

Integration of lines of evidence to facilitate prioritisation of plastic leachates for toxicity testing

Walter Zobl

Knut Erik Tollefsen

10th Norwegian
Environmental Toxicology
Symposium (NETS) 2025

PARC

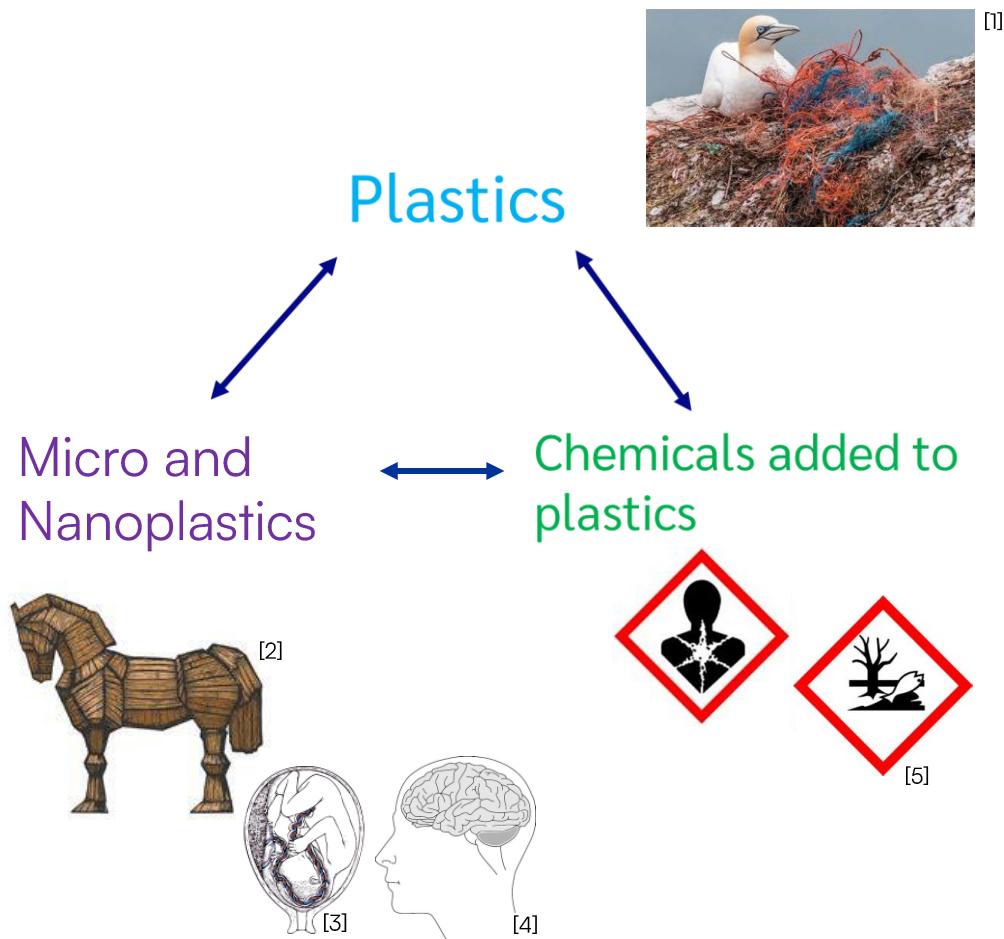
NIVA

Thursday, 28 August 2025

Table of content

- Motivation: Plastic chemicals and the hazards they pose to human and the environment
- The PlasticLeach project
 - Development of a workflow to
 - Integrate existing hazard-related data
 - Facilitate prioritising further action

Motivation (1)



- Plastic production to double by 2050
- ~10% get recycled
- Plastics contain many chemicals that can be released
- Evidence including biomonitoring data suggest widespread exposure and a potential for (eco)toxicity of leaching chemicals*

➤ PlasticLeach project:
Identify the most hazardous chemicals *released* from different types of plastic

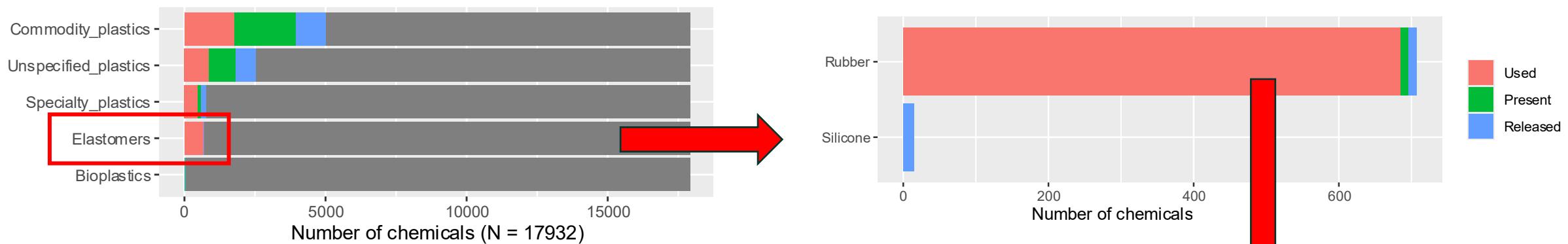
* UNEP (2023)

Motivation (2)

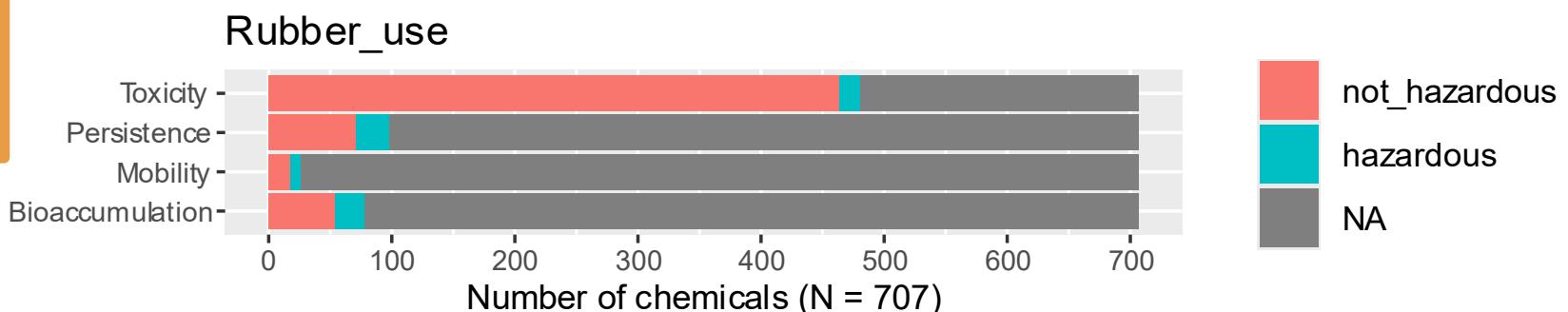
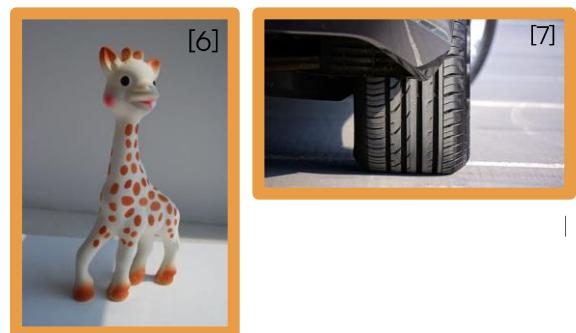
- Findings from the PlastChem project*
 - ~ 18 000 plastic chemicals
 - >25% thereof known to be P, B, M and/or T
 - ~ 66% lack hazard data
- Efficient hazard-based identification of chemicals of concern is required to confine risks from plastic chemicals**

Lack of data hinders effective risk management: elastomers as an example

- Use, presence and release*



- Hazard classifications*



* based on Wagner et al. (2024)

PlasticLeach project

Project leader: Hubert Dirven (Department of Chemical Toxicology, Norwegian Institute of Public Health, Norway)

Objective:

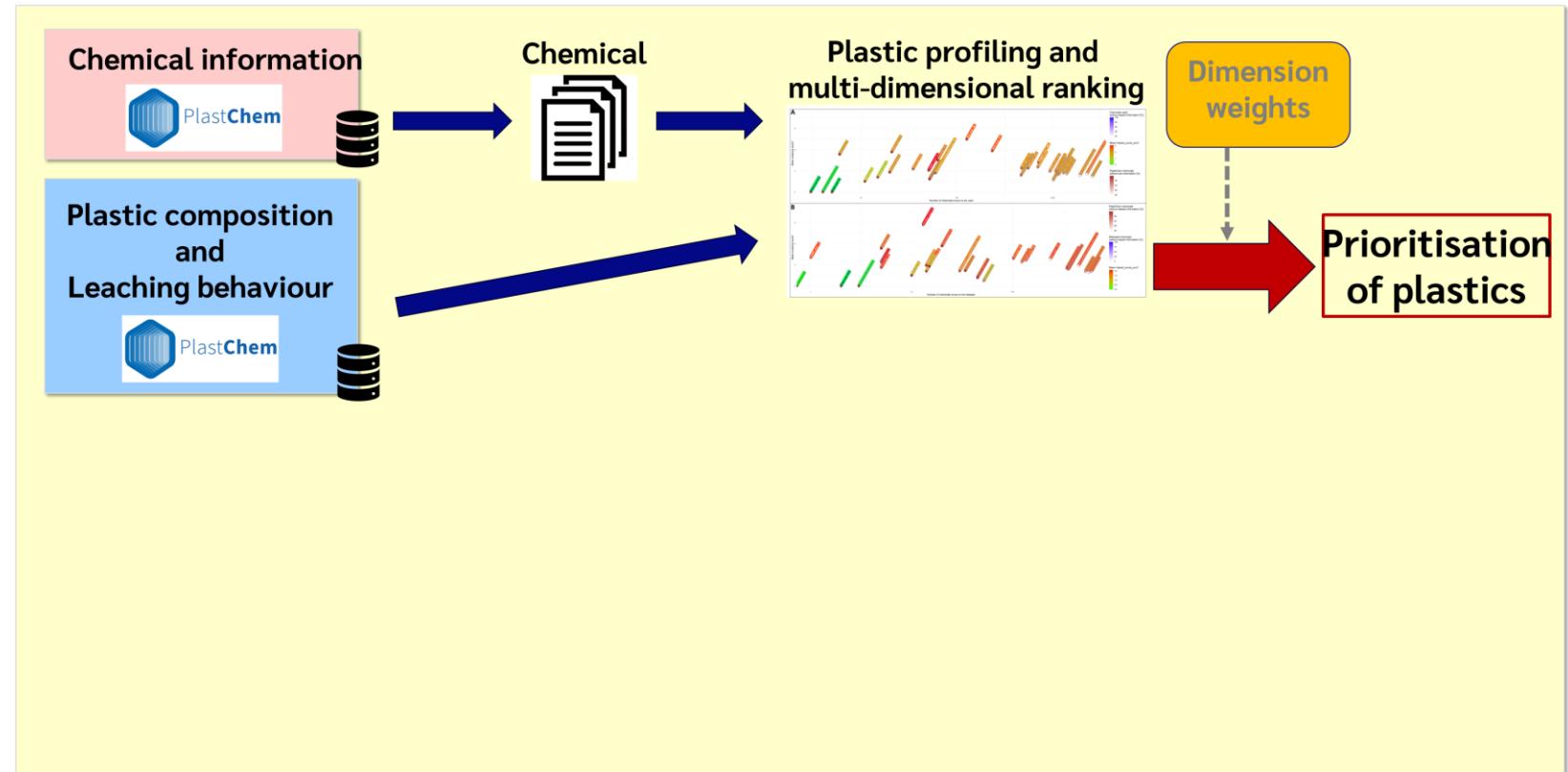
- Screening level identification of **the most hazardous chemicals** released from different types of plastic
- Characterise their hazard

Approach:

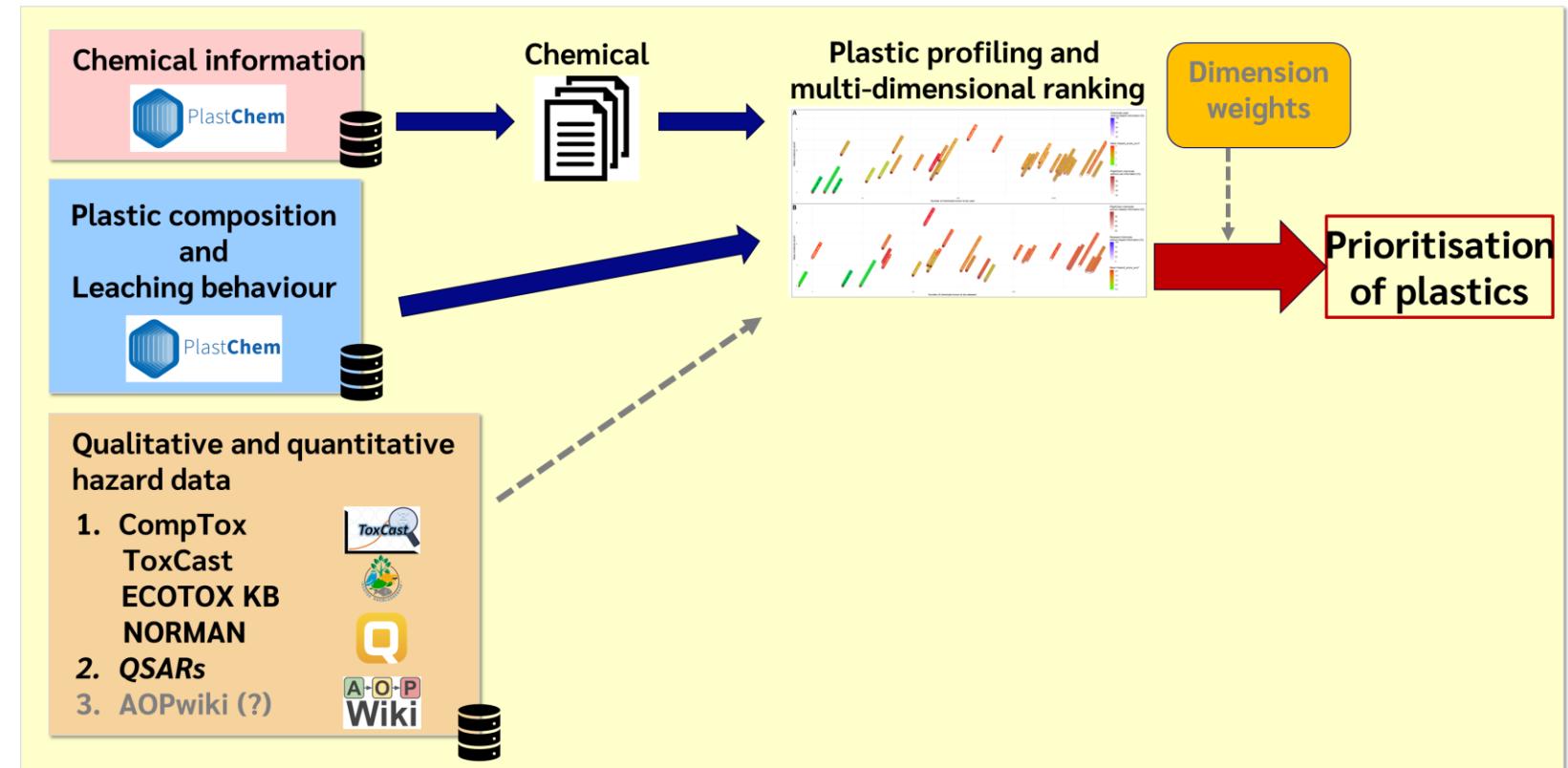
- Select **plastics**
- Prepare leachates
- *In vitro* toxicity testing of the mixtures in selected **assays**
- Determine chemical composition of the most toxic leachates
- Characterise chemicals of concern
 - *In vitro* toxicity testing of the single compounds in selected assays

Use existing data!

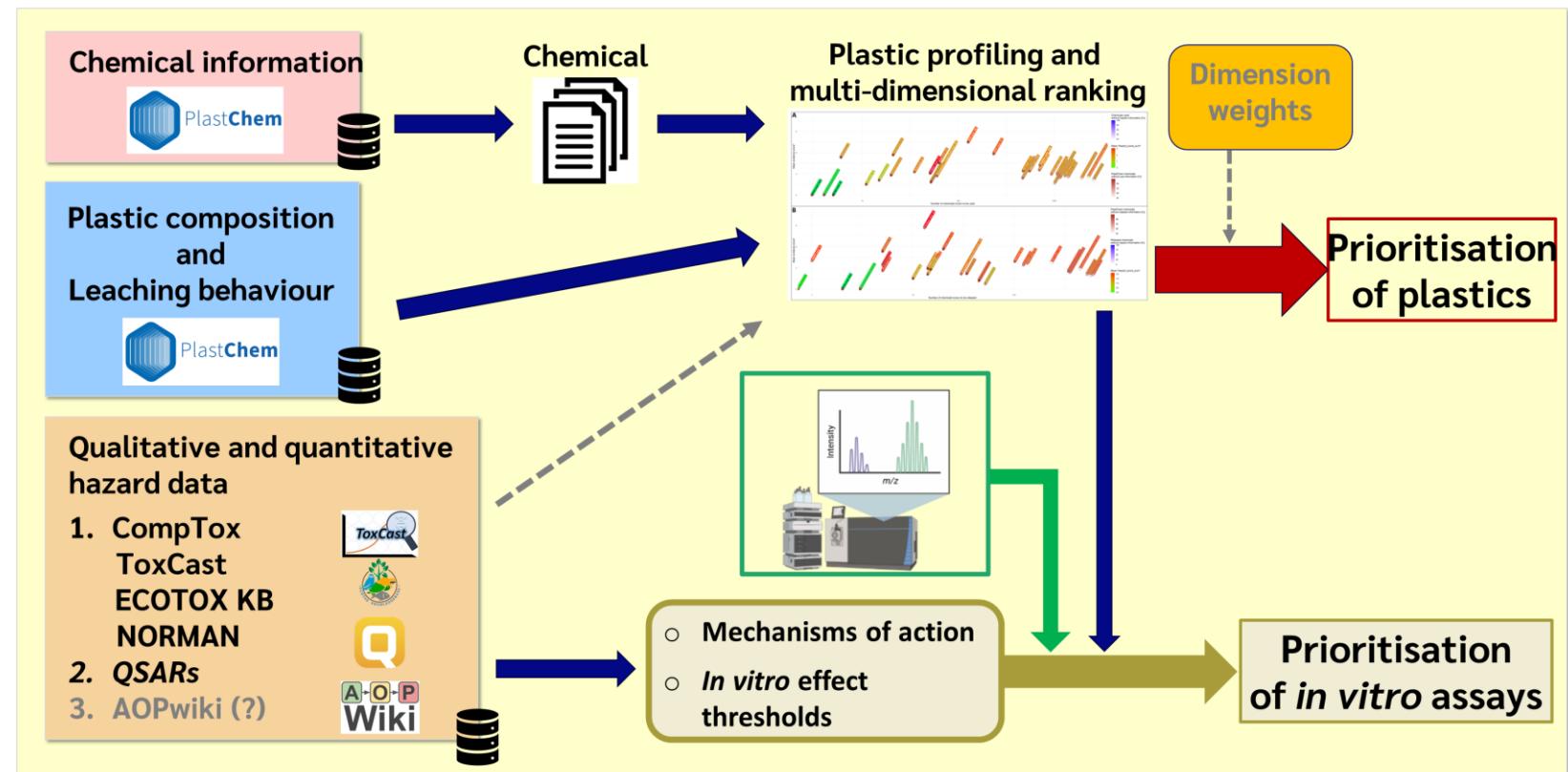
Workflow for prioritisation of plastics and *in vitro* tests



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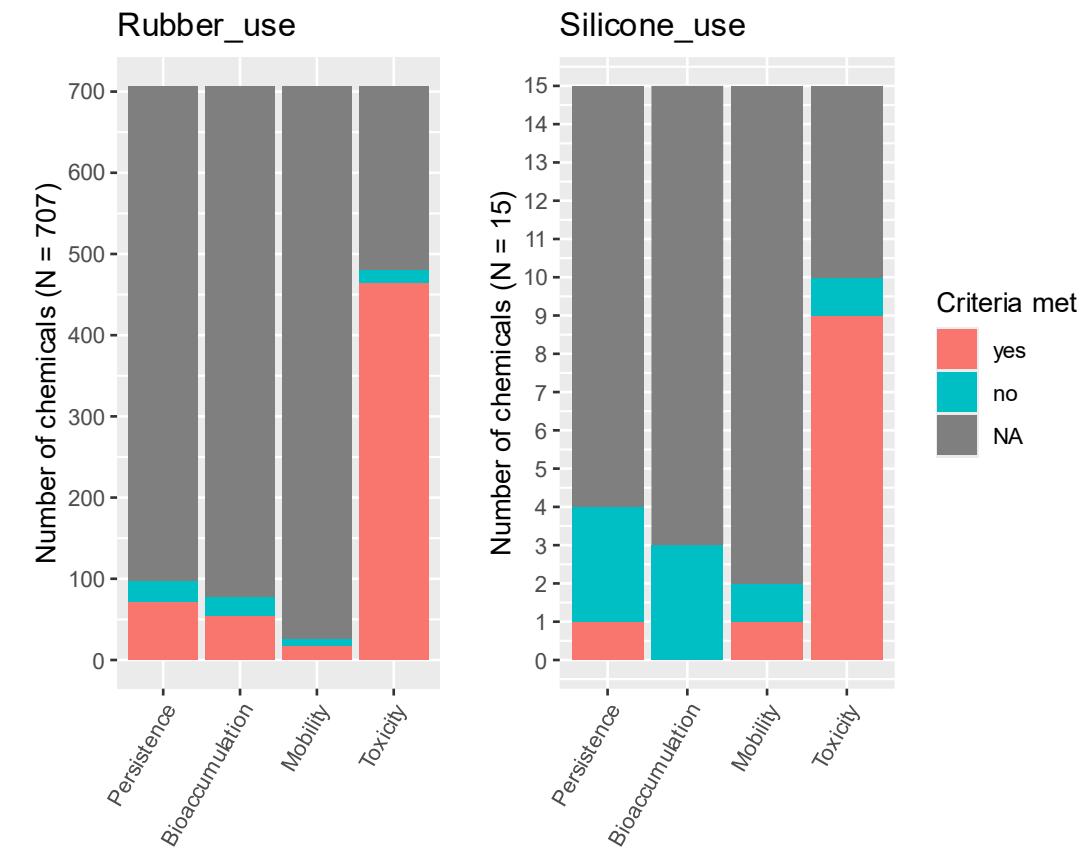


Prioritisation of plastics

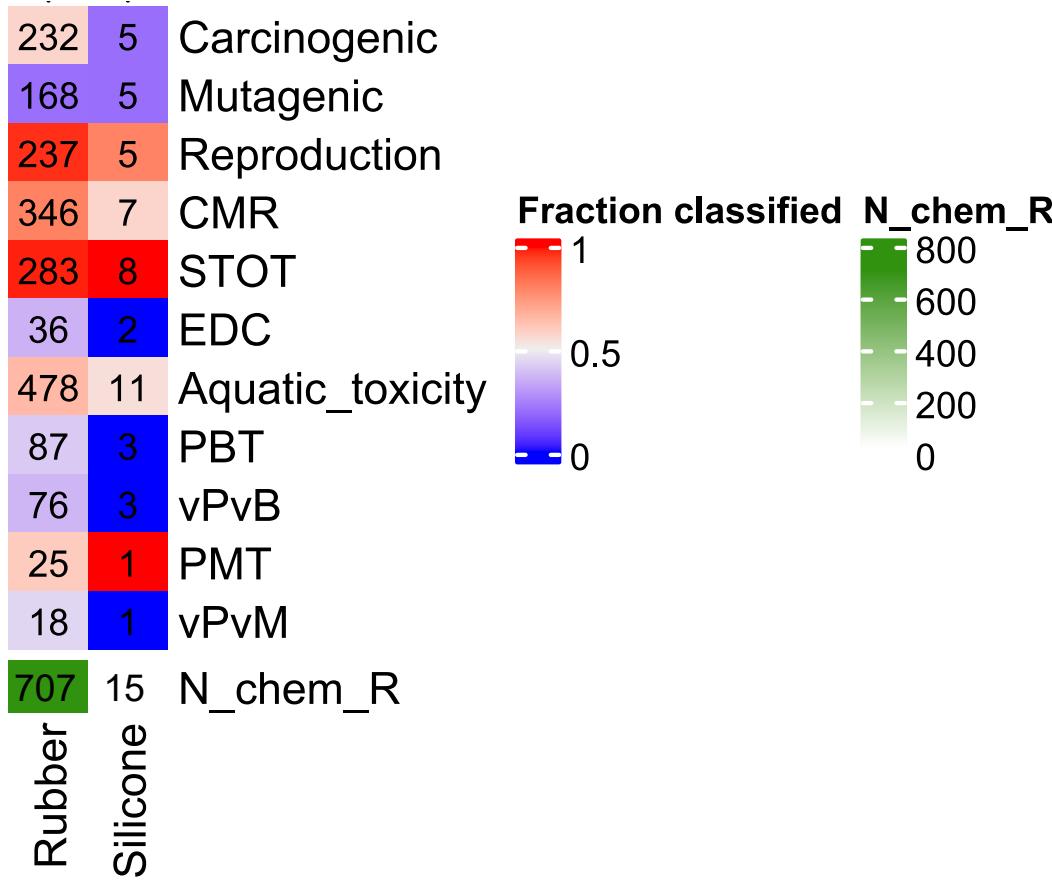
Conceivable criteria:

- Number of PBMT chemicals
- Production/import volume
- Product and use type
- Degree of lack of data

PBMT assessment



PBMT: details for assessed chemicals

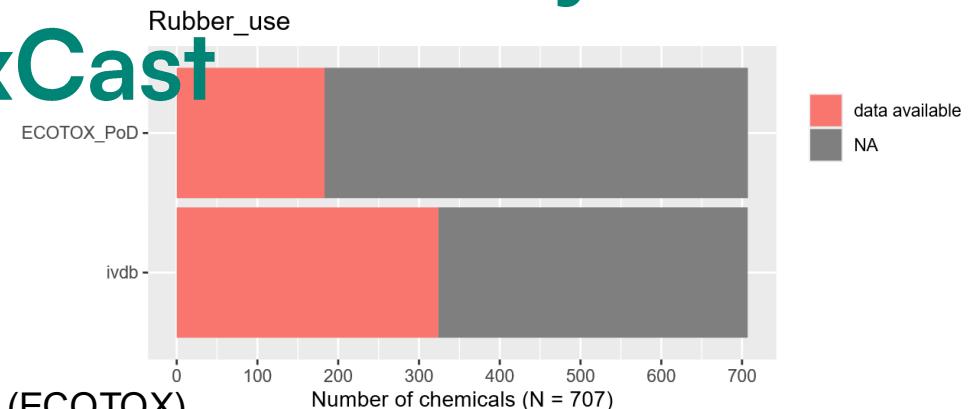
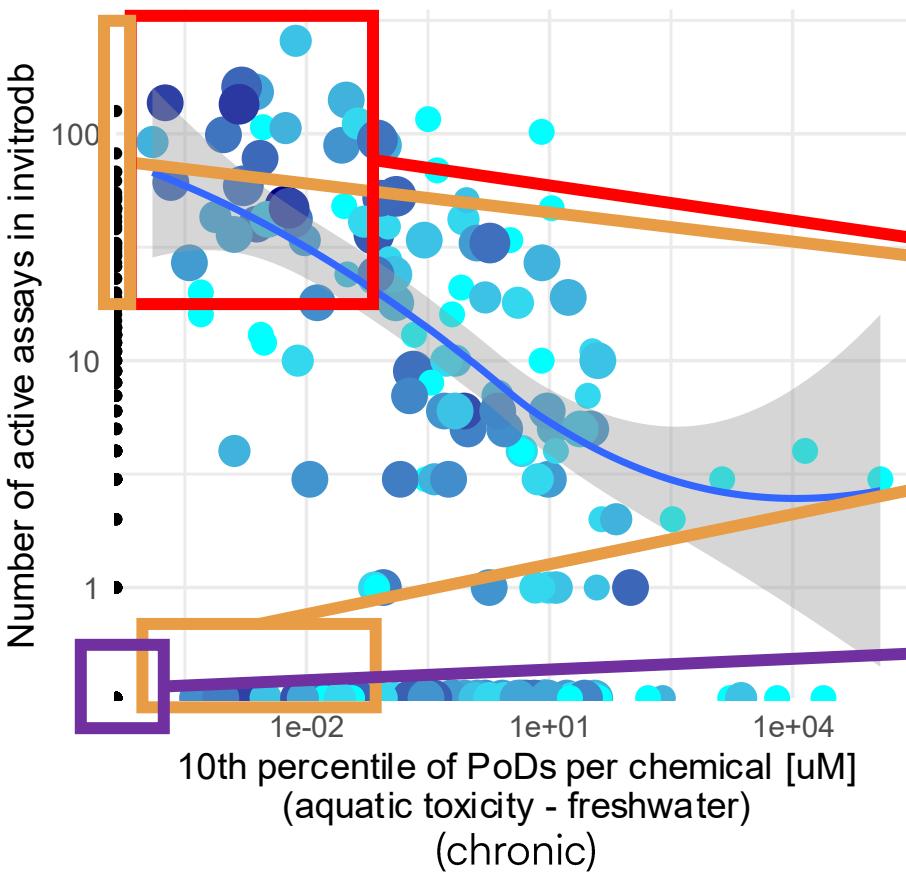


Interim summary:

- High fraction with repeated dose toxicity or reproductive toxicity
- Vast difference in number of chemicals known to be used in production
- Fraction with hazards assessed similar

Additional rich sources of experimental toxicity data: ECOTOX knowledgebase and ToxCast

Rubber_use:
Total number of chemicals: 707



- Additional focus for chemical identification and quantification
- Eventually they will be released to the environment unless if the plastic material gets to the environment.
 - Are they present in leachate under conditions of primary interest/concern?

Focus for in vitro hazard screening

Wrap up

- Major data gaps for plastic chemicals
 - P, B, M particularly under-assessed
 - Work towards efficient strategy for
 - Integrate available hazard-related information
 - Prioritise for closing the most severe data gaps in a screening-level approach to plastic leachate hazard characterization
- ➔ Reduce (unnecessary) presence of hazardous chemicals in plastics

Outlook

- Utilize QSAR predictions for data-poor chemicals
 - PBM screening*
- Enable grouping for chemical types (CHEBI, ...)
- Utilize AOP information to facilitate extrapolation from mechanistic data to apical endpoints
- Integrate the workflow into the Source To Outcome Predictor (STOP)

Acknowledgements

- Sam Welch
- Li Xie

This work was carried out in the framework of the European Partnership for the Assessment of Risks from Chemicals (PARC) and has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101057014, Research Council of Norway project EXPECT (RCN-315969) and NIVA's Computational Toxicology Program, NCTP (RCN-342628). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.



NCTP



EXPECT
Project



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Time for questions...

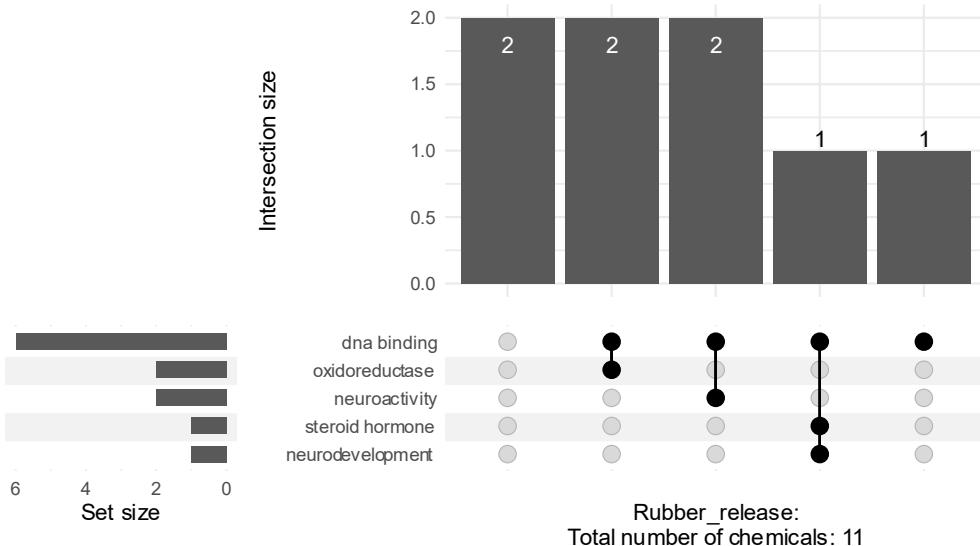
References

- Environment UN. Chemicals in Plastics - A Technical Report | UNEP - UN Environment Programme [Internet]. 2023 [cited 2025 Aug 25]. Available from: <https://www.unep.org/resources/report/chemicals-plastics-technical-report>
- Wagner M, Monclús L, Arp HPH, Groh KJ, Løseth ME, Muncke J, et al. State of the science on plastic chemicals - Identifying and addressing chemicals and polymers of concern [Internet]. Zenodo; 2024 Mar [cited 2025 Feb 10]. Available from: <https://zenodo.org/records/10701706>
- Hader JD, Wagner M, Arp HPH, Groh KJ, Løseth ME, Monclús L, et al. A Hazard-Based Approach Enables the Efficient Identification of Chemicals of Concern in Plastics. Environ Sci Technol [Internet]. 2025 Jul 29 [cited 2025 Aug 6]; Available from: <https://doi.org/10.1021/acs.est.5c02912>

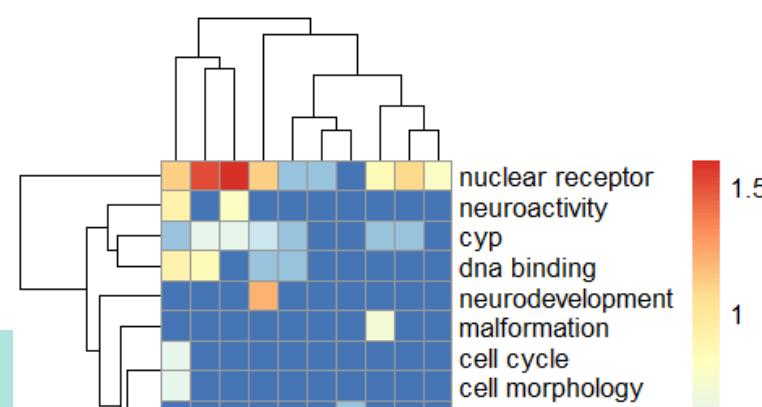
Pictures

1. <https://www.pikist.com/free-photo-sjzxh>
2. <https://www.publicdomainpictures.net/view-image.php?image=5734>
3. <https://www.publicdomainpictures.net/view-image.php?image=5734>
4. <https://pixabay.com/ko/vectors/%EB%87%8C-%ED%95%B4%EB%B6%80%ED%95%99-%EC%83%9D%EB%A6%AC%ED%95%99-%EC%9D%B8%EA%B0%84%EC%9D%98-153550/>
5. <https://pixabay.com/it/vectors/inquinamento-ambiente-avviso-98682/>
6. <https://pxhere.com/en/photo/1075787>
7. <https://www.pickpik.com/pile-rubber-stacked-tires-vehicle-tire-57446>

Facilitate selecting in priority in vitro assays for leachate testing: Mechanistic characterisation based on ToxCast [still draft]



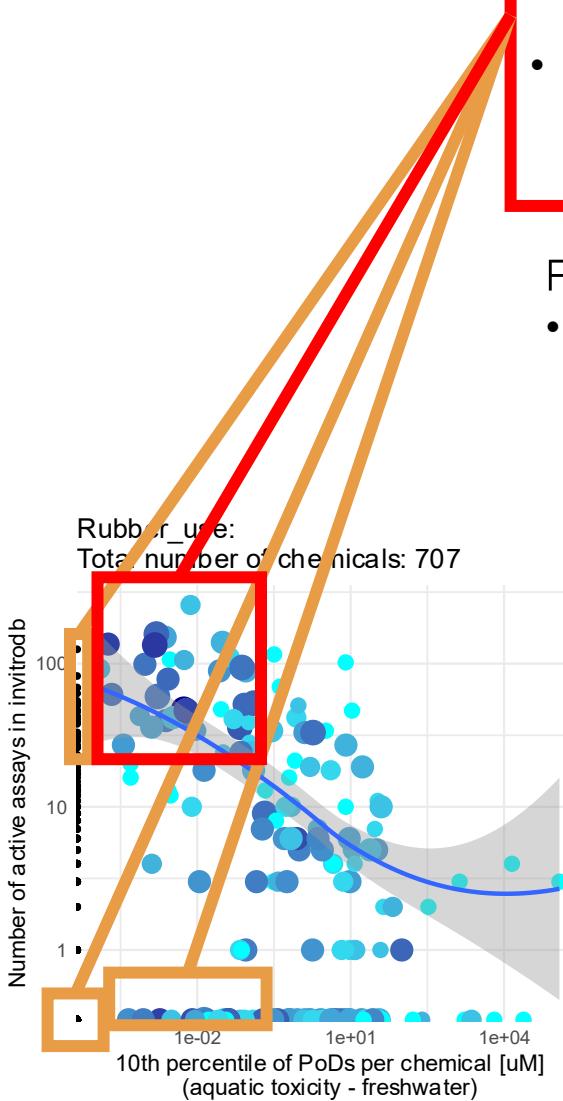
- First level analysis reveals high fraction of rubber chemicals activating
 - nuclear receptors
 - ...



Rubbers: Generic PoD and cellular response

We can focus on these!

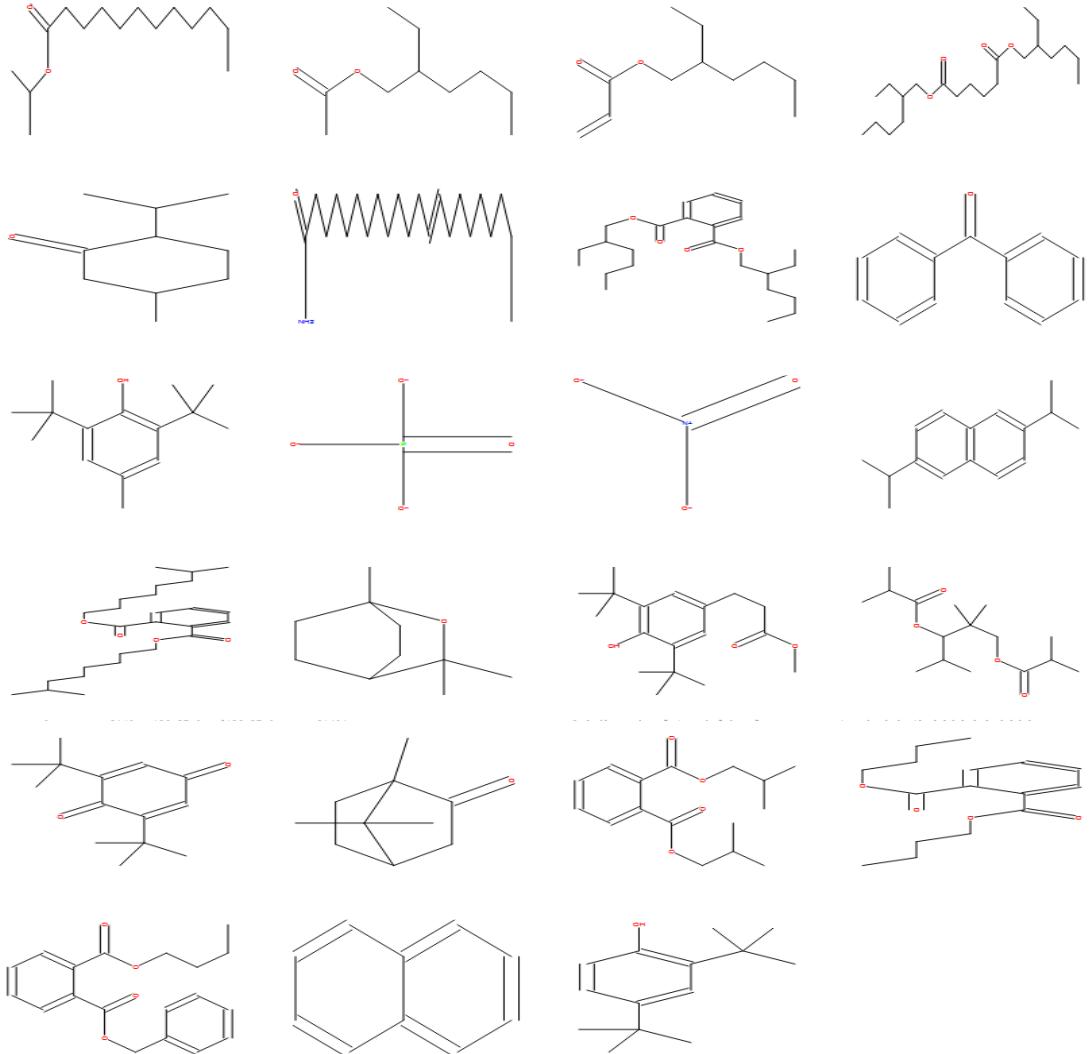
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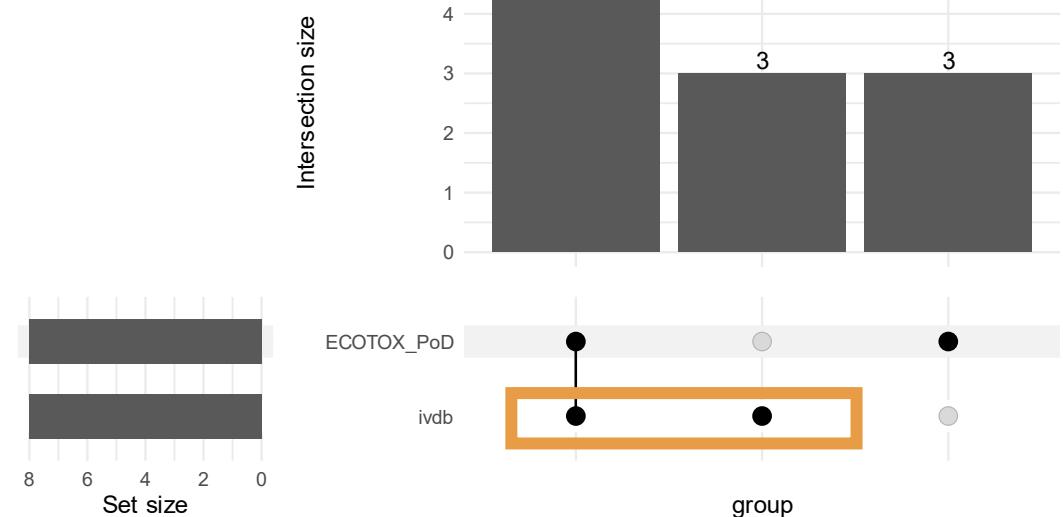
Further questions:

- In the xy plot:
 - Use coloured circles instead: size: number of species/tax. Groups, colour: used/present/released (and shape: classification)

Available data for chemicals known to leach from elastomers



A closer look at ecotoxicity and frequent modes of action:
Identify information available from major public databases



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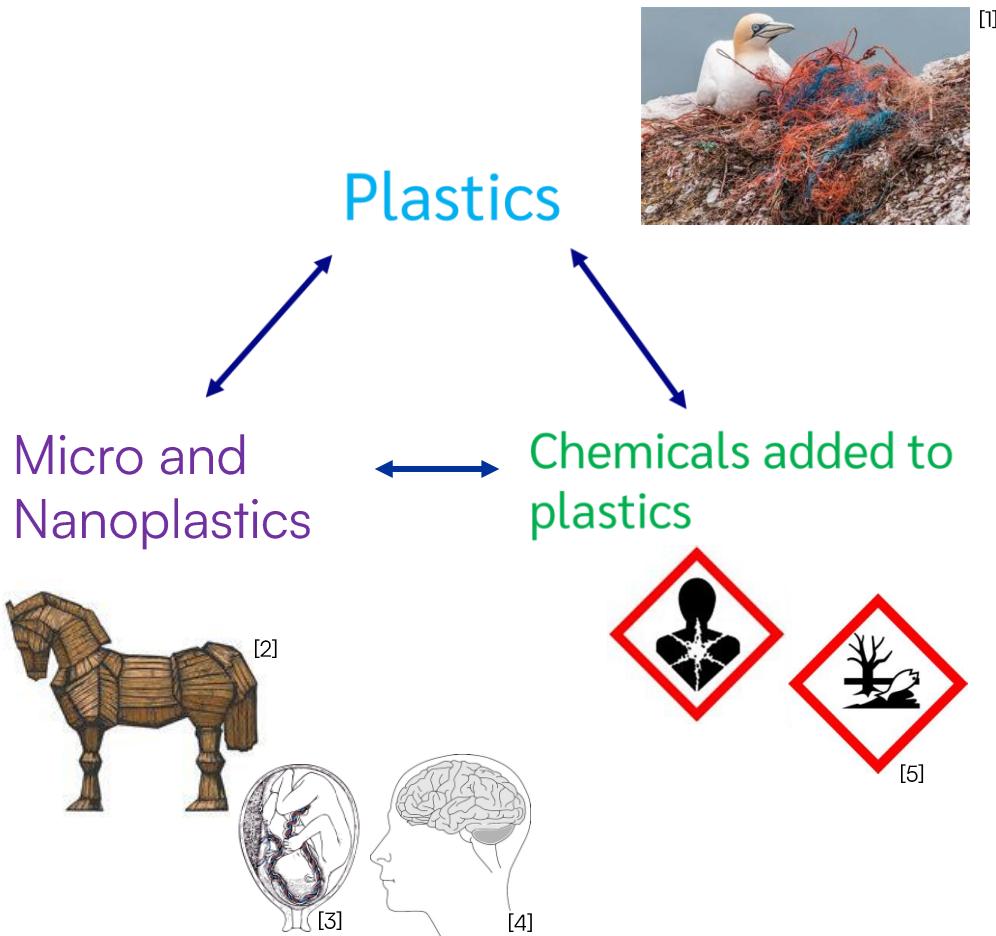
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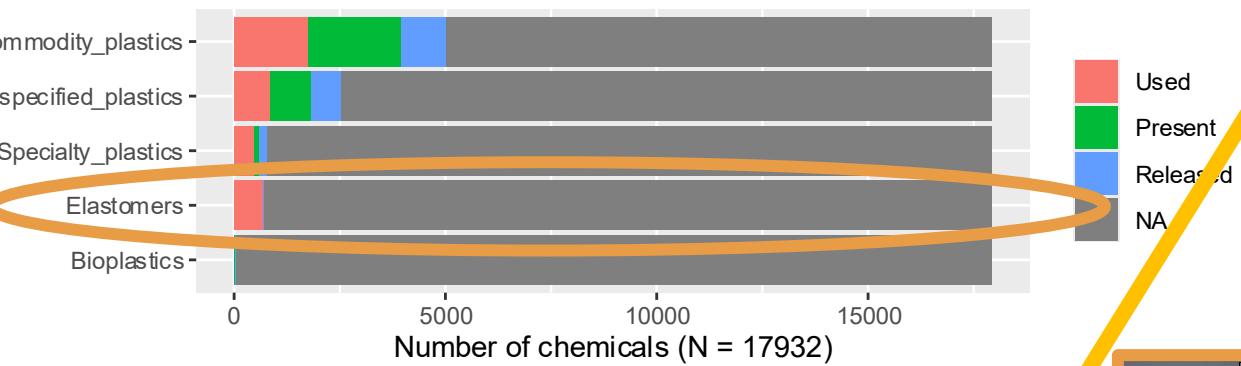
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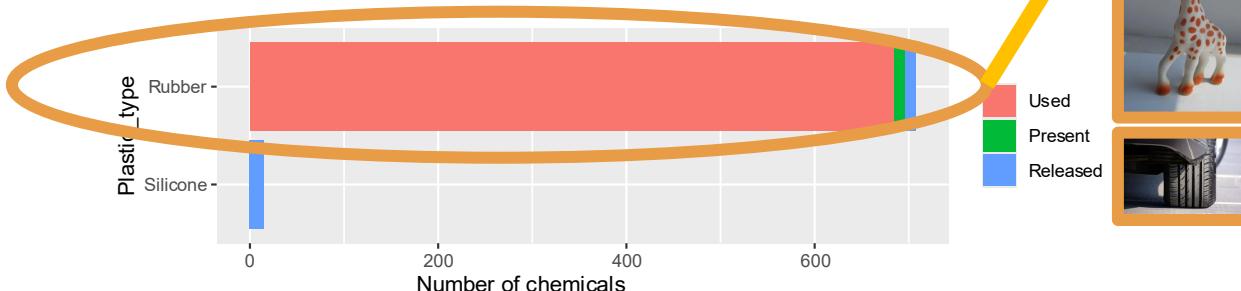
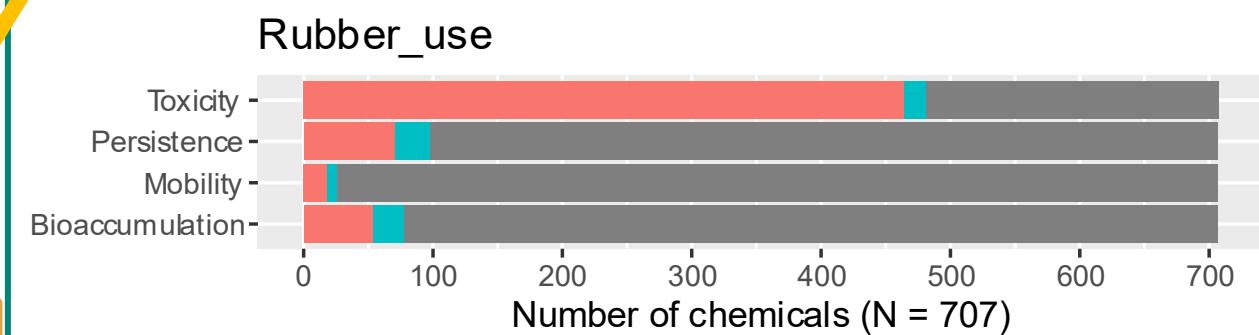
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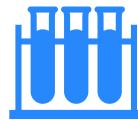


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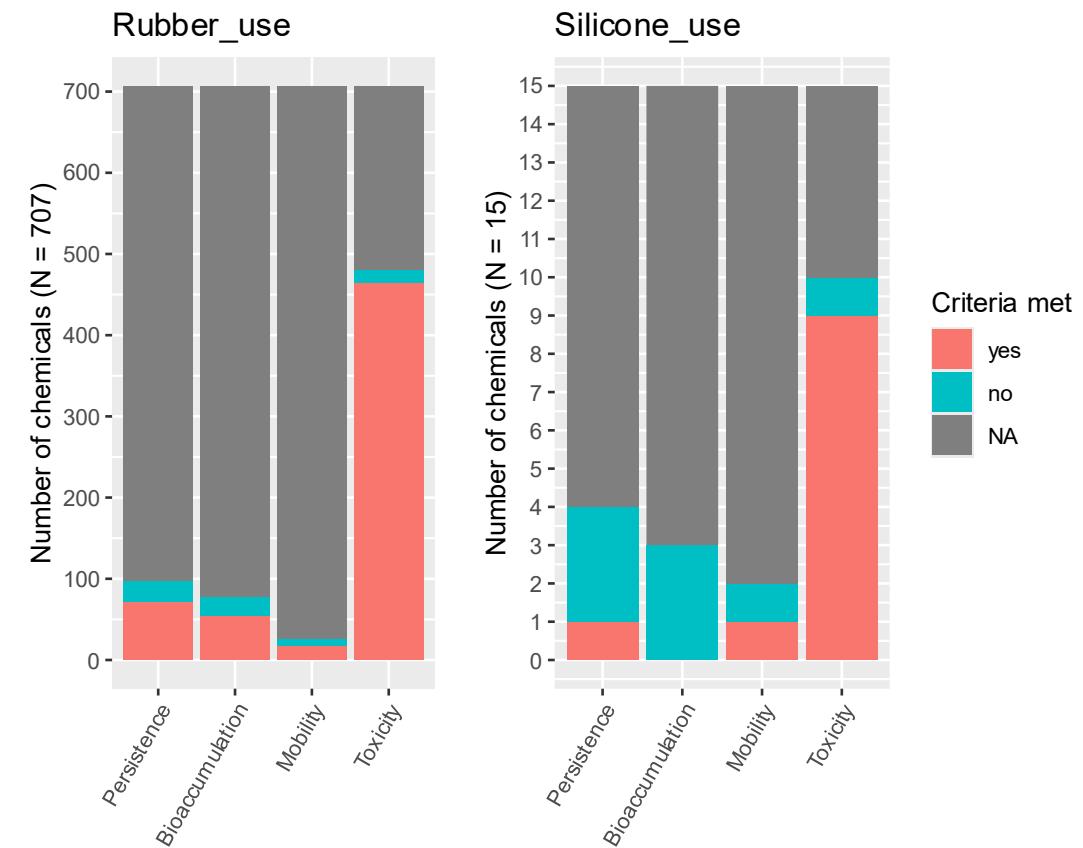
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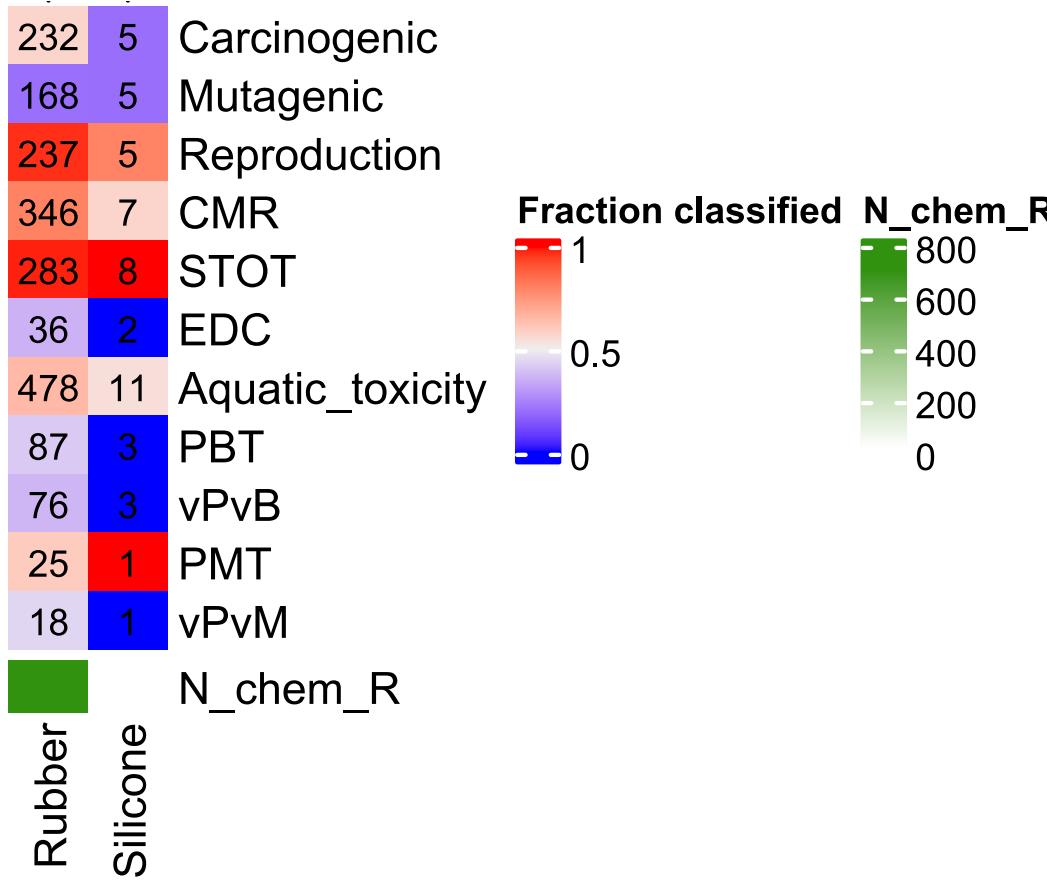
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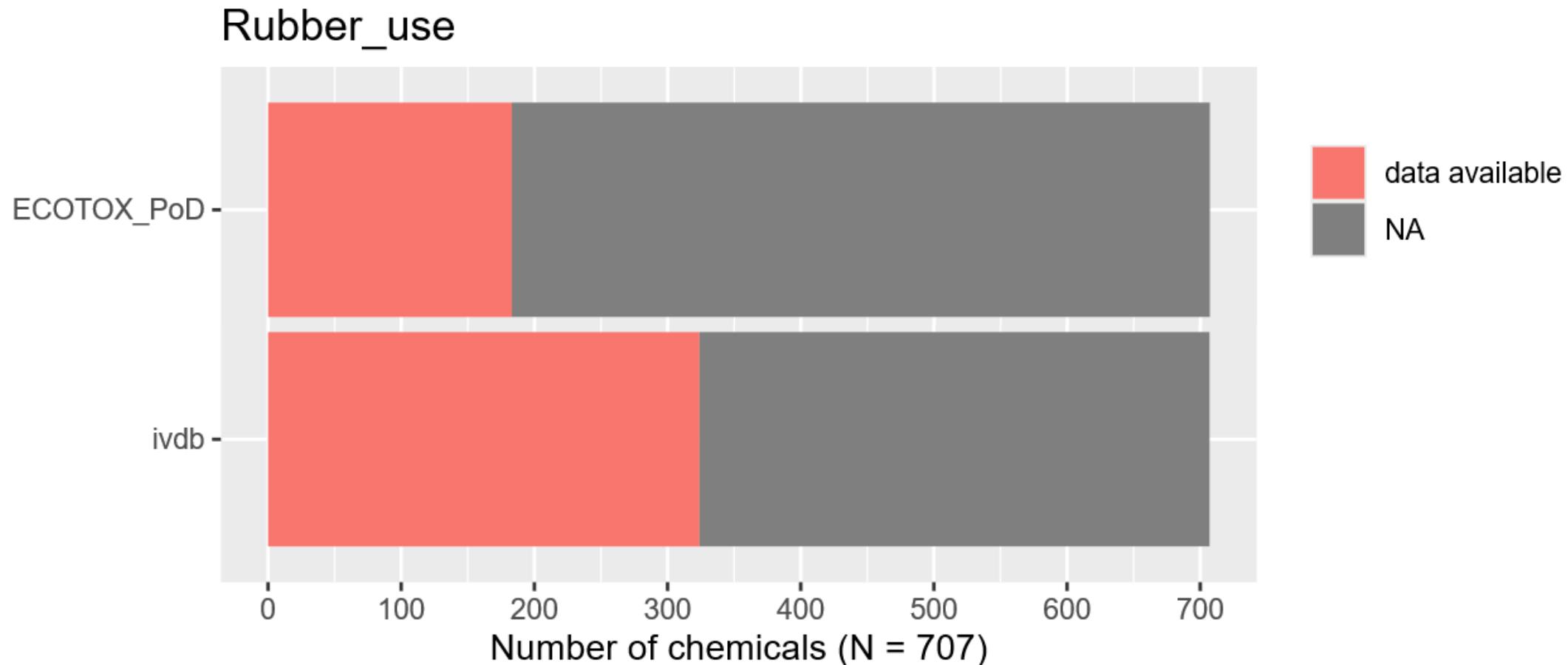
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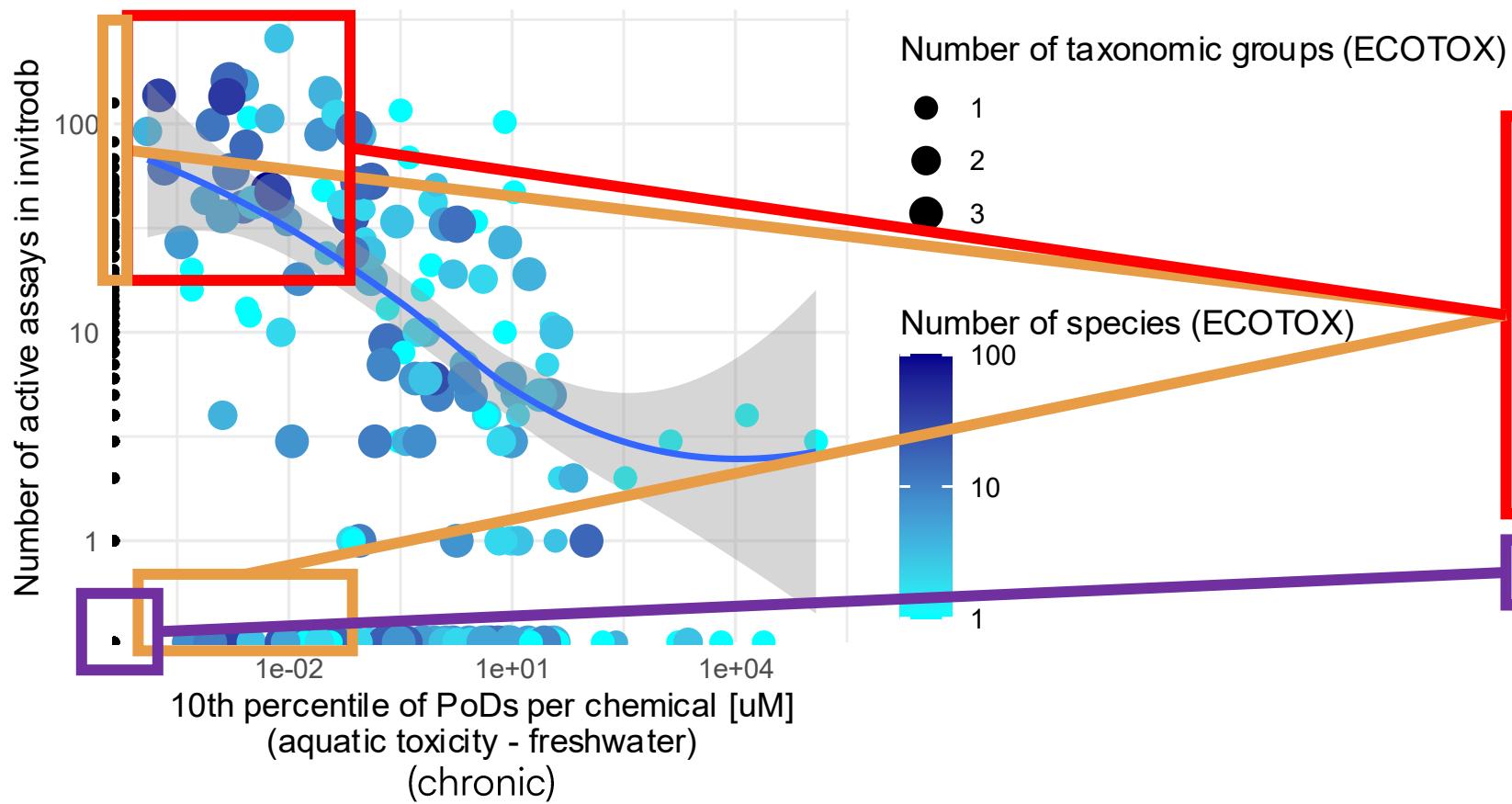
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 - Prioritisation for closing the most severe data gaps in a screening-level approach to plastic leachate hazard characterisation
- Eventually, reducing unnecessary presence of hazardous chemicals in plastics