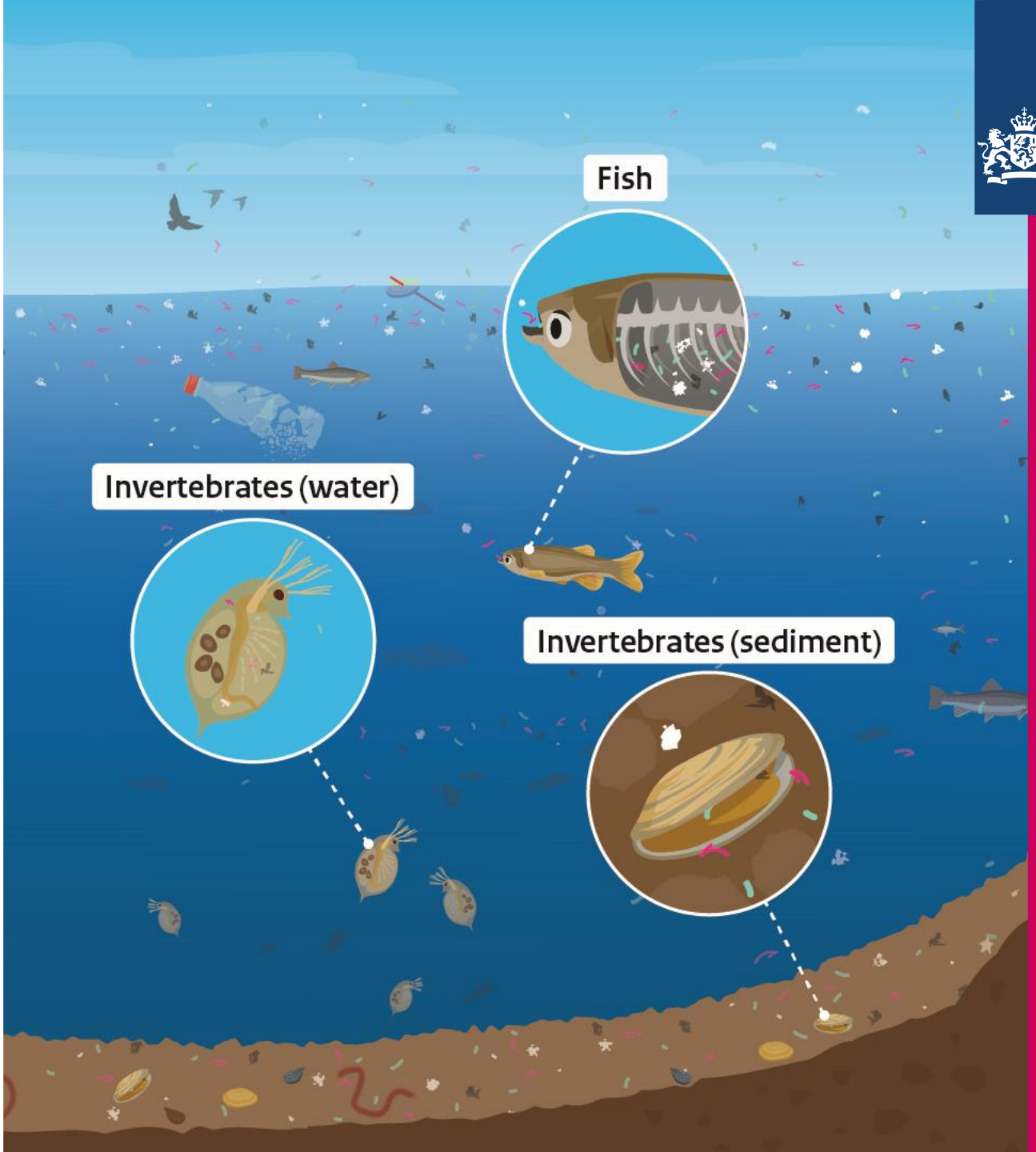


National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Microplastics in the (aquatic) environment

Joris Quik and colleagues

Workshop Microplastics van de Internationale Scheldecommissie

28-11-2023

RIVM: the Netherlands National Institute for Public Health & the Environment

Minister of Health, Welfare & Sport

RIVM:
knowledge and advisory institute
(national government; international research)

- Infectious Disease Control
- Environment & Safety
- Public Health & Health Services

15 Centres: board, CSO's, professors, scientific & policy advisors, support staff
≈ 2100 employees

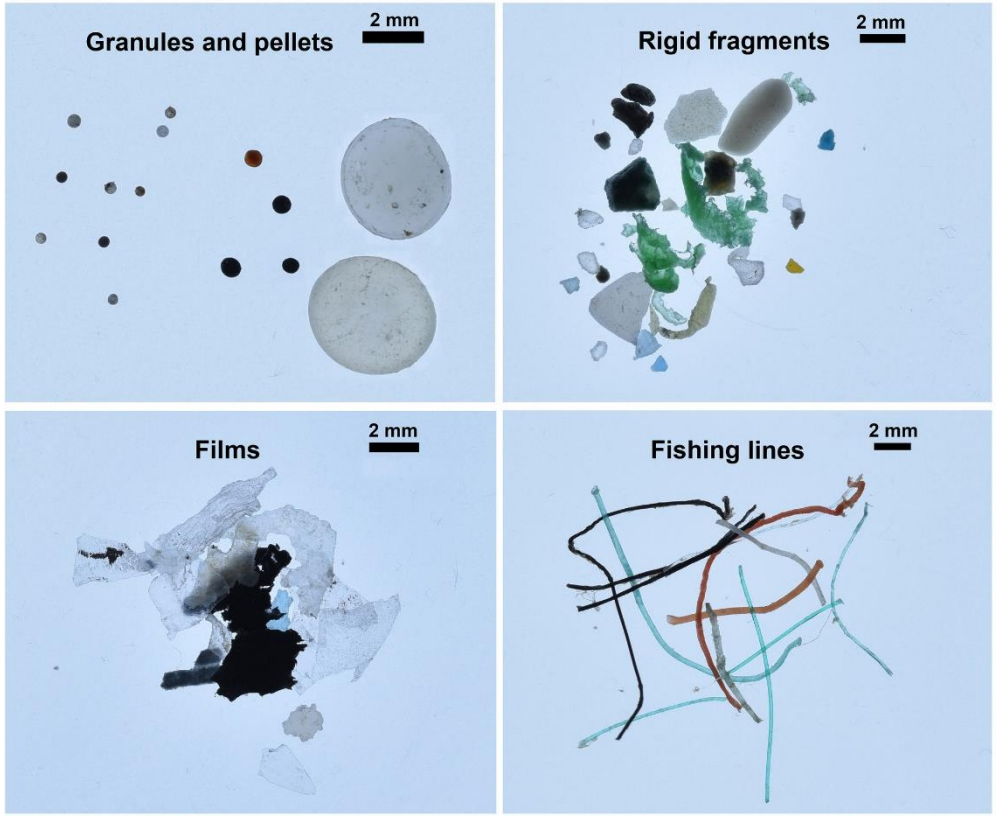
Prof. Dr. Hans Brug (left), Director General of RIVM, in conversation with Dutch Foundation "Farmers Defence Force"

Main take-away points

- **Still many uncertainties**
  - Insufficient quality of studies
  - Information on smallest particles often lacking
- **System thinking** is needed; soil, sediment and water are interconnected
- **Persistent** problem + **increased emissions/particle numbers** due to
  - increased production
  - fragmentation of plastics
- **Current & future risks** cannot be excluded
- Irreversible environmental pollution

Microplastics

- What particle types are being used in research?
- (Policy) definition remains unclear:
  - Solid polymers ✓
  - ≤5 mm ✓
  - ≥ 1 µm ?
  - Biodegradable ?
  - Solubility < 2 g/L ?
  - Natural and/or synthetic polymers ?



The different categories of microplastics found in the Arctic Ocean. (Andres Cózar on latimes.com)

Public attention

- (Micro)plastics are a popular topic receiving much attention in the media
- Societal concern
- **But are there risks?**




Pathogenen zitten graag op plastic

Biologie Plasticresten in rivierwater zitten vol met micro-organismen waarvan mensen ziek kunnen worden.

Spermakwaliteit holt achteruit door plastic, maar strengere EU-wetten blijven nog uit

Microplastics nog jarenlang in cosmetica, terwijl steeds duidelijker wordt hoe schadelijk het is

01-03-2023 18:46 | Klimaat en energie

Plasticdeeltjes nu ook gevonden in menselijk bloed – de vraag is hoe schadelijk ze zijn

Erger dan microplastic: Deze deeltjes verhogen het risico op parkinson en dementie

De stoffen kunnen hersencellen binnendringen en natuurlijke processen verstoren.

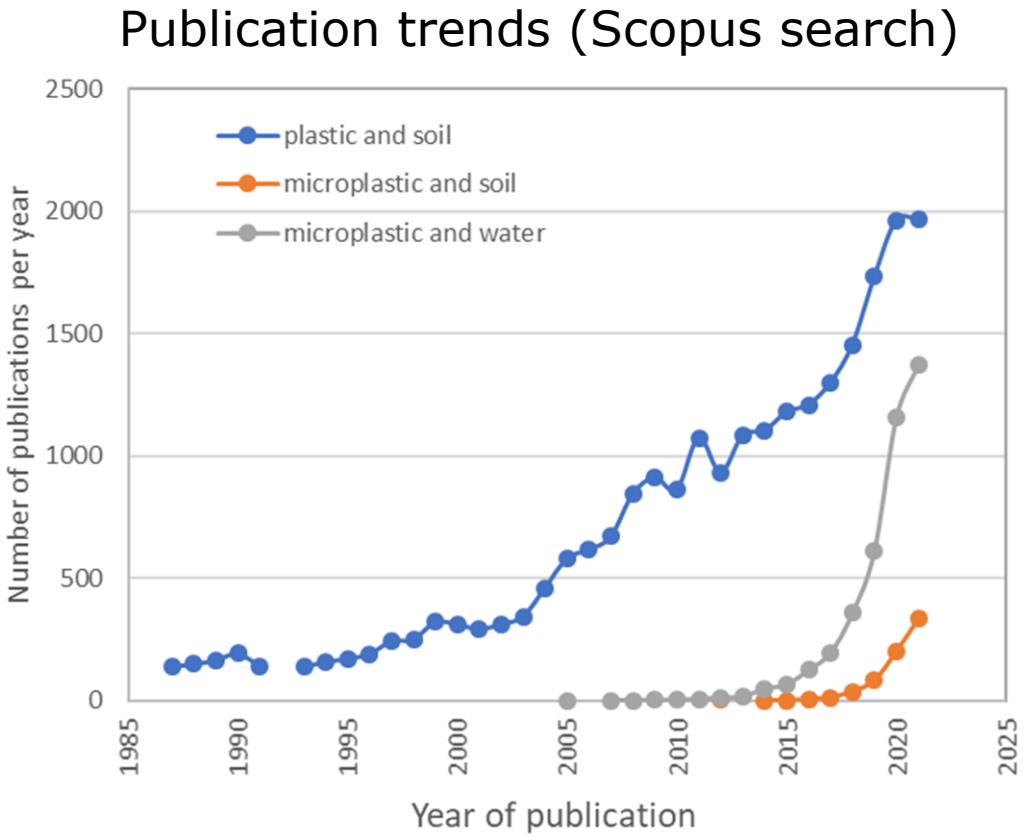
What is risk?

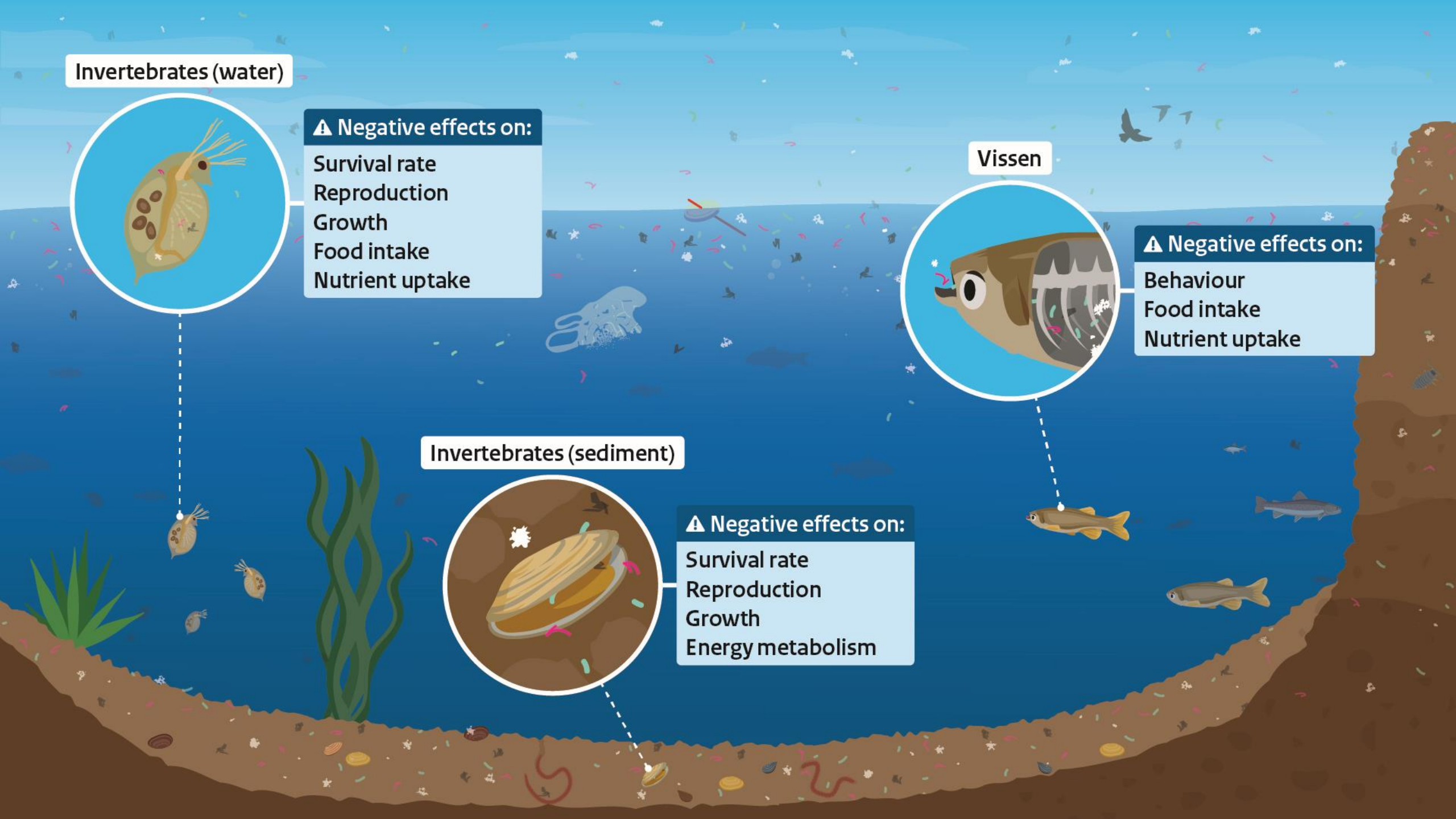
- **Hazard:** something that can potentially cause harm at a specific exposure concentration

- **Risk:** likelihood that harm is caused

Knowledge on effects rapidly increasing

- Exponential growth in studies
- Focus on aquatic system, soil slowly catching up
- Not all studies are relevant:
  - Time until method and criteria development
  - Only a small fraction of studies can be used in risk assessment (de Ruijter et al 2020)

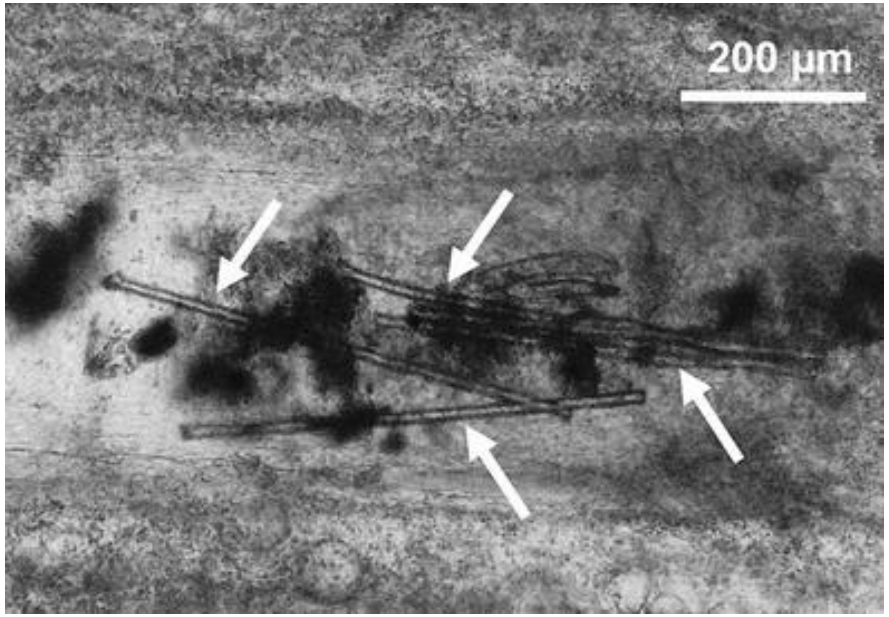



Invertebrates (water)
⚠ Negative effects on:
Survival rate
Reproduction
Growth
Food intake
Nutrient uptake
Vissen
⚠ Negative effects on:
Behaviour
Food intake
Nutrient uptake
Invertebrates (sediment)
⚠ Negative effects on:
Survival rate
Reproduction
Growth
Energy metabolism

Main effect mechanisms in aquatic organisms

- **Food related**, e.g. inhibition of assimilation or decreased nutritional value of food
- Internal or external **physical damage** (e.g. due to sharp edges)
- Other, incl. oxidative stress
- See de Ruijter et al (2020)

MP fibers in the gut of an amphipod

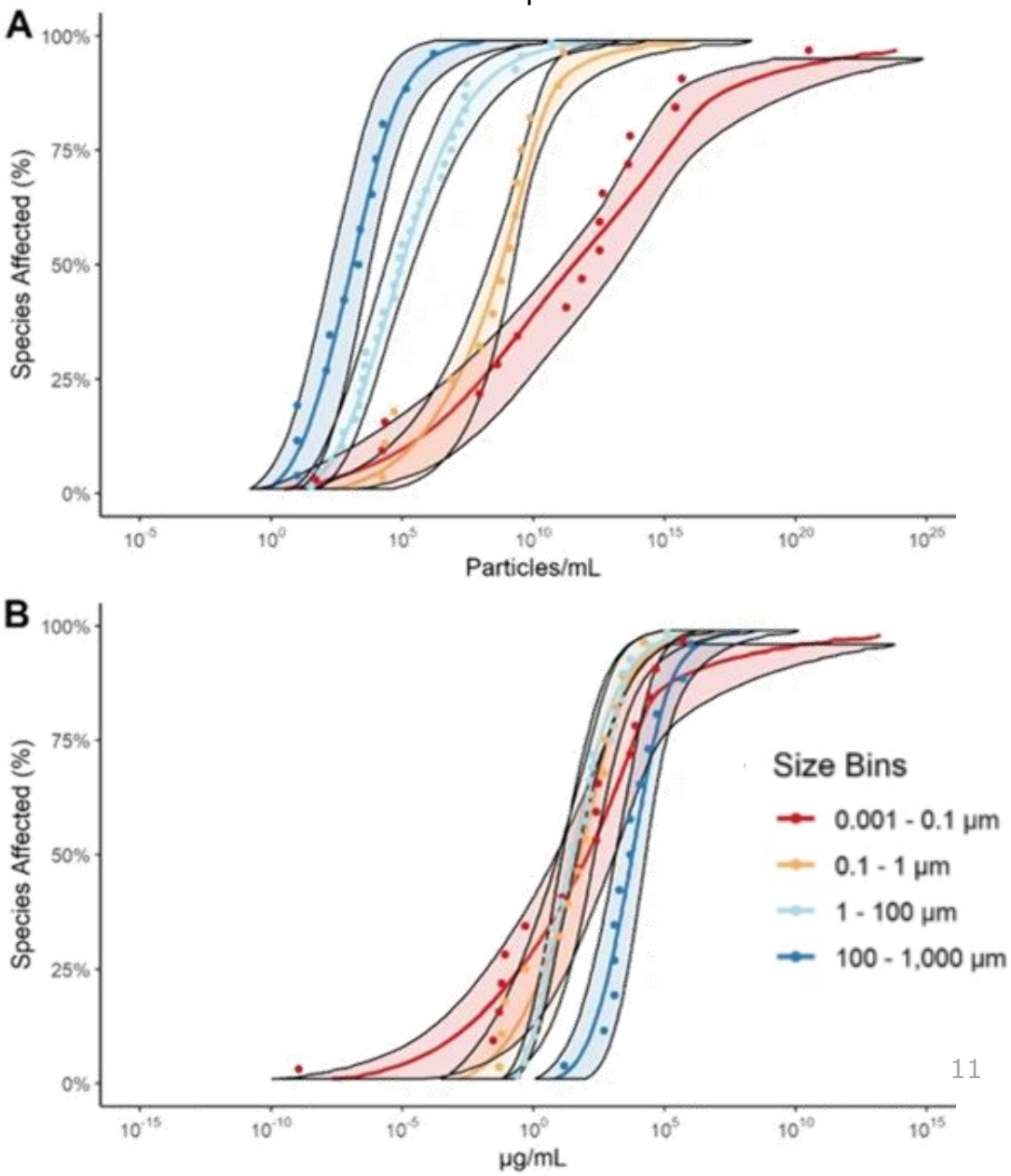


Blarer and Burkhardt-Holm **2016**

What drives the effects?

- Particles, mass or volume?
- Particle properties:
  - *Size*
  - *Shape*
  - *Polymer type*
  - *Biofilm/corona and weathering state*
- Often little and conflicting evidence
  - Little variation in tested plastic types (mostly polystyrene) → uncertainty

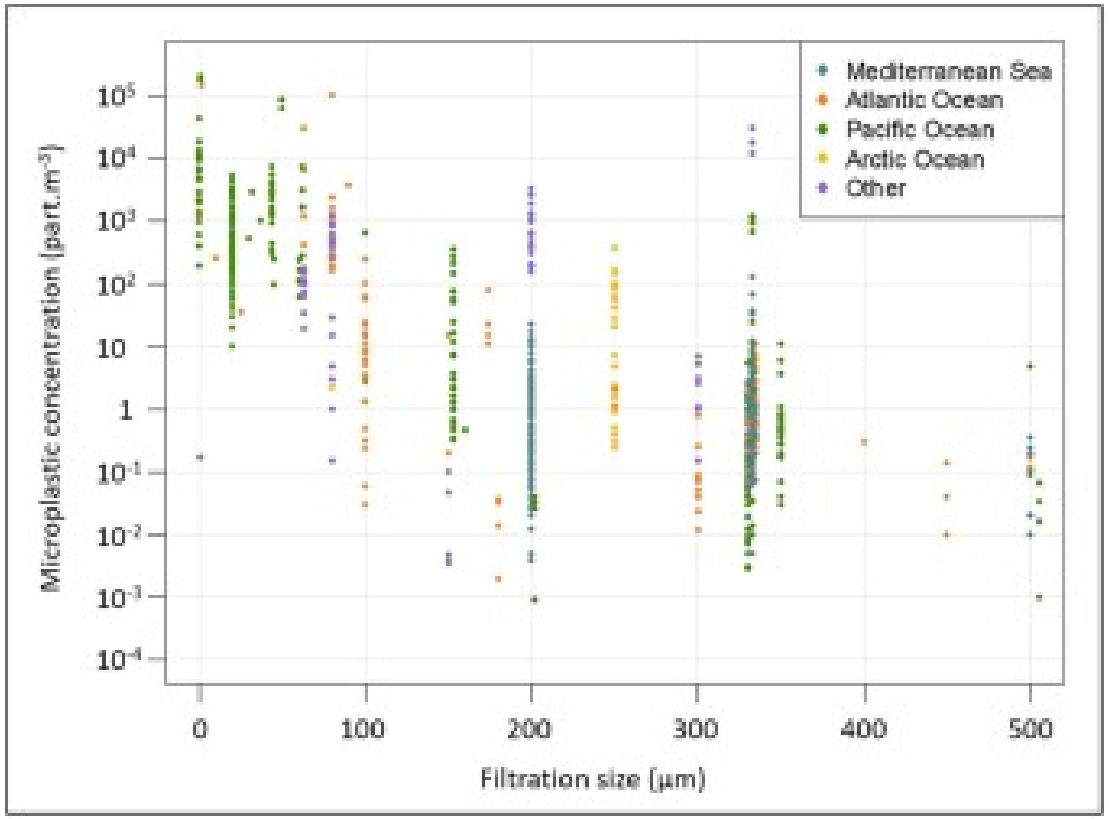
Thornton Hampton et al **2022**



Microplastics are widely present in the environment

- **Freshwater and marine**: mostly between 0.01 – 10 000 particles per m^3 (Adam et al **2018** and **2021**)
- Challenges include:
  - Measuring submicron particles
- Improvement of techniques and smaller filters → higher numbers
- Current estimates may be considered as conservative estimates

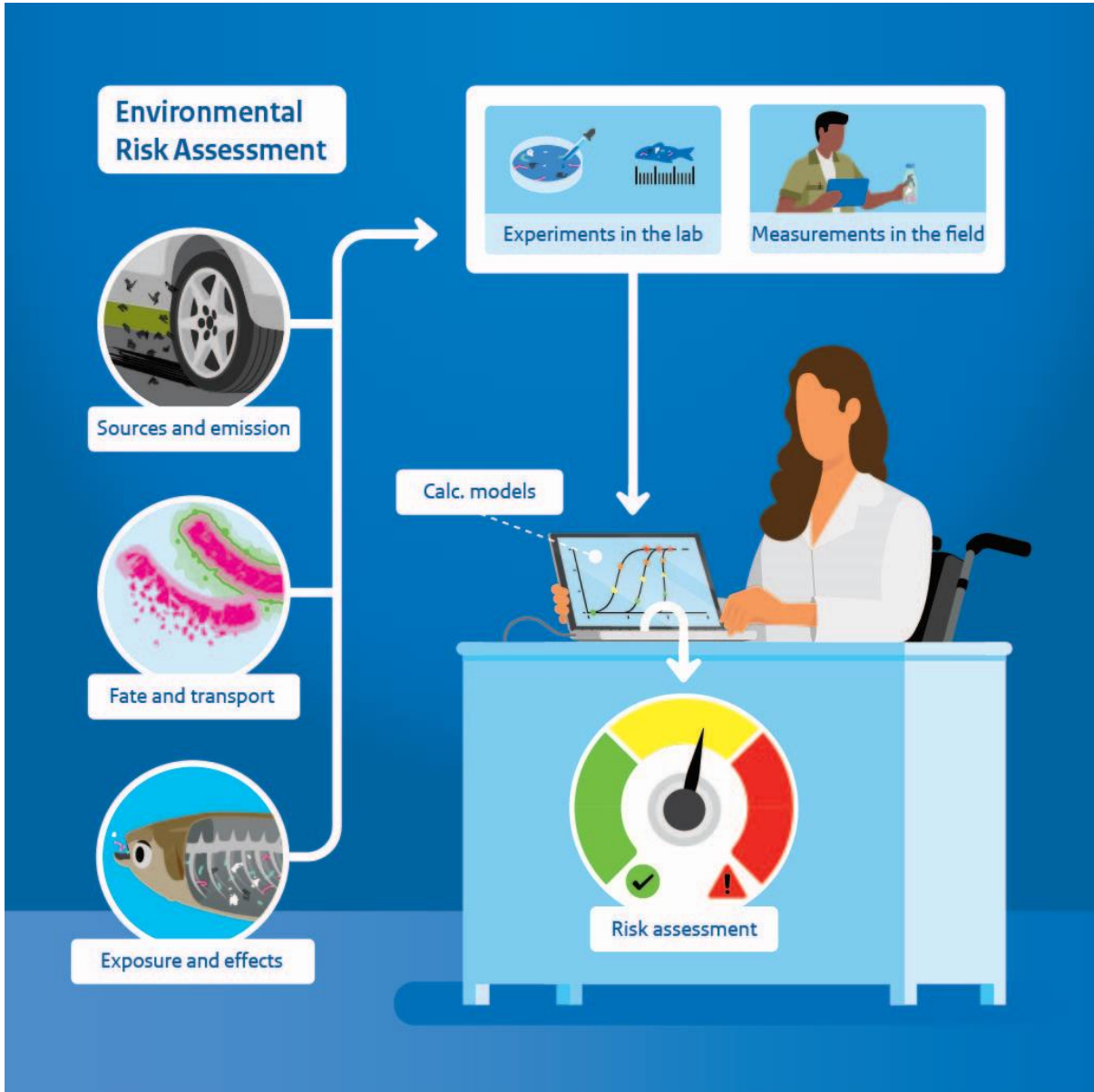
Particle numbers in marine waters, per sampling cut-off



Adam et al **2021**

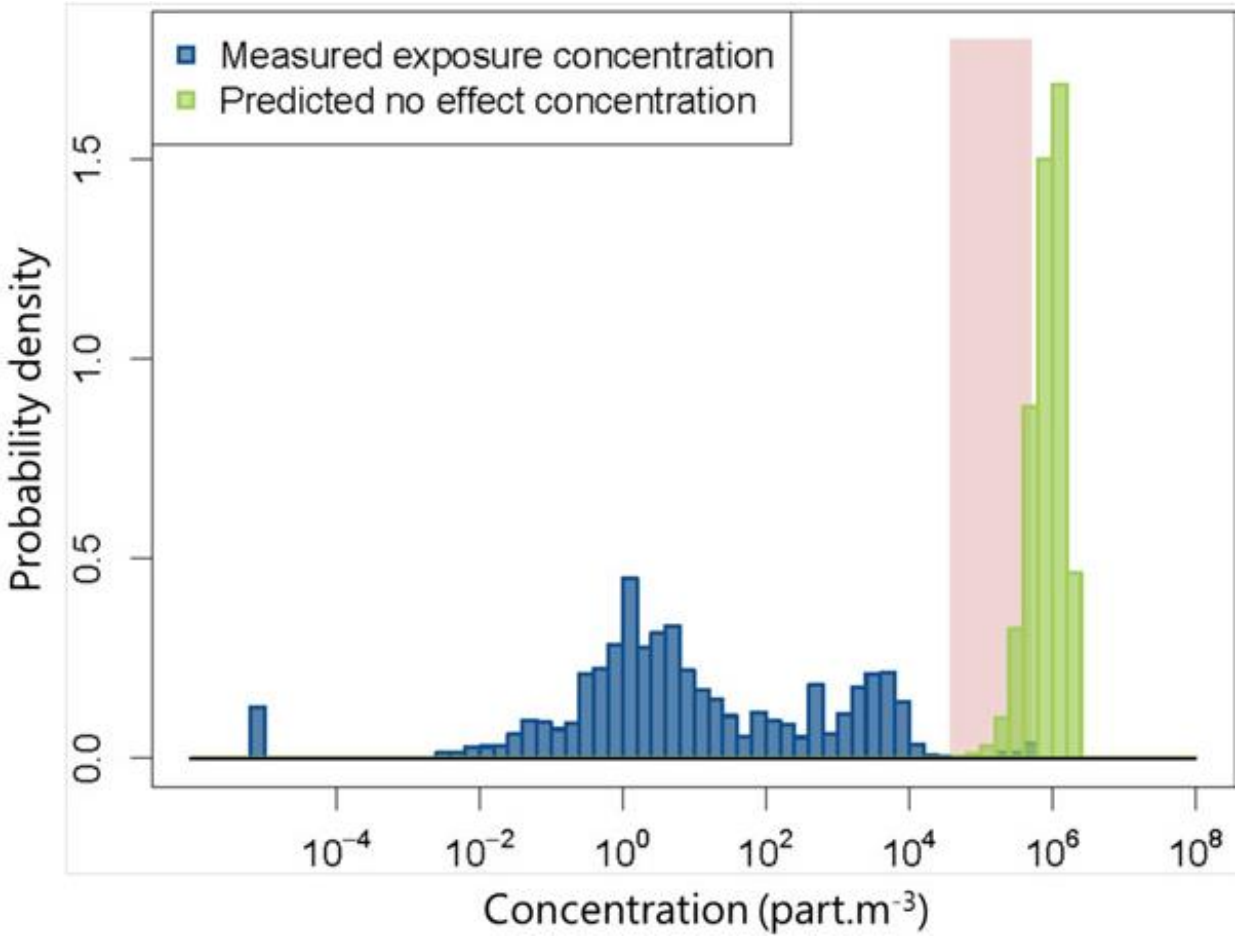
Challenges for the risk assessment

- Dealing with diversity of particles
- **Disconnect** between particles tested and those (that can be) measured in the environment
- Chemical effects (leaching)
- Biological effects (pathogens)
- Quality and relevance of studies
  - Exponential growth of studies
- Long term effects



Comparison exposure and effect concentrations: **the freshwater environment (water phase)**

- Adam et al 2018:
  - "0.12% of the probability distribution calculated for the global RCR* was >1"
  - In Europe RCR < 1
- Quality assessment not included

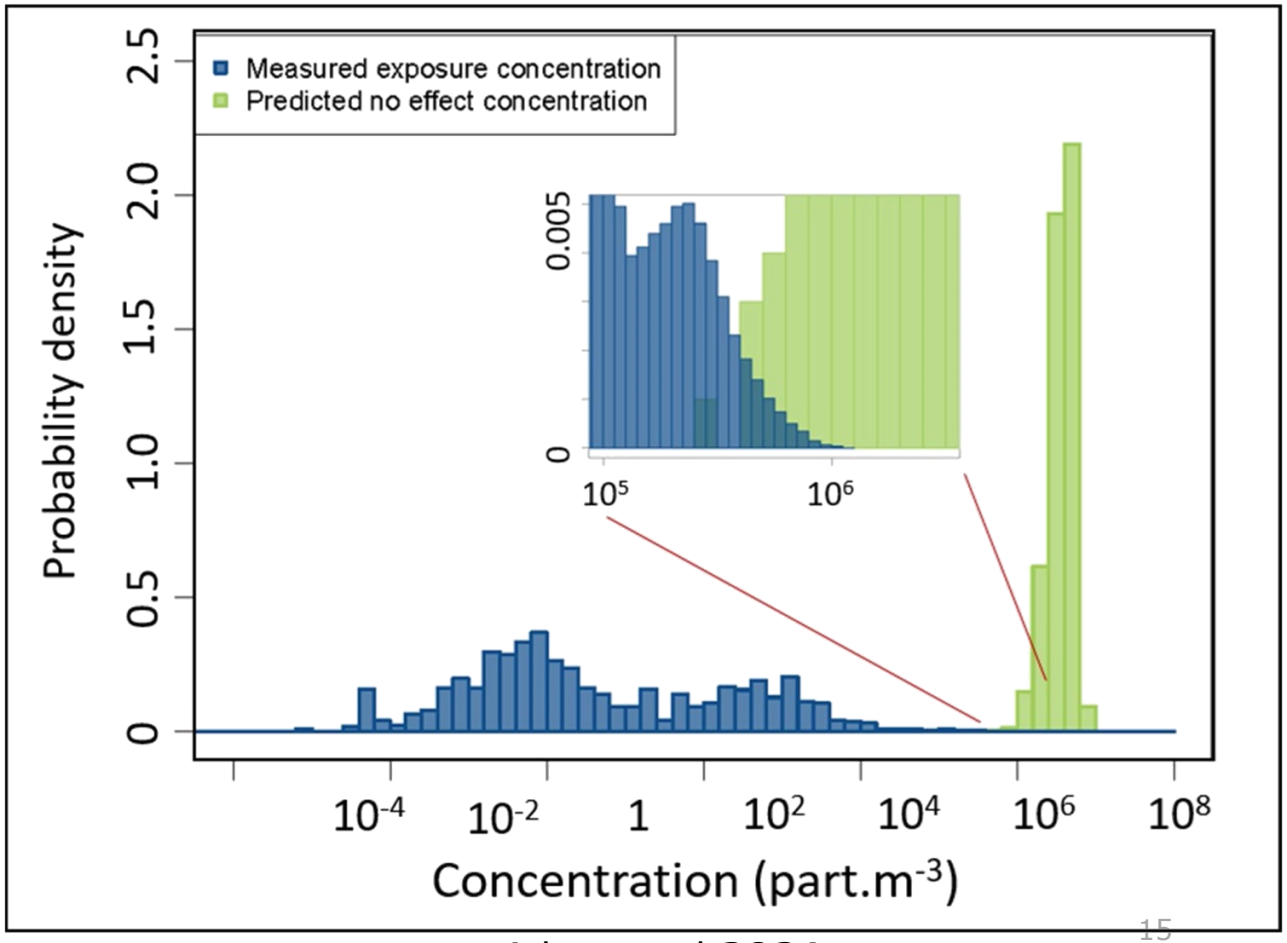


* RCR = risk characterization ratio (the ratio between environmental and effect concentrations)

Comparison exposure and effect concentrations: **the marine environment (water phase)**

- Adam et al 2021:
  - Mean RCR* = 0.004
  - RCR > 1 in 0.0002% of cases
  - “Risks to marine (water phase) environment are unlikely”

* RCR = risk characterization ratio (the ratio between environmental and effect concentrations)

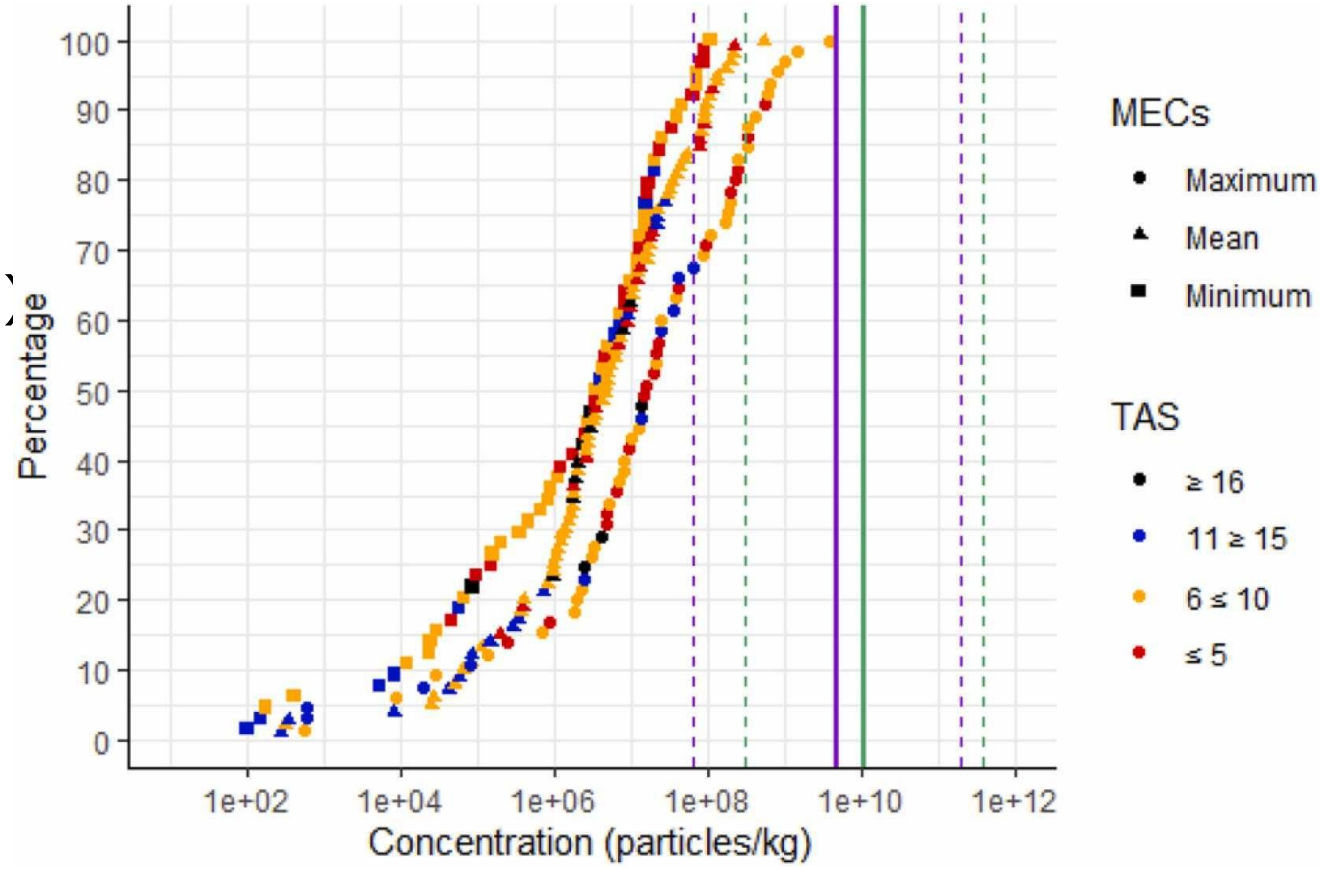


Adam et al **2021**

Comparing exposure and effect concentrations: **the freshwater environment (sediments)**

Redondo-Hasselerharm et al 2023:

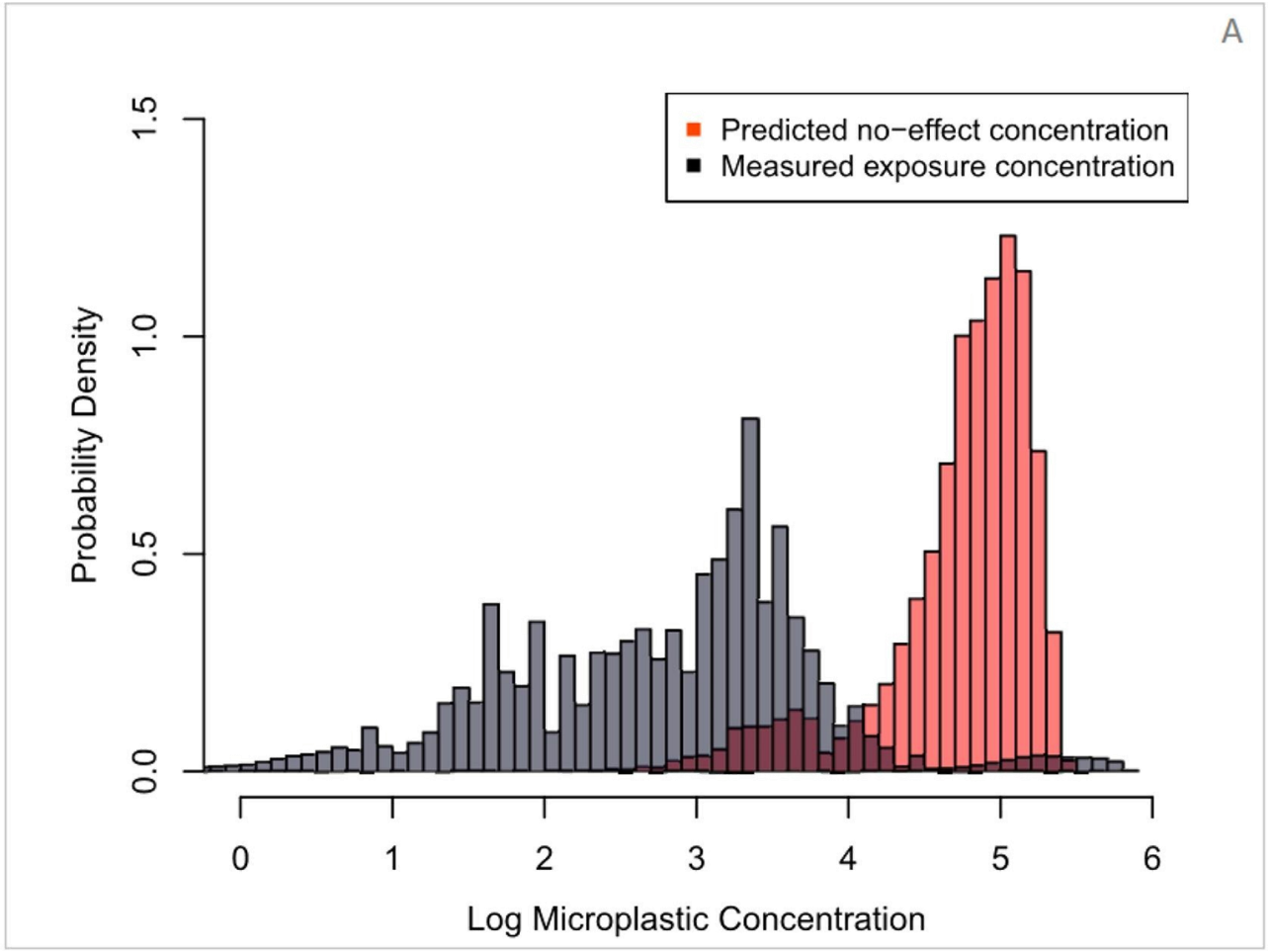
- Environmental concentrations are lower than effect concentrations (HC_5)
- Lower limits of HC_5 overlap with environmental concentrations
- Risks appear currently limited but cannot be fully excluded



Redondo-Hasselerharm et al **2023**

Comparing exposure and effect concentrations: **soils**

- Tunali et al 2023
  - RCR* ≥ 1 in 4.8 % of cases, with industrial and urban sites mostly at risk
- Zantis et al 2023:
  - Effects in plants occur at environmentally relevant concentrations

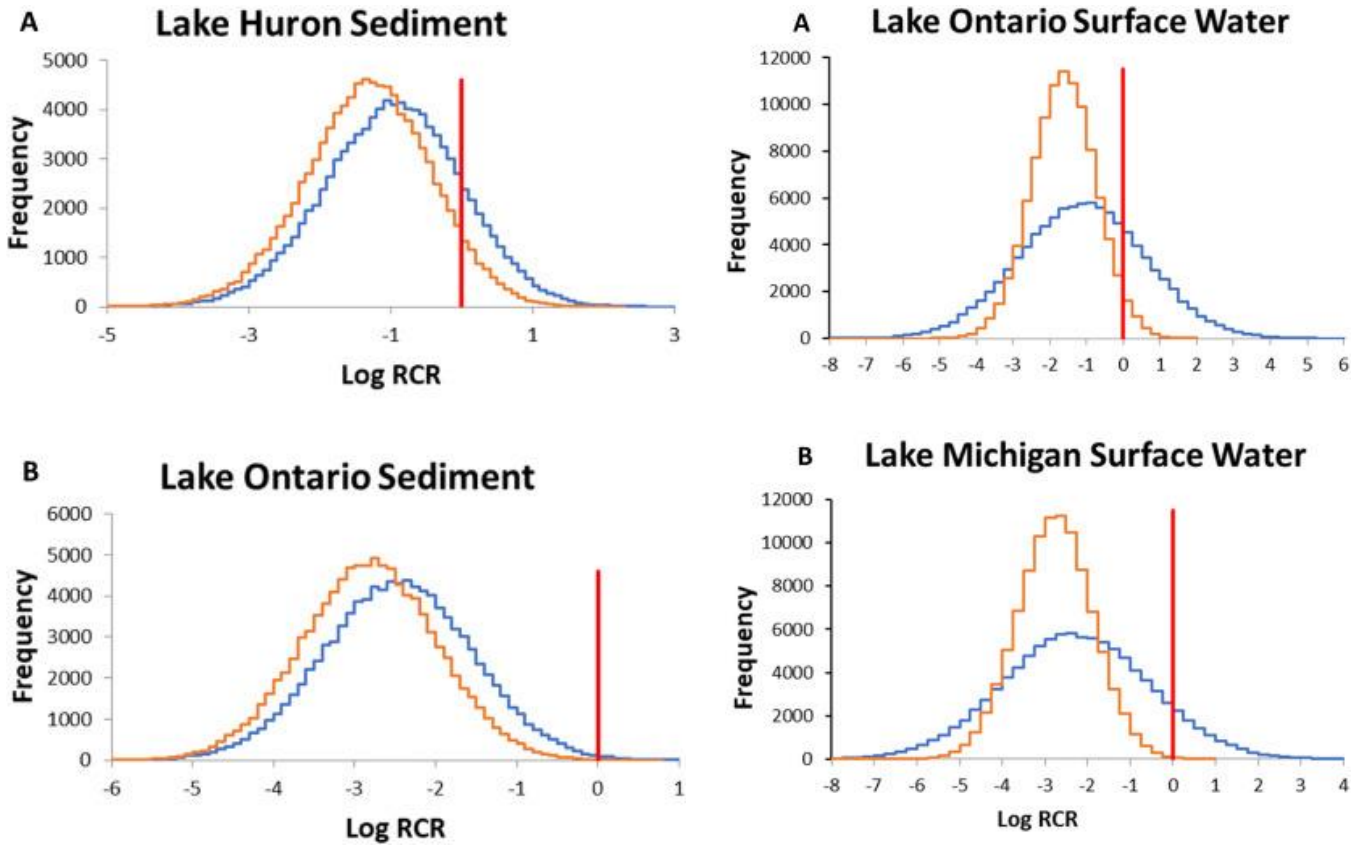


Tunali et al **2023**

* RCR = risk characterization ratio

Locally risk may be different

- **Mean RCR*** in North American Great Lakes are <1 for the sediments and water
- **Uncertainty** in threshold values and **variability** in exposure concentration
- Exposures may exceed effect thresholds in water (10–20%) and sediment (0–20%) in North American Great Lakes

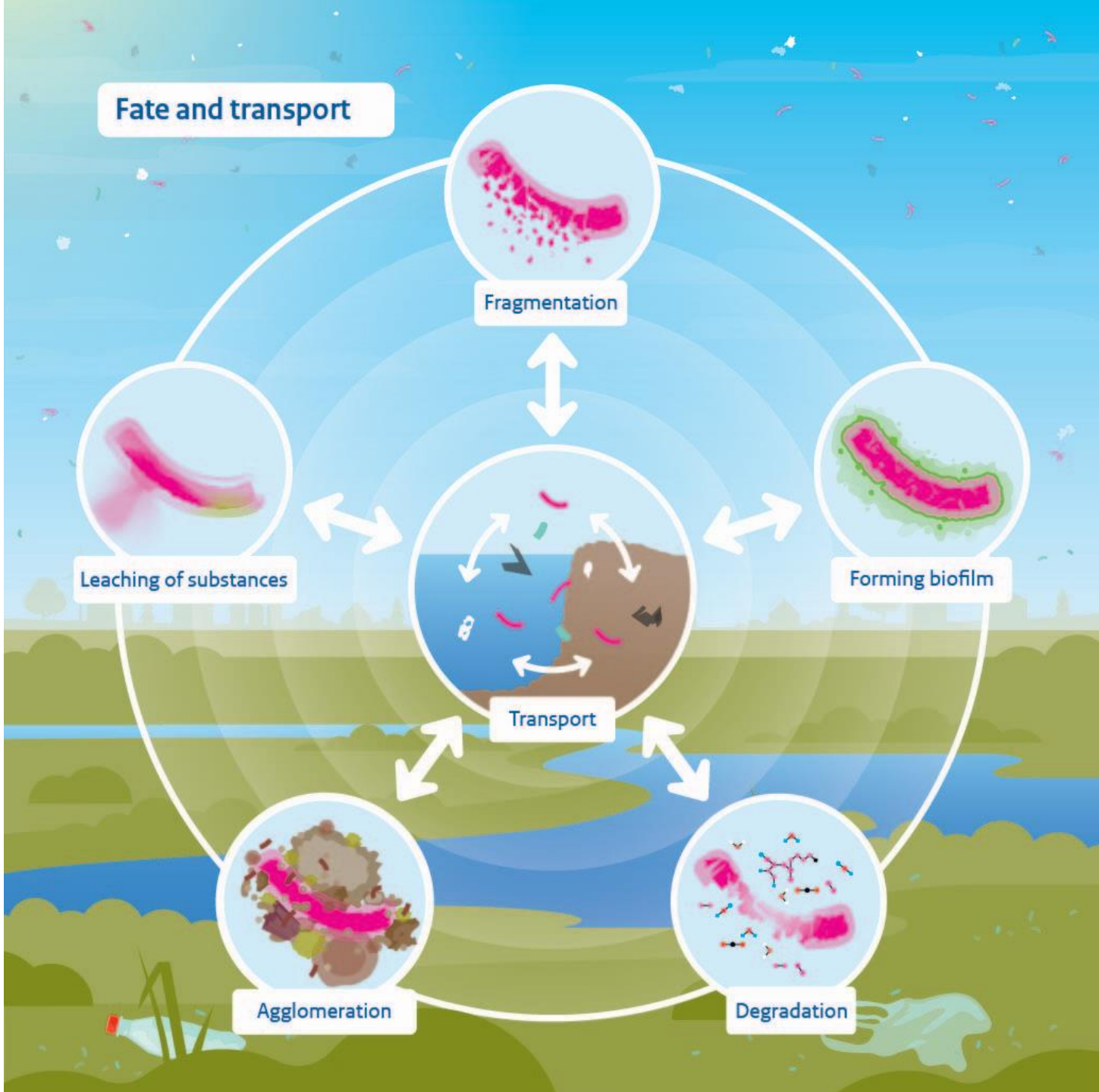


Koelmans et al 2023

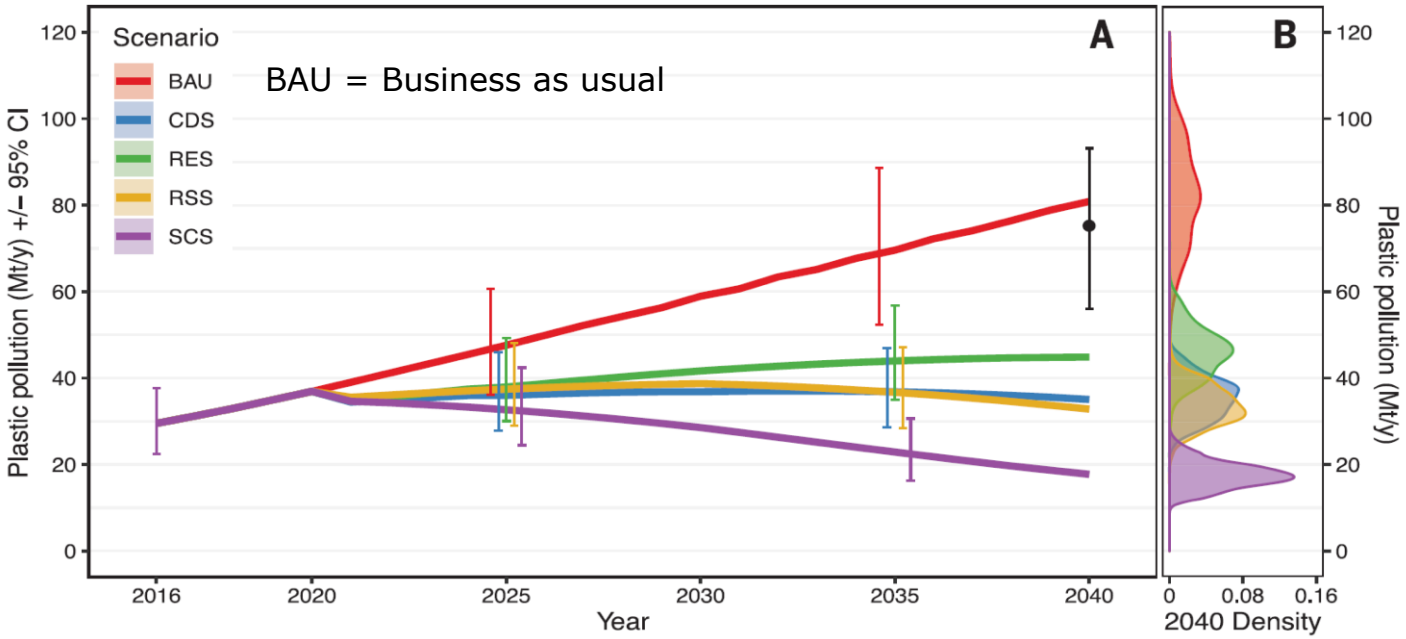
* RCR = risk characterization ratio (the ratio between environmental and effect concentrations)

Consider the system

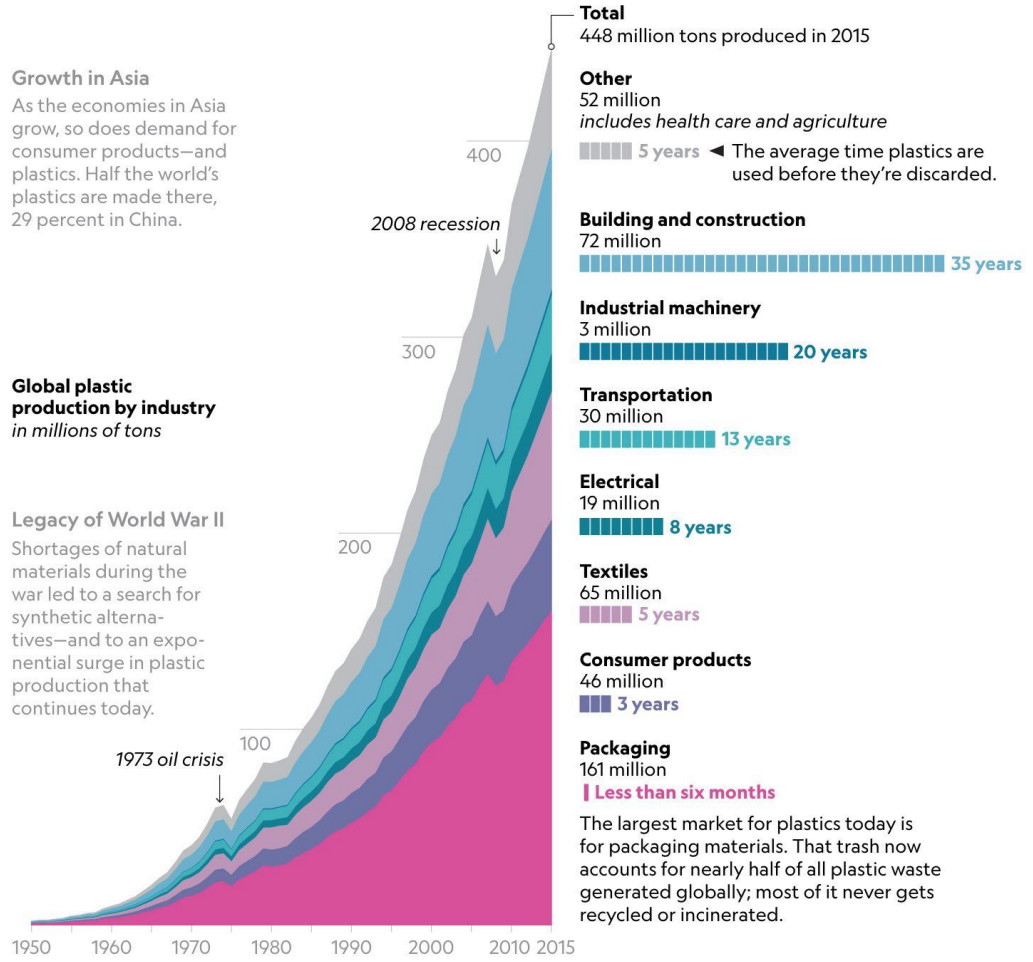
- Environmental compartments are connected → plastics can be transported to other environments
- Soils and sediments may act as a sink
- Human exposure via the environment
- *Knowledge gaps plastic properties and environmental behaviour*



Without policy, plastic use and emissions will increase in the future



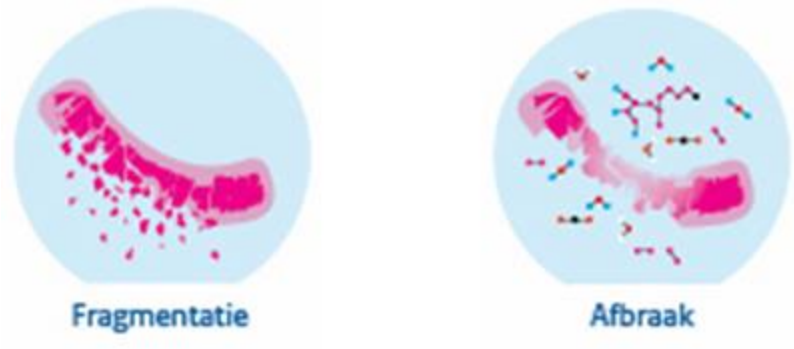
Lau et al **2020**

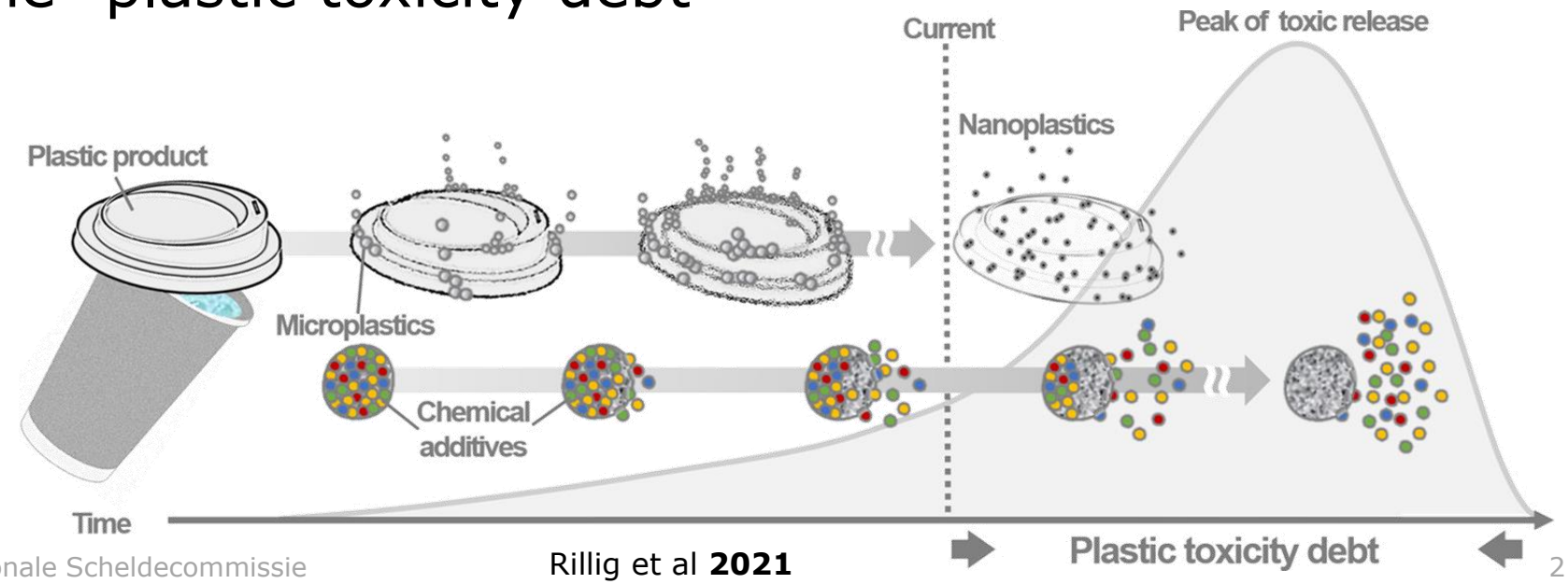


Source image: National Geographic 2018

Plastic fragmentation, slow degradation

- Plastic released to the environment will remain there for long periods
  - Data lacking regarding complete degradation
- Release and effects may be disconnected: the “plastic toxicity debt”





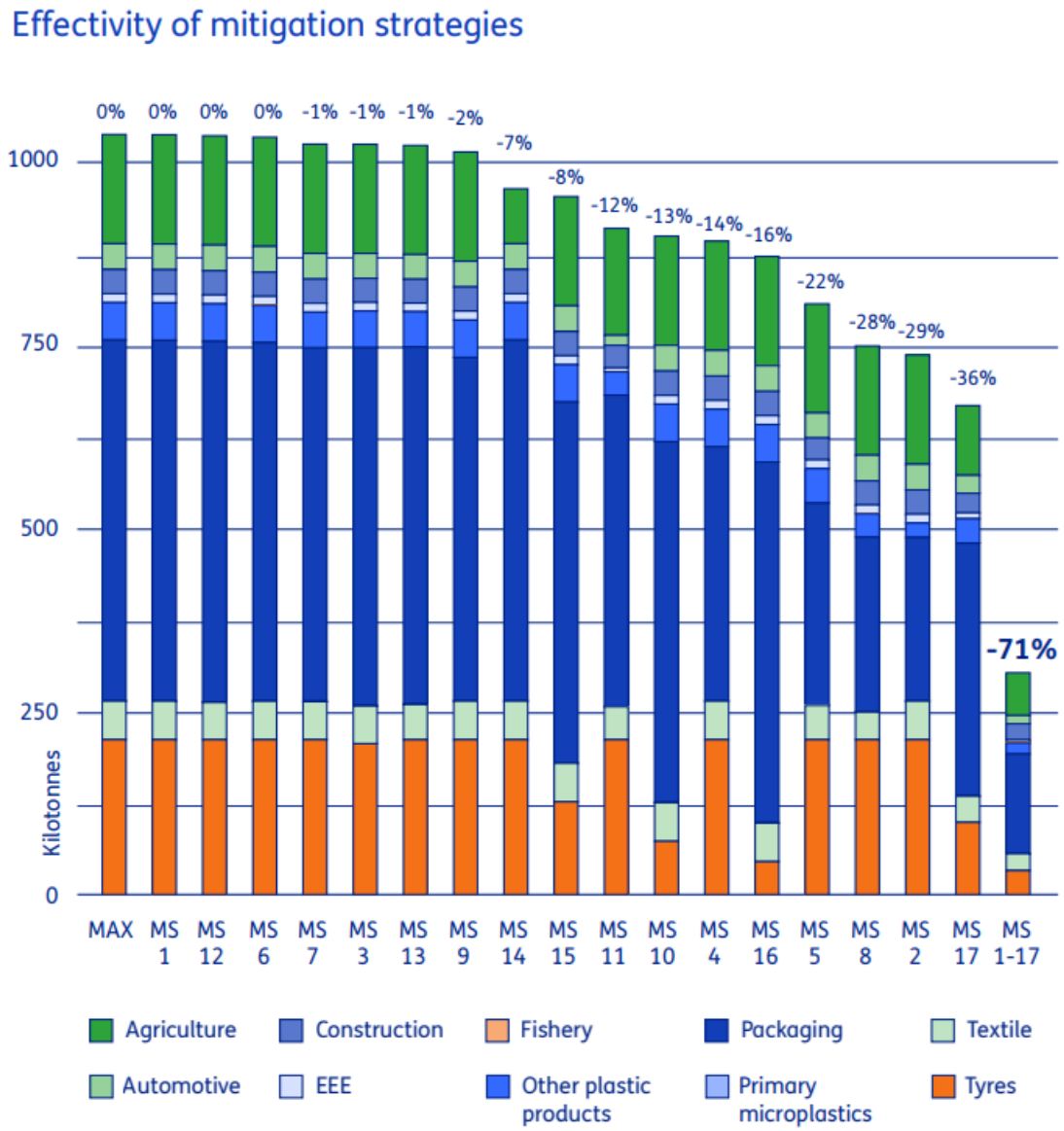
Rillig et al **2021**

Need for action

- Current situation indicates limited (water) to some overlap between estimated environmental concentrations and effect levels
- **More research** needed on knowledge gaps
  - *Kennisagenda Microplastics in milieu* (Quik 2022)
- Plastic pollution is widespread, persistent and will increase in the future
- (In addition to research) **measures** needed to avoid and reduce emissions

Policy options

- Research and mitigation in line with European ‘Zero Pollution Ambition & Action Plan’
- EC measures on plastic pellets
- REACH restriction on intentially added microplastics
- EU measures to reduce emissions from tyres and brakes
- TNO 2022:
  - Reductions are achievable



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  - fragmentation of plastics
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- Irreversible environmental pollution

Thank you

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- Contact: joris.quik@rivm.nl

- RIVM Plastic collaborations, e.g.:
  - Wageningen University & Research
  - Rijkswaterstaat
  - Dutch Research Council (NWO) Microplastics & Health
  - World Health Organisation (WHO)
  - Organisation for Economic cooperation and Development (OEDC)
  - Platform Accelerating the Circular Economy (PACE)
  - MOMENTUM, SUPRASS

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