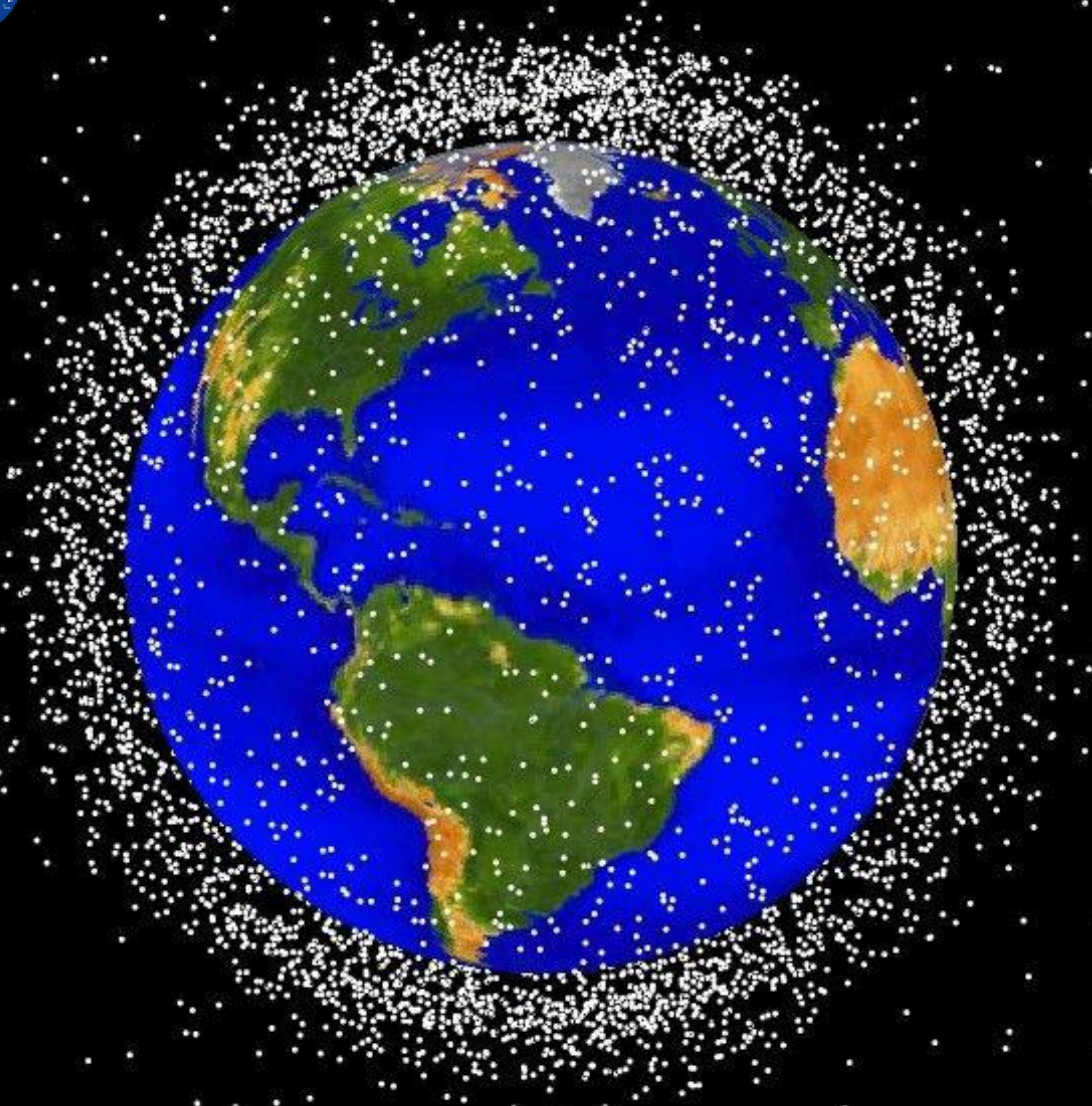

Micro- and nanoplastics and human health

Bart Koelmans

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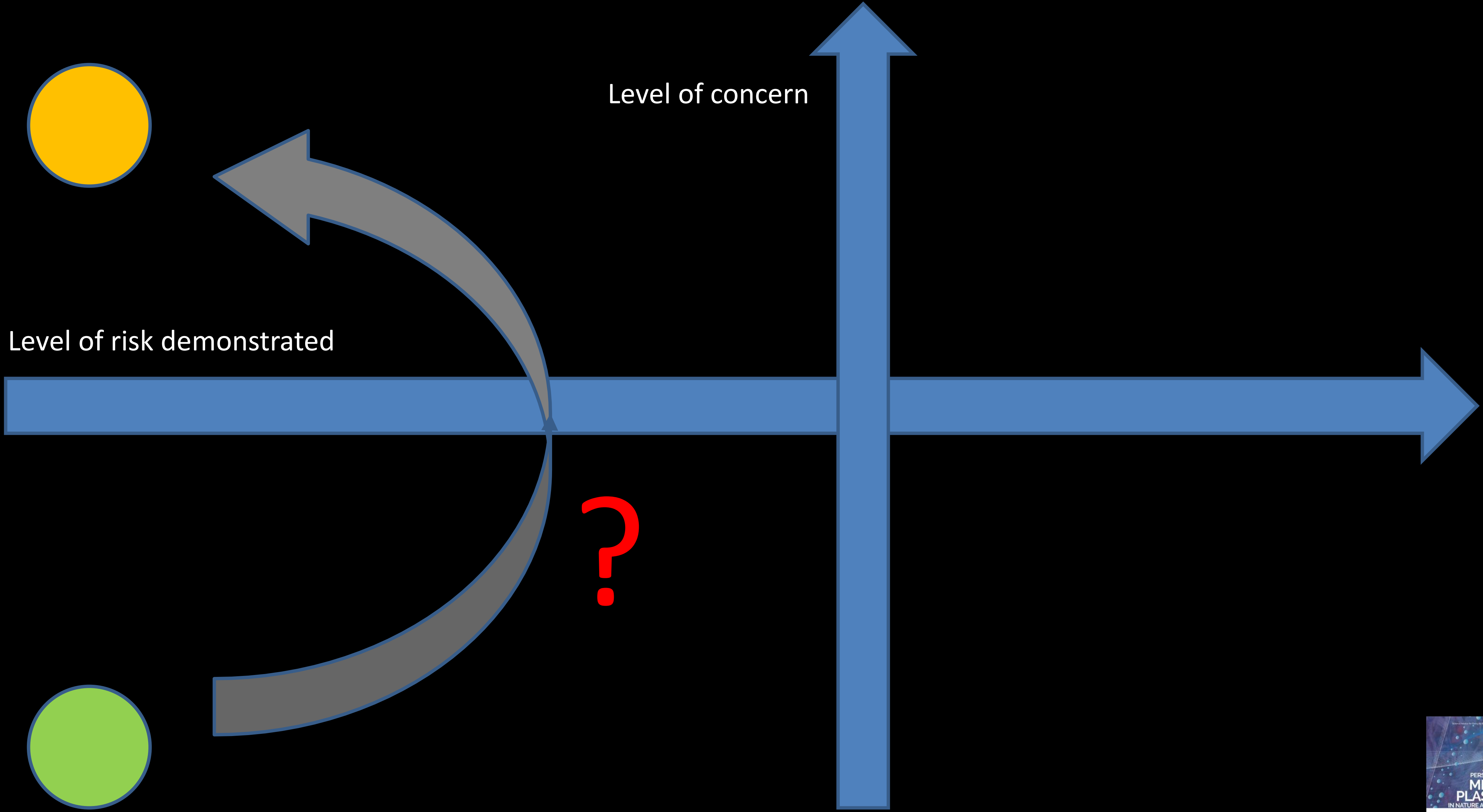
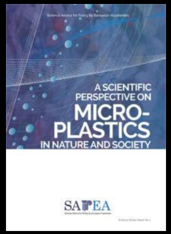
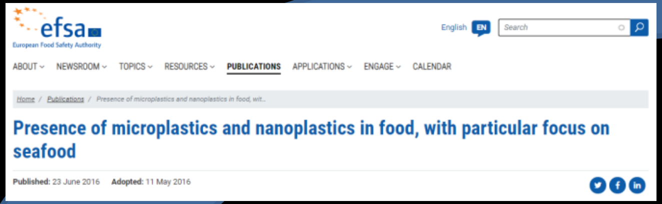
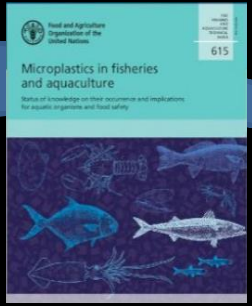

Level of concern
Level of risk demonstrated
?

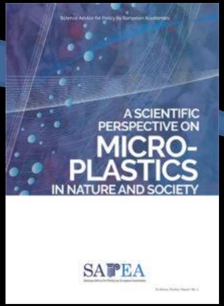

A SCIENTIFIC PERSPECTIVE ON
MICRO-PLASTICS
IN NATURE AND SOCIETY
SAPEA



EFSA
2016



FAO
2017



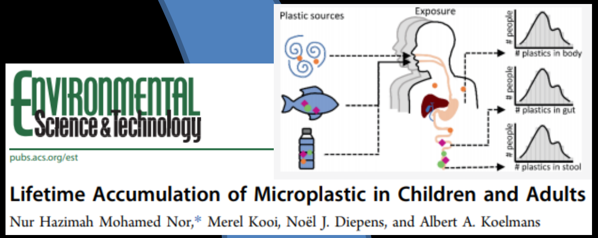
SAPEA
2019

WHO
2019

Cox et al
2019

WWF
2019

Mohamed
Nor et al
2021



- *Refinement of exposure estimates → far from complete*
- *Not much evidence w.r.t. hazard → more research needed*

Nanoplastic

Key to page sidebars

These sidebars are used in Chapter 2 only. They are not applied elsewhere in this report.

- What is known
- What is partially known
- What is unknown

2.3 EXPOSURE

In wastewaters too, nanoplastics are an unknown. While we think they are generated due to larger plastics ageing, we cannot be sure, because the mechanism is unknown and we cannot measure them.

One of the major unknowns across all environmental compartments relates to the question of through which mechanisms, at which timescales and where plastic debris progressively fragments to eventually reach the scale of nanomaterials. Are

2.4 OCCURRENCE

Sampling and analysis methods of nanoplastics are not yet establish
therefore, information on their occurrence in freshwaters is currently unava

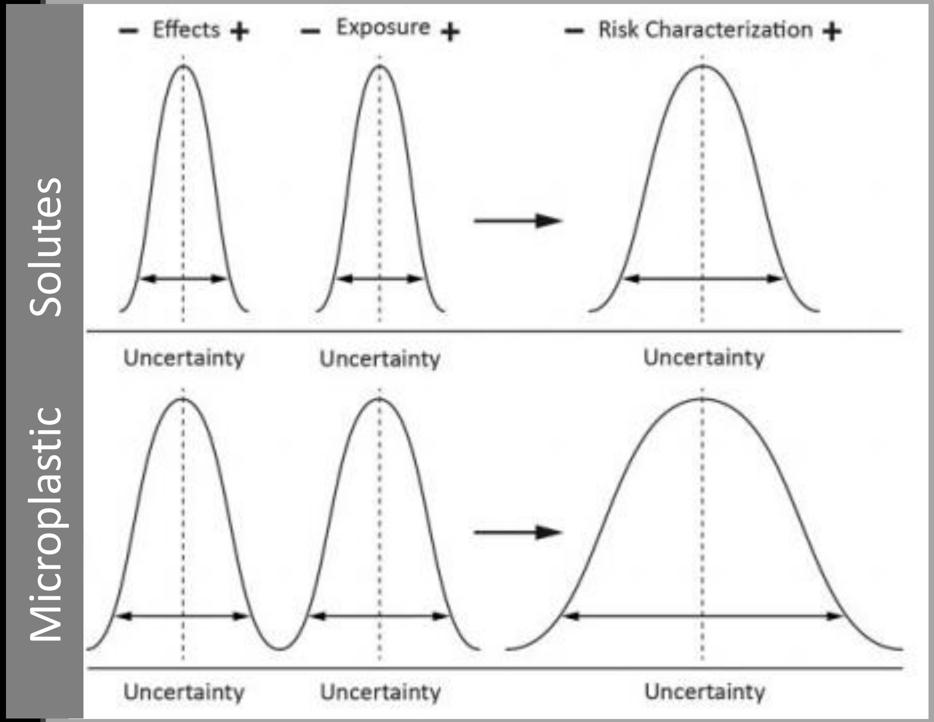
2.4.7 Drinking Water and Food

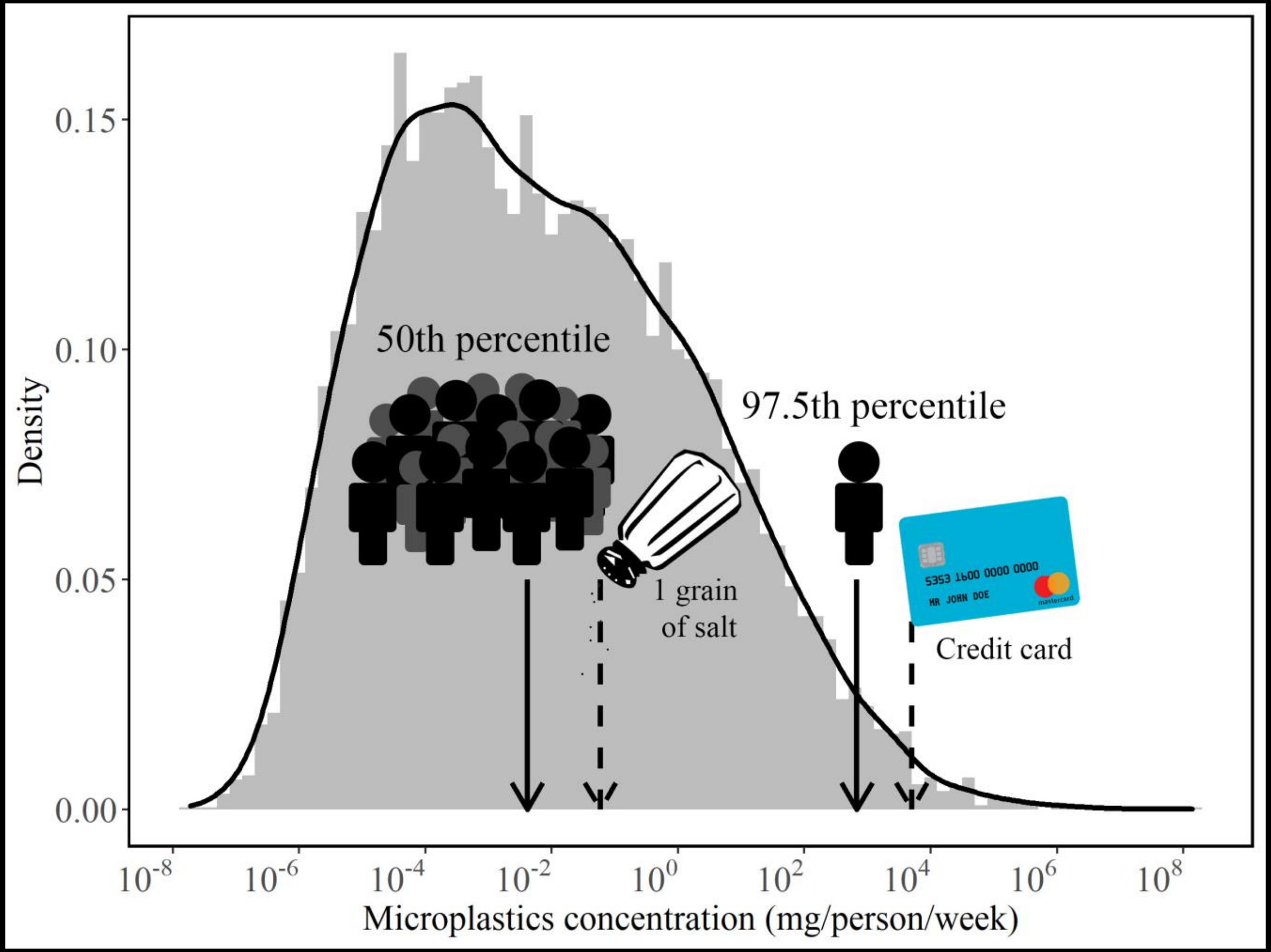
Our knowledge of the occurrence of microplastics in components of the
diet varies across regions. As for nanoplastics in drinking water and food,
no information at all. This means that currently there is insufficient data to

2.6 RISKS

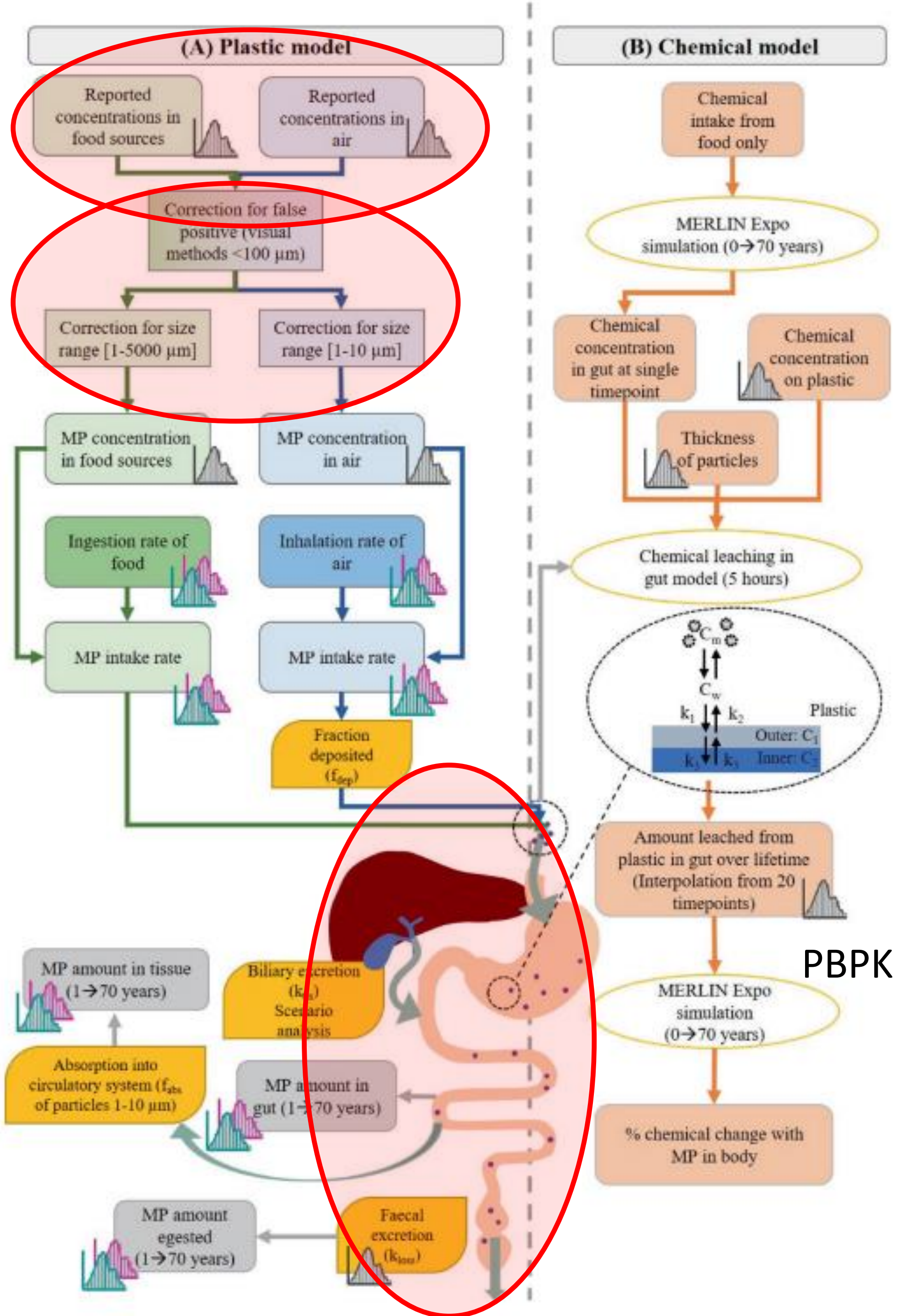
No risk assessments have been published for nanoplastics. As yet, it is unknown what the concentrations are of nanoplastics in environmental compartments or components of the human diet. Therefore, exposure cannot yet be assessed. As for effects, there is limited data, however, most of the experimental designs did not allow for constructing a dose-effect relationship. Furthermore, the limited studies use synthesised nanoparticles, most often nano-sized polystyrene, and it is unknown how well these represent nanoplastics that occur in the environment

Additional uncertainty in particle characterisation

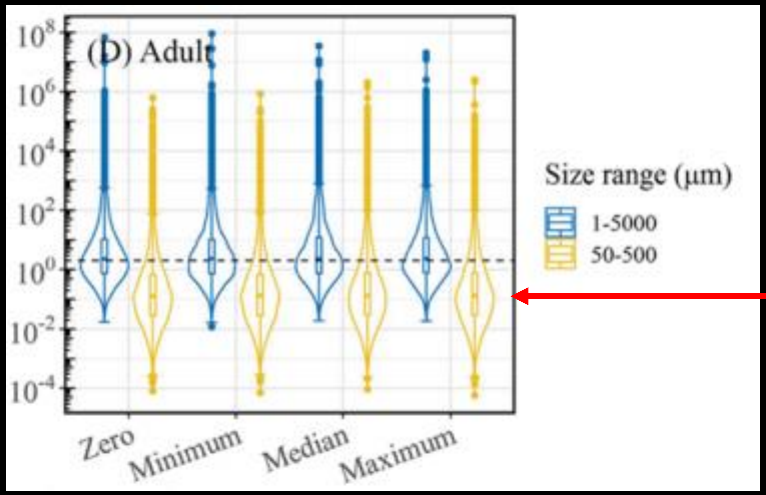




Mohamed Nor, N.H., Kooi, M., Diepens, N.J. Koelmans, A.A. 2021. Lifetime accumulation of nano- and microplastic in children and adults. ES&T

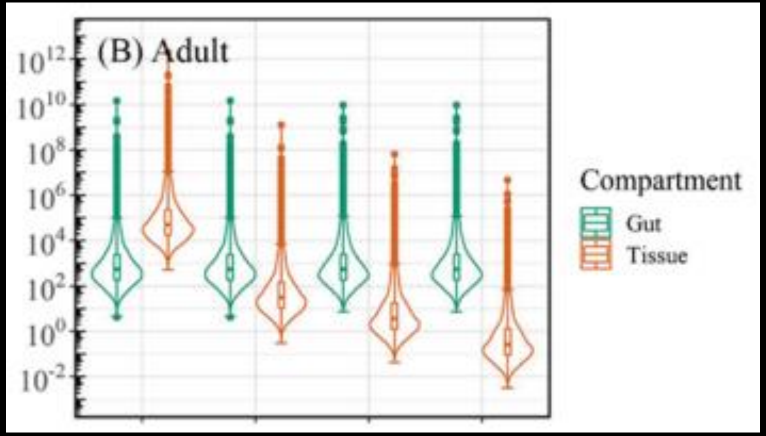


Exposure



------ = Schwable et al
MP in stool

- Model predicts 1/7 of # MP found in stool
- Model accounts for 1/5 of diet by weight



Lifetime accumulation in tissue, preliminary assumptions:

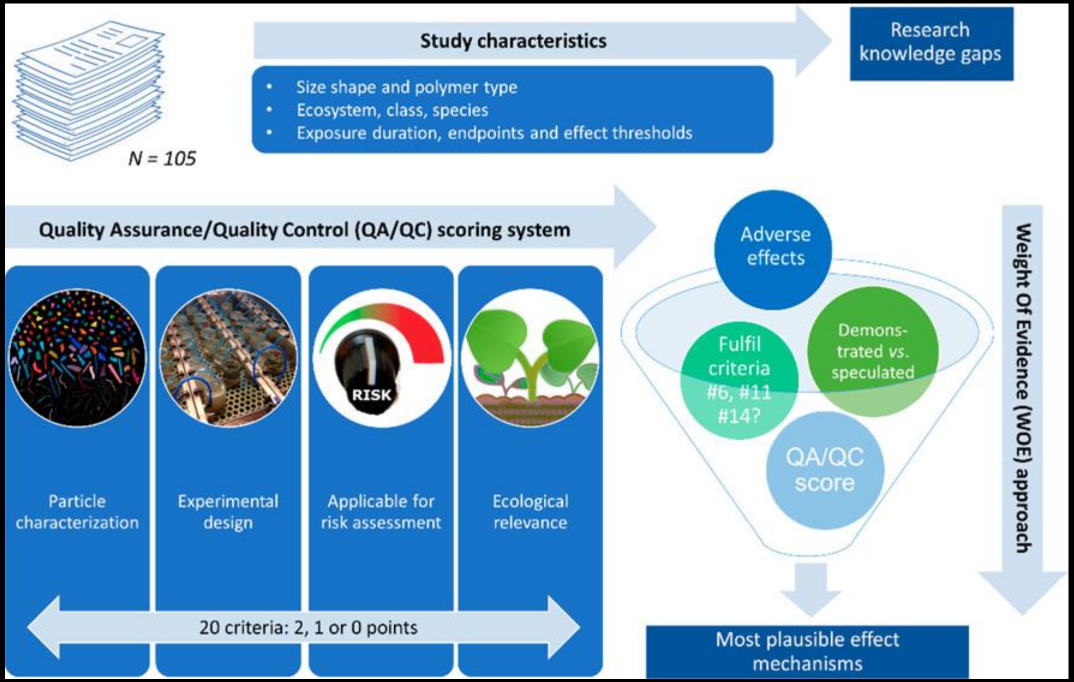
- ~1-10 μm considered bioavailable
- ~ 0.3 % considered to be absorbed
- Four biliary excetion scenarios

Mohamed Nor, N.H., Kooi, M., Diepens, N.J. Koelmans, A.A. 2021. Lifetime accumulation of nano- and microplastic in children and adults. ES&T

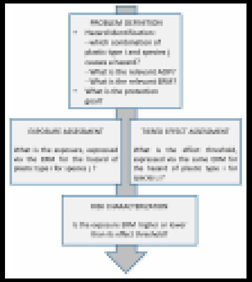
QA/QC tool to screen utility of data for RA

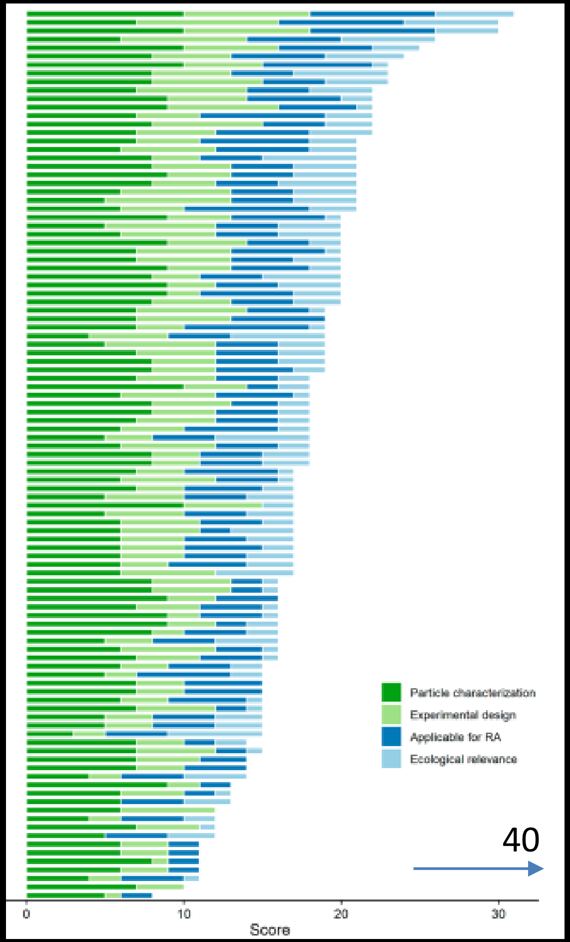
All (literature) data

Prioritize higher quality data



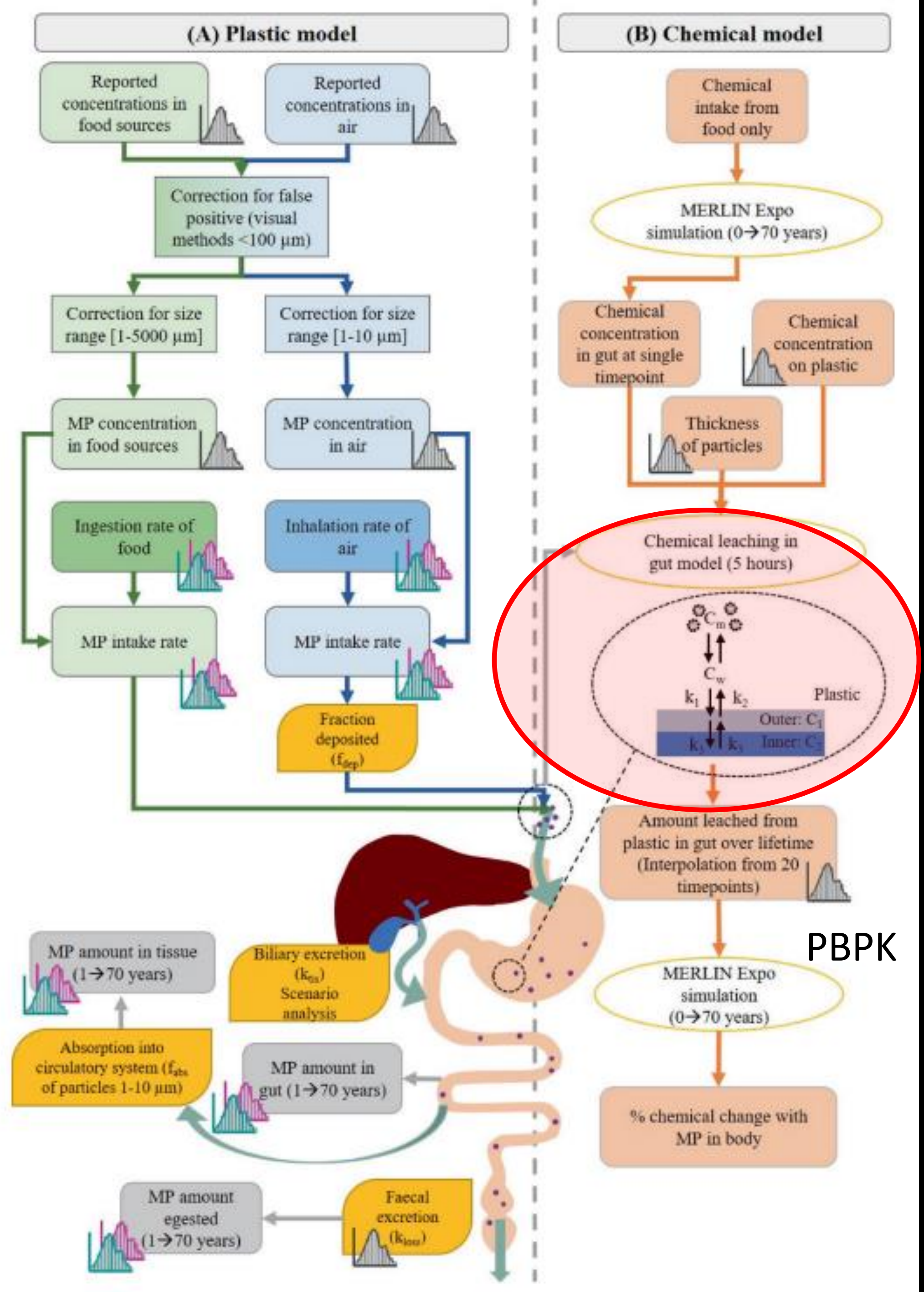
Scoring systems for quantifying QA/QC of MP studies
(‘Klimisch criteria’; de Ruijter et al, ES&T, 2020)





<u>Developed for</u>:
Biota, water, air samples; effect studies, MP ‘chemical vector’ studies

Hermsen *et al.* ES&T 2018, Koelmans *et al.*, WR, 2019, De Ruijter *et al.* ES&T, 2020, Koelmans *et al* 2021, Wright *et al. MINA, 2021*



Chemicals

Relevance of MP as a carrier of contaminants

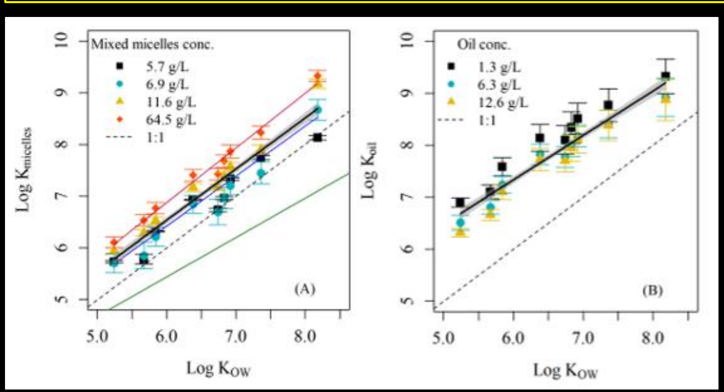
- EFSA 2016, worst case: very small
- FAO 2017, worst case: very small
- SAPEA 2019: very small
- WHO 2019, worst case: very small
- Mohamed Nor, ES&T, 2021, probabilistic: very small

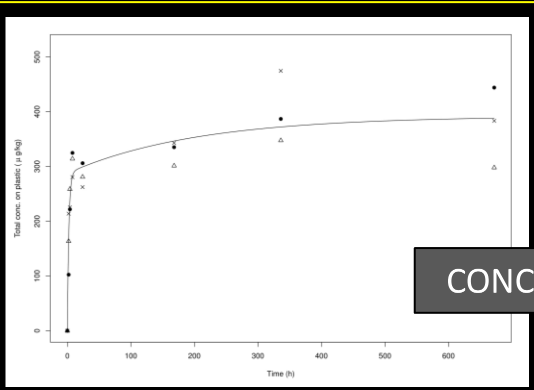
Dynamic modeling of MP- and food-associated chemical bioavailability in the gut

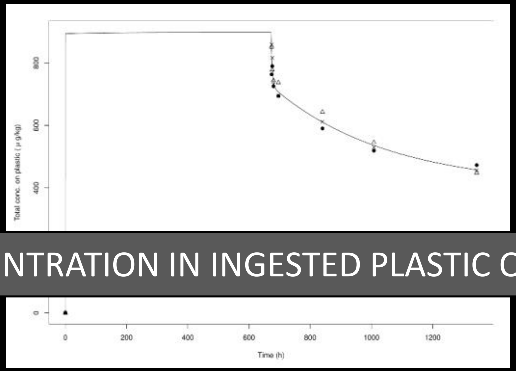
→ Context dependent, yet assessment tool available

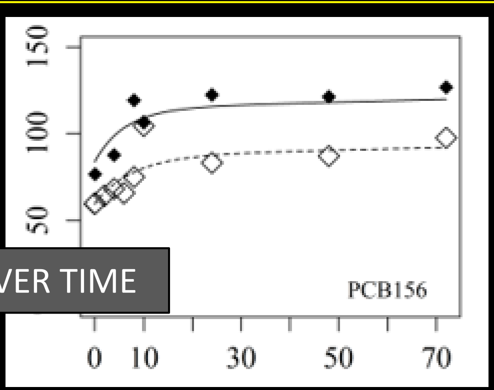
Mohamed Nor, N.H., Kooi, M., Diepens, N.J. Koelmans, A.A. 2021. Lifetime accumulation of nano- and microplastic in children and adults. ES&T

EXPERIMENTAL DATA FOR CHEMICAL BINDING & KINETICS TO MICELLES, FOOD COMPONENTS, MP - RELEVANT SCENARIOS





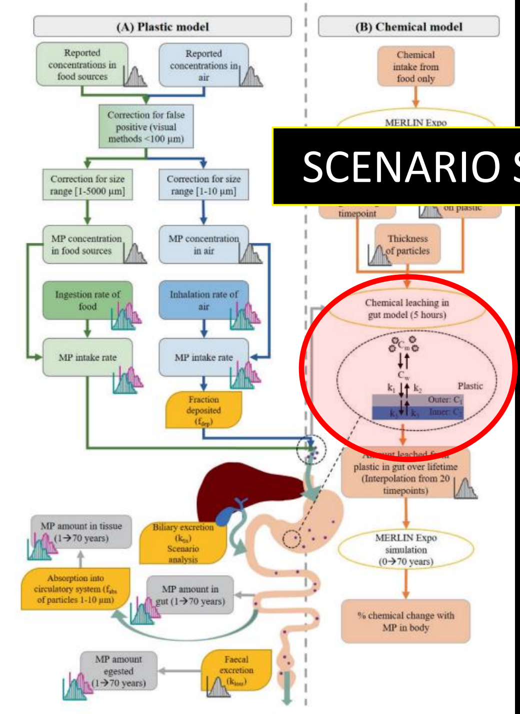




CONCENTRATION IN INGESTED PLASTIC OVER TIME

Framework for MP-chemical bioavailability in the human GIT

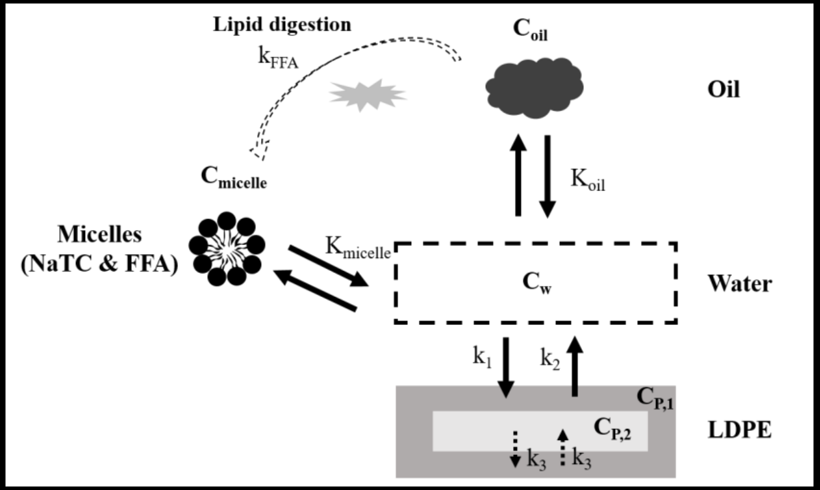
Mohamed Nor, N.H., Koelmans, A.A. 2019. Transfer of PCBs from microplastics under simulated gut fluid conditions is biphasic and reversible. ES&T., 53, 1874−1883.
Mohamed Nor, N.H., Niu , Z.., Hennebelle , M., Koelmans, A.A. 2021. Microplastics trap chemicals from contaminated food during digestion, J. Haz. Mat. submitted

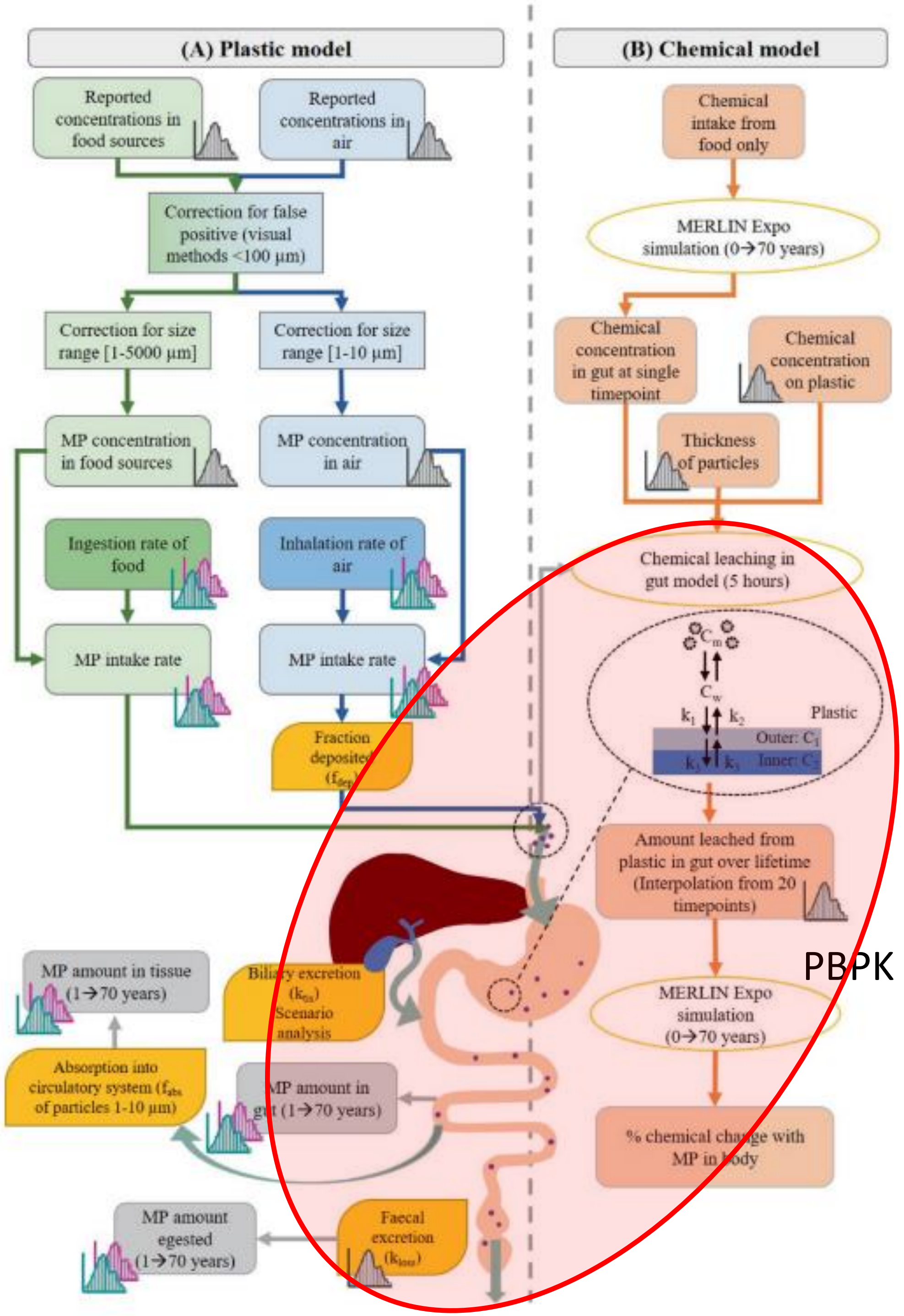


SCENARIO STUDIES ← PARAMETER ESTIMATION ← Equations — MODEL DEVELOPMENT

Table S4. Kinetic rate constants of LDPE for high and low enzyme treatment with standard errors (SE) (***significant at p<0.001; **significant at p<0.01; *significant at p<0.05)

Enzyme treatment	PCB congener	Log K_{OW}	k_1 (h^{-1})	SE	k_2 (h^{-1})	SE	K_P (L/kg)	log K_P
High	18	5.24	2.36E+02**	7.36E+01	0.345**	0.116	3.28E+05	5.52
High	28	5.67	1.61E+03**	4.50E+02	0.554**	0.163	1.21E+06	6.08
High	52	5.84	9.79E+02**	2.85E+02	0.283**	0.090	1.37E+06	6.14
High	101	6.38	5.59E+03*	2.39E+03	0.418*	0.190	4.44E+06	6.65
High	118	6.74	9.01E+03**	2.58E+03	0.322**	0.099	8.28E+06	6.92
High	138	6.83	1.40E+04*	5.88E+03	0.390*	0.173	1.03E+07	7.01
High	153	6.92	2.42E+04*	1.09E+04	0.477*	0.224	1.42E+07	7.15
High	156	7.18	1.33E+04***	3.38E+03	0.159**	0.045	2.15E+07	7.33
High	180	7.36	9.87E+04*	4.37E+04	0.550*	0.254	4.35E+07	7.64
High	209	8.18	1.37E+07	1.35E+07	4.355	4.316	5.85E+08	8.77
Low	18	5.24	1.38E+02***	2.09E+01	0.193***	0.033	3.42E+05	5.53
Low	28	5.67	6.04E+02***	8.40E+01	0.229***	0.036	1.10E+06	6.04
Low	52	5.84	3.33E+02***	5.43E+01	0.087***	0.017	1.51E+06	6.18
Low	101	6.38	3.13E+03***	4.15E+02	0.197***	0.030	5.28E+06	6.72
Low	118	6.74	5.92E+03***	1.08E+03	0.218***	0.044	8.04E+06	6.91
Low	138	6.83	1.00E+04***	1.77E+03	0.262***	0.051	1.10E+07	7.04
Low	153	6.92	1.58E+04***	2.81E+03	0.289***	0.056	1.53E+07	7.18
Low	156	7.18	1.03E+04***	1.75E+03	0.124***	0.024	2.13E+07	7.33
Low	180	7.36	4.22E+04***	7.04E+03	0.210***	0.039	4.87E+07	7.69
Low	209	8.18	6.32E+05**	2.14E+05	0.191*	0.071	6.16E+08	8.79





Hazard

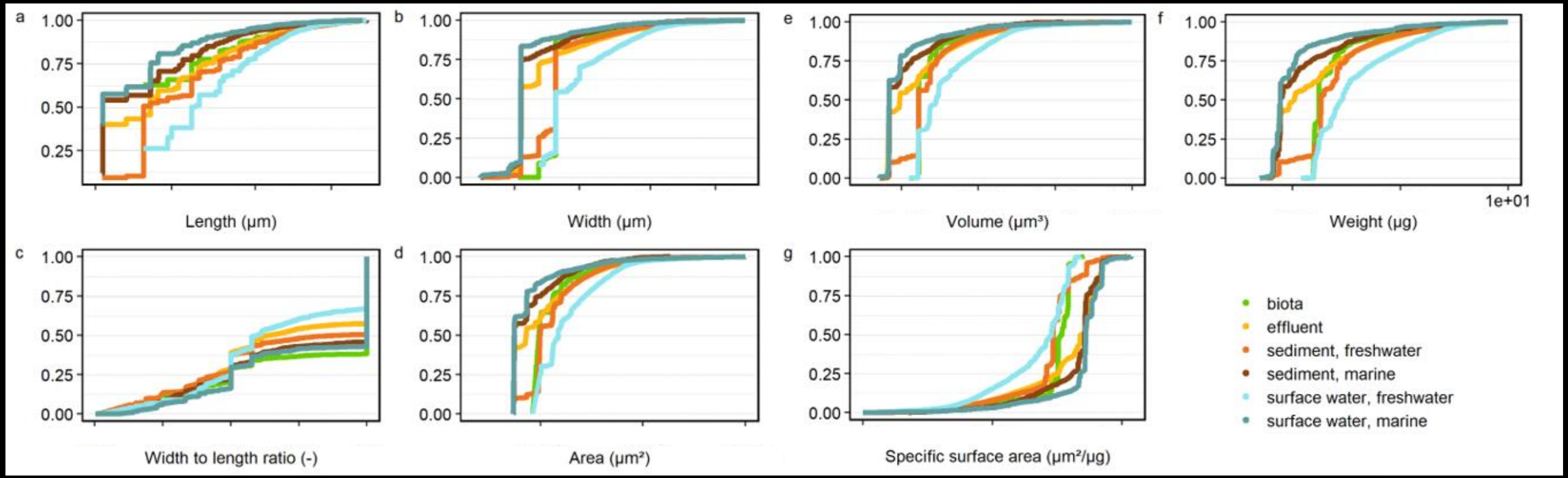
Hazard assessment challenges

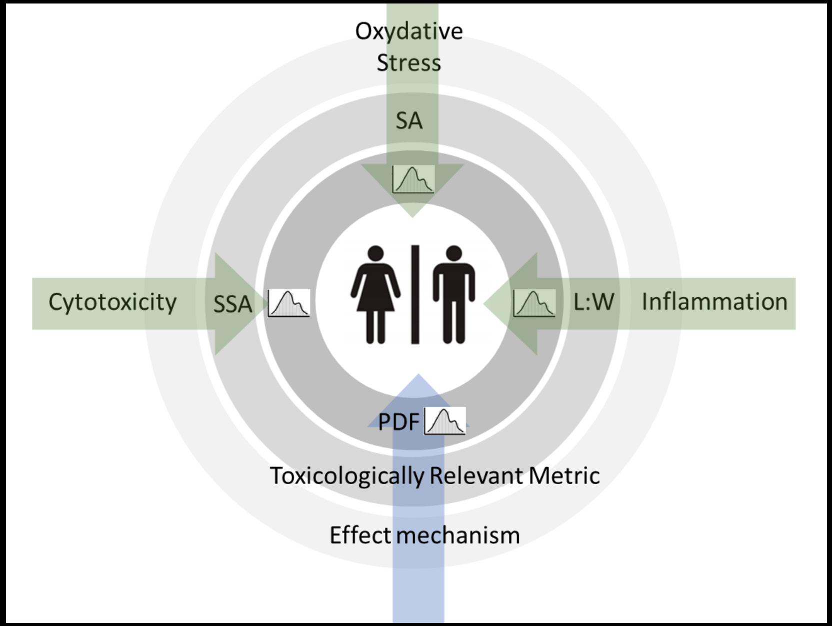
1. Uncertainty around observed effects *in vitro* tests & *in vivo* animal models
2. Uncertainty in translations to in vivo scenarios
3. Particles used in tests not representative for those we are exposed to
4. QA/QC of data with respect to applicability for hazard and risk assessment
5. Unknown bioavailability & PBPK parameters
6. Unknown hazard profile as compared to other particles

Mohamed Nor, N.H., Kooi, M., Diepens, N.J. Koelmans, A.A. 2021. Lifetime accumulation of nano- and microplastic in children and adults. ES&T

Dealing with the diversity of NMP

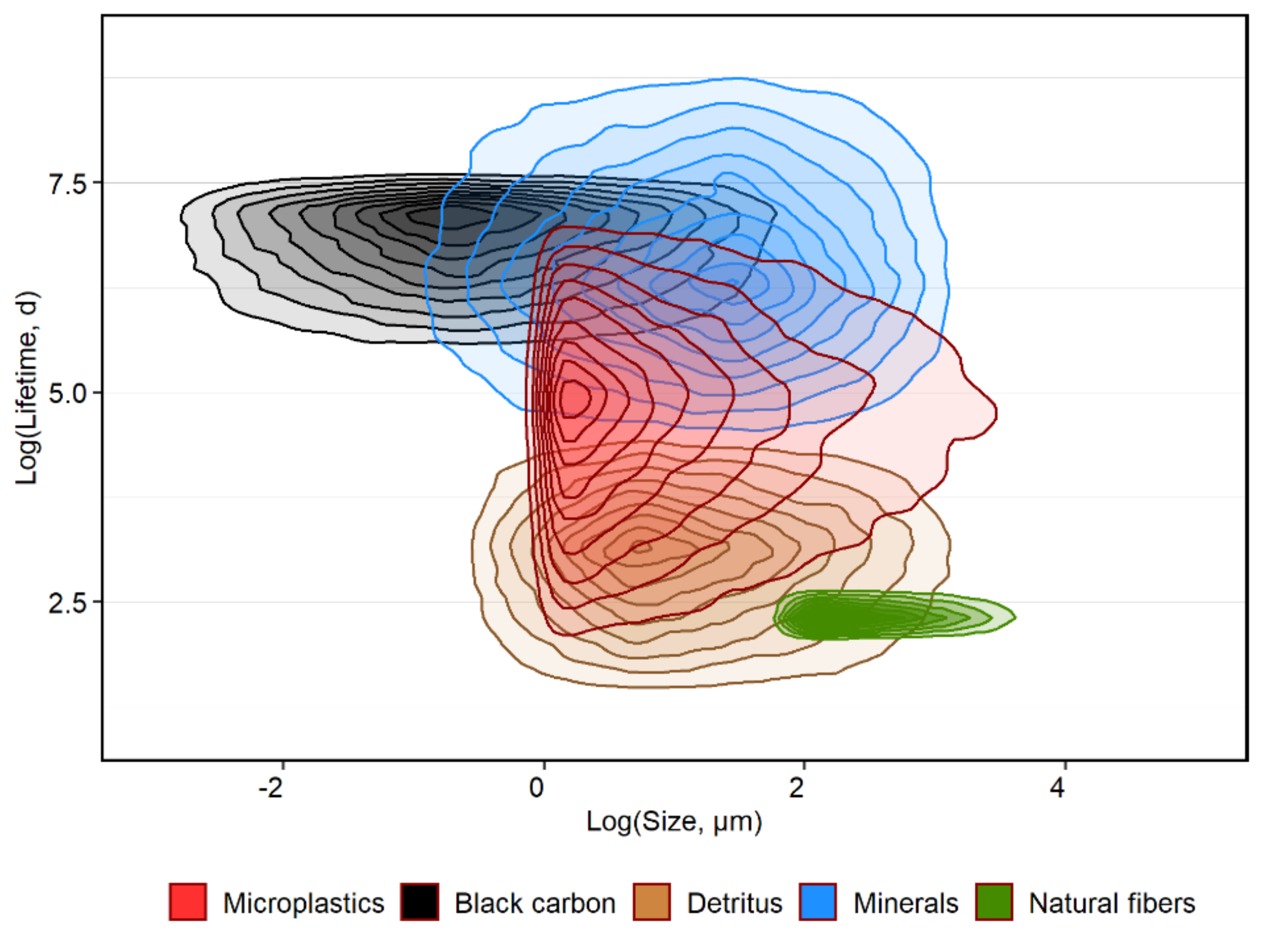
Kooi, M .. Koelmans et al 2021. Characterizing the multidimensionality of microplastics across environmental compartments. *Submitted.*





Koelmans, A.A., et al. 2021. Paradigms for the risk assessment of microplastic. Nature Materials. *Submitted*.

NMP versus other particles



- Other particle categories can have a *similar size* but then have higher density (minerals, sand, silt, clay, metal-based nanoparticles and colloids).
- Other particle categories can have similar density but then are far less persistent (organic matter flocs, detritus, algae, detritus, or organic colloids).
- Other particle categories do not exist in a nm to > cm size range with all other properties being similar to those of plastics.
- Other particles categories do not exist in a 'from fibre to sphere' range of shapes with all other properties being similar to those of plastics.

Koelmans, A.A., et al. 2021. Paradigms for the risk assessment of microplastic. Nature Materials. *Submitted*.


Microplastics and human h...
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sciencedirect.com
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sciencedirect.com
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mdpi.com
Airborne microplastics: Consequences to human h...
semanticscholar.org
Microplastics: an emerging threat to food security ...
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Airborne microplastics: Consequences to human health?...
sciencedirect.com
You Are What You Eat: Microplastics In Our Food &...
medium.com
Report: Plastic Threate...
plasticpollutioncoalition...
Junk Food – Woods Hole Oceanographic Institution
whoi.edu
Start of scientific research into the health ris...
plastichealthcoalition.org
Potential human health risks due to environ...
doi.org
Airborne microplastics: Consequences to human h...
semanticscholar.org
Plastic & Health | Center for Inter...
ciel.org
Trophic transfer of microplastics in zooplanktons towards ...
pubs.iscience.in
How dangerous is it for humans to inge...
countryliving.com
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Finding the right metho...
ec.europa.eu
Plastic & Health | Cent...
ciel.org
The Average Person Eats 70,000 Microplastics ...
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researchgate.net
Frontiers | Microplastics in Sea Turtles, Marine Mammal...
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forbes.com
there's work to be done

Thank You !

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Ellen Besseling

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Hazimah Mohamed Nor

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