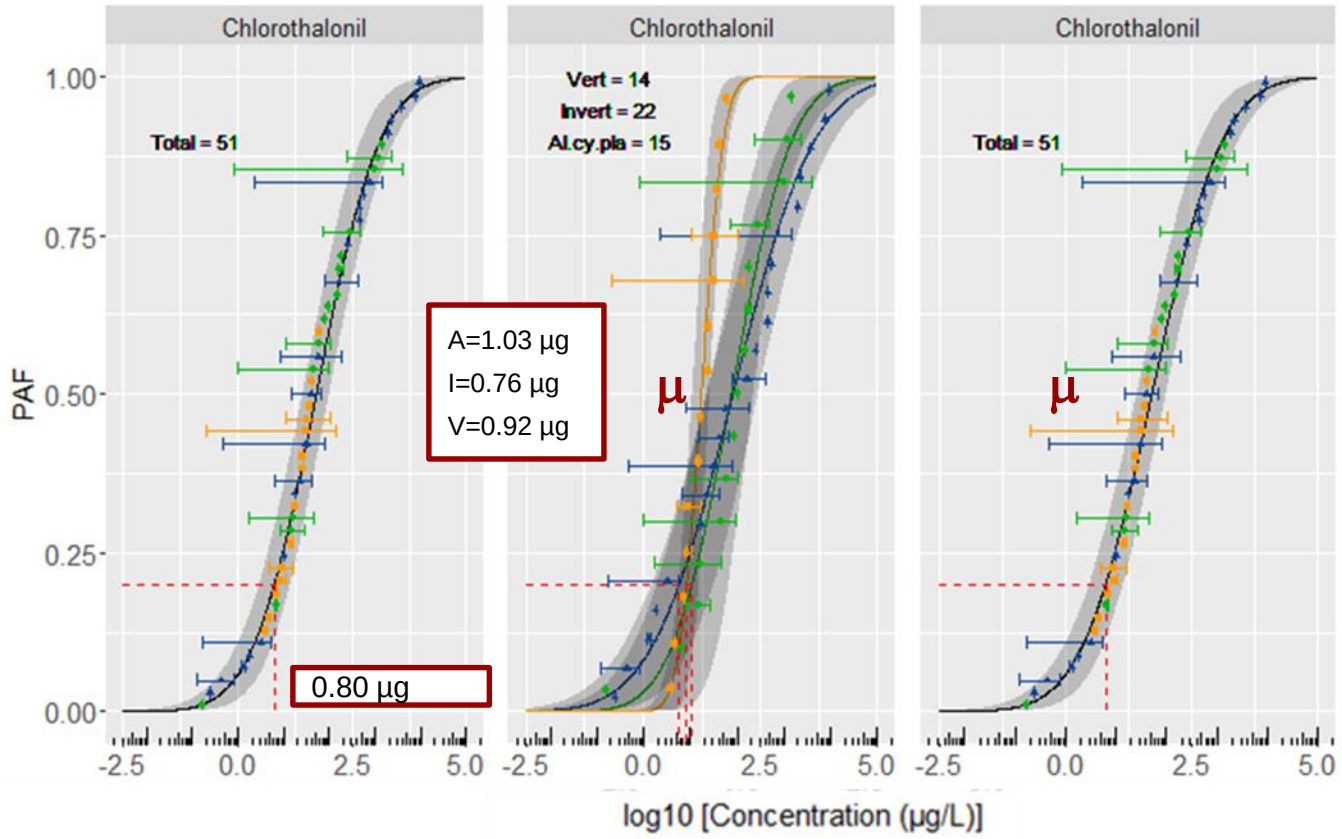
	diff	lwr	upr	p
I-A	1.432	0.850	2.015	0.000
V-A	2.059	1.501	2.618	0.000
V-I	0.627	-0.016	1.270	0.057

SSD split supported

- A particular species group (Algae) is significantly more sensitive to exposure for the concerned chemical than other species groups

Results: Chlorothalonil (broad-spectrum fungicide, #data 51)

b. Overlapping/crossing 95% CI ranges around split SSDs at μ



Kruskal Wallis; p=0.054, df=2

term	estimate	std.error	statistic	p.value	Reference
(Intercept)	1.877	0.277	6.780	0.000	Algae.cyano.plants
Invertebrates	0.031	0.359	0.085	0.933	
Vertebrates	-0.644	0.399	-1.615	0.113	

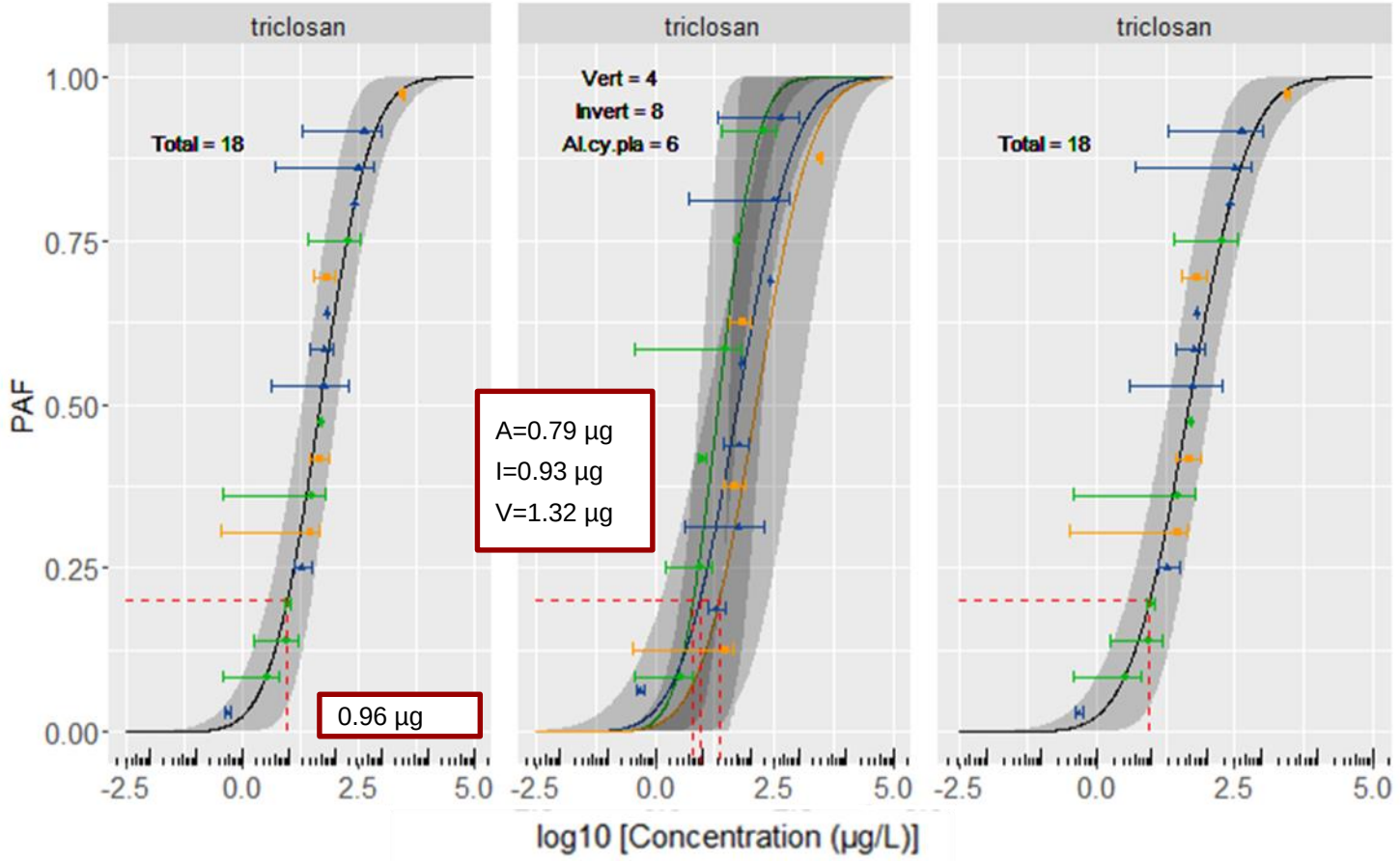
SpeciesGroup_Harmonized
- Algae, cyanobacteria and aquatic plants
- Invertebrates
- Vertebrates

SSD split not supported

- The compound is not affecting particular species groups more than others at μ
- Note slope (vertebrates)

Results: Triclosan (multi-target antimicrobial agent, #data=18)

c. Overlapping/crossing 95% CI ranges around split SSDs with limited dataset



ANOVA, p=0.370, df=2

term	estimate	std.error	statistic	p.value	reference group
(Intercept)	0.997	0.349	2.854	0.012	Algae.cyano.plants
Invertebrates	0.654	0.462	1.414	0.178	
Vertebrates	1.413	0.553	2.558	0.022	

SpeciesGroup_Harmonized
- Algae, cyanobacteria and aquatic plants
- Invertebrates
- Vertebrates

SSD split not supported

- Chemicals with poor dataset gives unreliable *p*-values for splitting SSDs

Conclusions

- For chemicals with specific mode of action targeting particular species groups → splitting SSDs increases fit of multiple SSDs to the data
  → this improves interpretation of assessment outputs (PAF)
- For chemicals with no specific mode of action (not shown)
  → splitting SSDs does not matter for fit, and yields similar PAF with/without split
- Available # of data limit the possibilities for a ‘responsible split’
- Improved interpretation of SSD-based outcomes (with split, if needed) improves identifying priority chemicals in chemical safety assessments and life cycle impact assessments

Thank you for your attention!

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Susan Anyango Oginah
sanog@dtu.dk