National Policy Workshop Webinar Series

On

Countermeasures for Riverine and Marine Plastic Litter in India

12 -22 May 2020

Session 4: Assessment of plastic pollution impact on natural capital and riverine and marine ecosystems needing policy intervention

The Lost Plastic and it's Consequences

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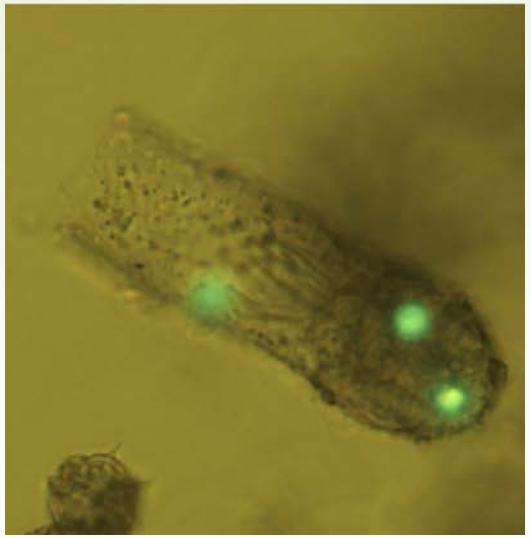

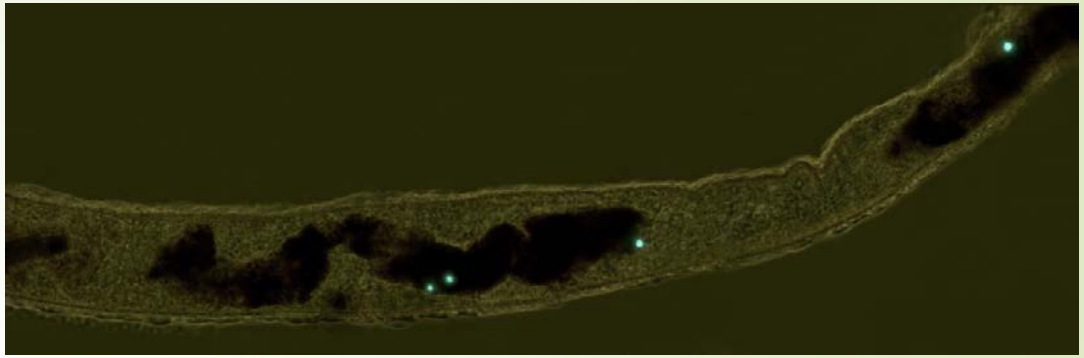

Setälä et al. (2014)

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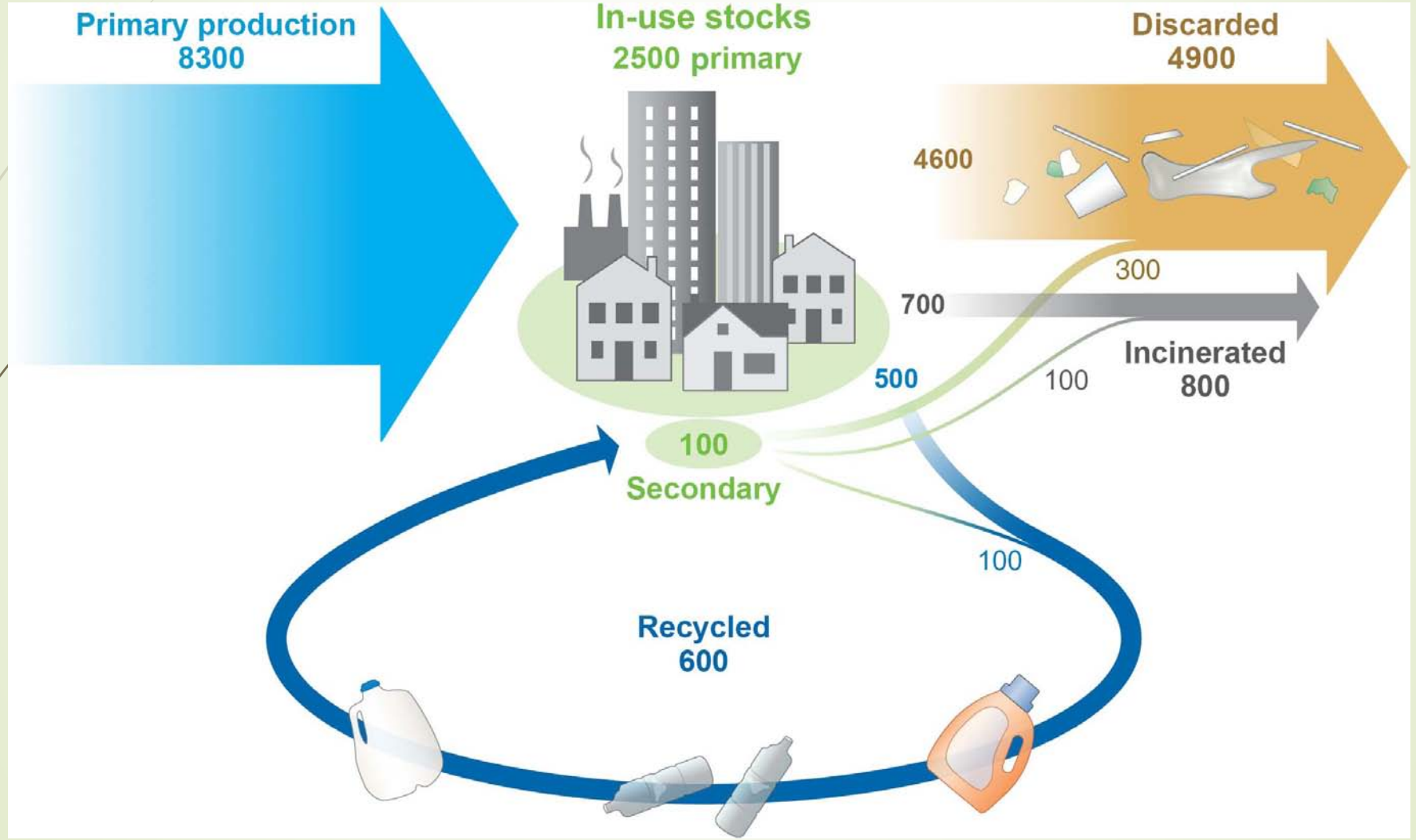
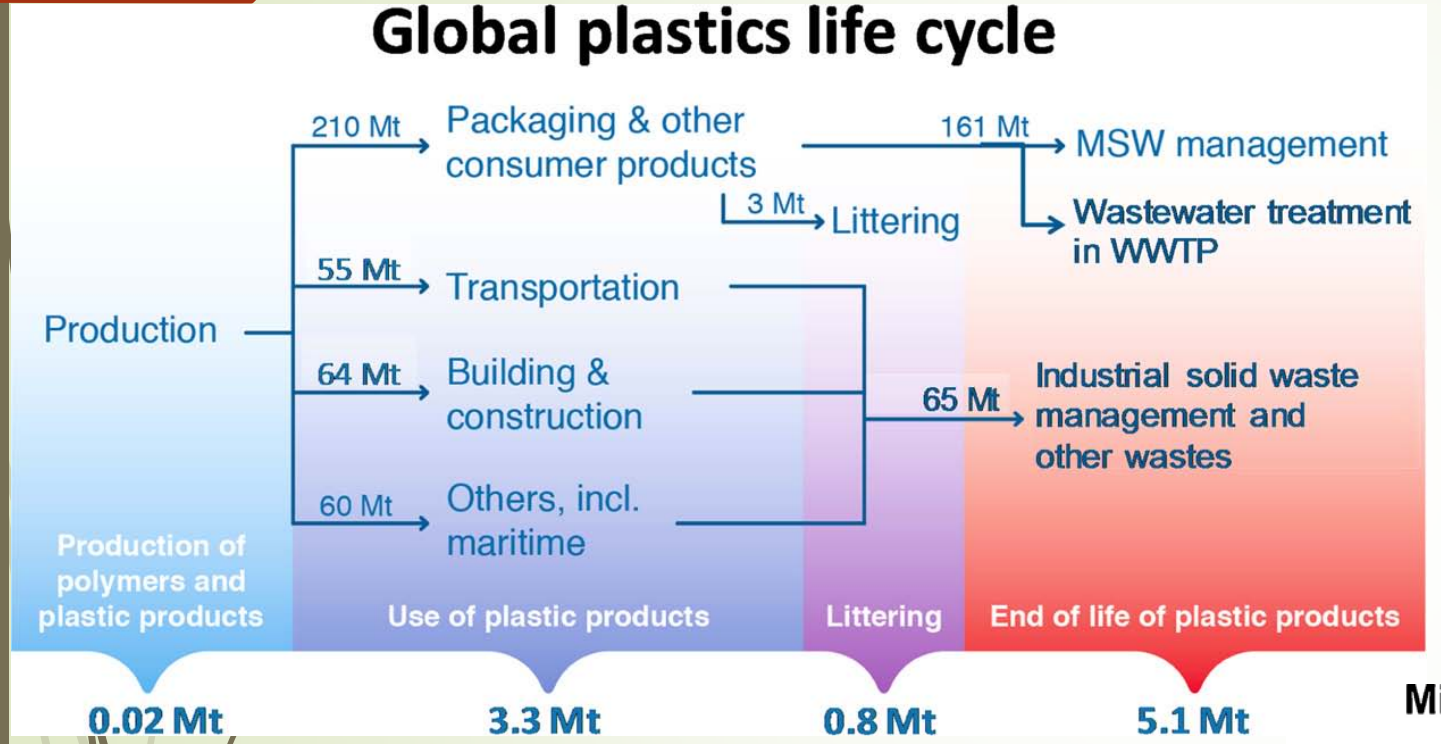
Can we imagine a world without Plastic?

Global production, use, and fate of polymer resins, synthetic fibers, and additives (1950 to 2015; in million metric tons)

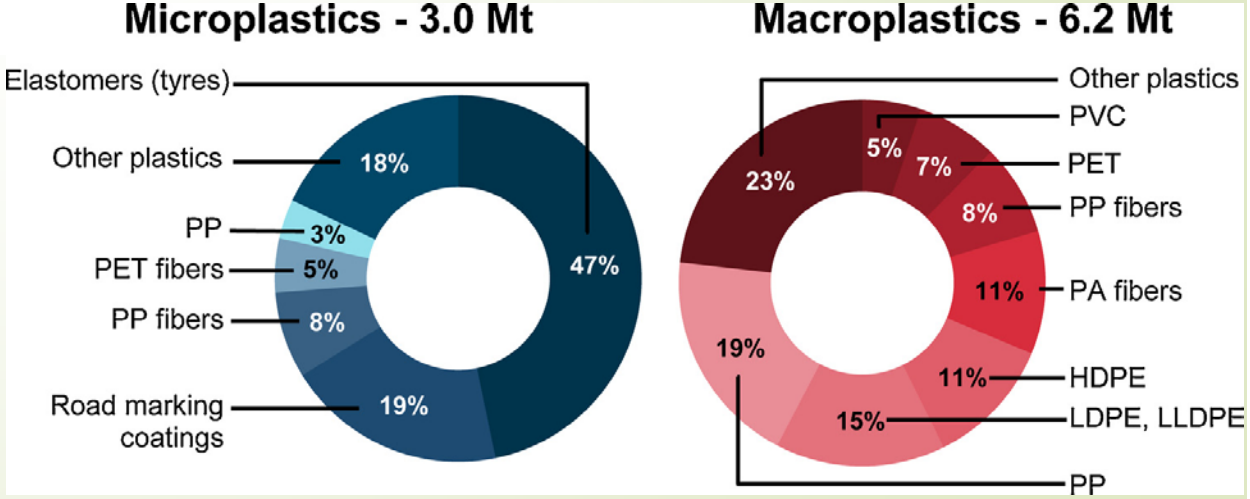


Geyer et al. (2017)

Global plastic value chain and estimated losses to the environment for the year 2015



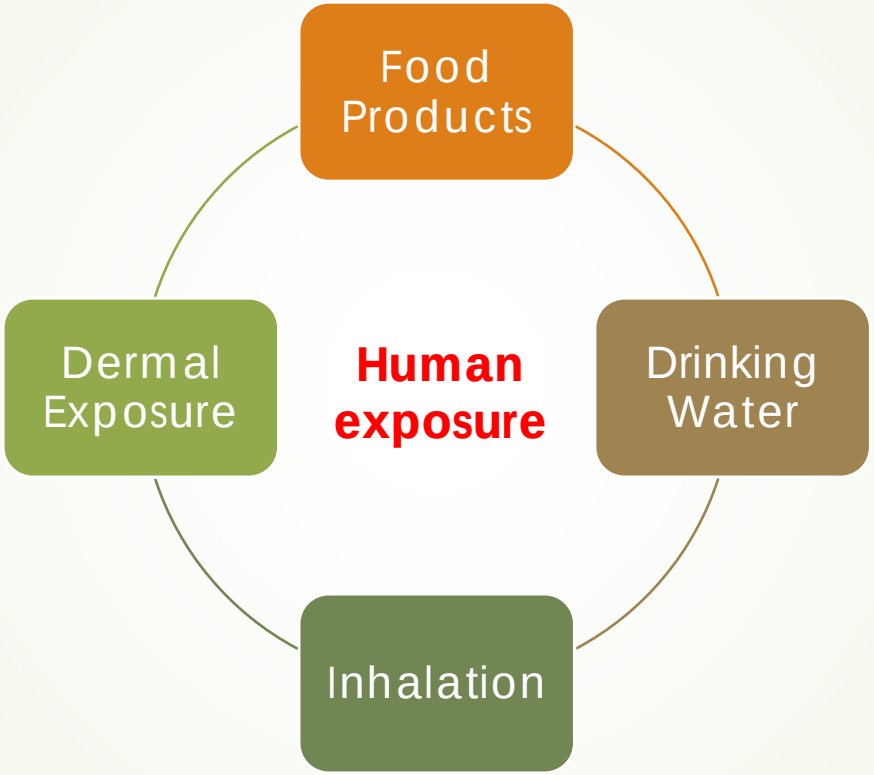
Ryberg et al. (2019)



Should we worry about Microplastic exposure?

- How are we exposed to microplastic?
- What are the direct and indirect evidences for the associated health effects on various organisms?
- Are their evidences for microplastic toxicity on humans?
- What are the governing factors?
- Has the overall risk been characterized?

Human exposure to Microplastic



Microplastic in Food

Food type	Microplastic average content (SD)	Method of analysis	Reference
Shrimp			
Brown shrimp (*Crangon crangon*), Southern North Sea, English Channel, 16 locations	0.75 (0.53)[a] particles/g wet weight (n = 165) Size: 200–1,000 µm	Extraction/digestion with HNO_3/$HClO_4$, detection/counting microscope, confirmation with hot point test Method blanks used	Devriese et al. (2015)
Bivalves			
Mytilus edulis, commercial mussels, from three Belgian supermarkets. Wild mussels, from Belgian groynes (three locations) and quaysides (three locations)	0.37 (0.22)[a] particles/g wet weight (n = 9) Size: 200–1,500 µm	Extraction/digestion with HNO_3/$HClO_4$, detection/counting microscope, confirmation with hot point test Method blanks used	De Witte et al. (2014)
Commercial bivalves: *Mytilus edulis*, from one location (mussel farm), *Crassostrea gigas*, from one location (supermarket)	*M. edulis*: 0.36 (0.07) particles/g wet weight (n = 72) *C. gigas*: 0.47 (0.16) particles/g wet weight (n = 21) Size: 5–25 µm (55–100%), > 25 µm (0–45%)	Extraction/digestion with HNO_3, detection/counting microscope, confirmation (subset) with Raman Method blanks used	Van Cauwenberghe and Janssen (2014)
Commercial bivalves (9 species), from a fish market in China	Median 4.0, range 2.1–10.5 particles/g (n = 9) Size: 5–250 µm (60%), 5–5,000 µm (40%)	Extraction/digestion with H_2O_2, floatation with NaCl, filtered over 5 µm, detection/counting microscope, confirmation (subset) with µ-FT-IR Method blanks used	Li et al. (2015)
Oysters (*Crassostrea gigas*) commercial, from fish markets in California (USA)	1.8 (1.72)[a] particles/oyster (n = 4) Size (mainly fibres): average 5,500 (SD 5,800) µm	Extraction/digestion with KOH, microscope (detection limit: > 500 µm) Method blanks used	Rochman et al. (2015)
Mytilus edulis, French-Belgian-Dutch coastline, six locations	0.2 ± 0.3 particles/g (size range 20–90 µm) Size: 20–90 µm	Extraction/digestion with HNO_3, detection/counting microscope, confirmation (subset) with Raman Method blanks not indicated	Van Cauwenberghe et al. (2015)

Food type	Microplastic average content (SD)	Method of analysis	Reference
Table salt			
15 Chinese brands, from local supermarkets	Sea salts: 0.550–0.681 particles/g (n = 5) Lake salts: 0.043–0.364 particles/g n = 5) Rock/well salts: 0.007–0.204 particles/g (n = 5) Size, (all salts): 45–4,300 µm	Dissolved in water, digestion with 30% H_2O_2, filtered (5 µm), detection counting microscope, confirmation with µ-FT-IR Method blanks not indicated	Yang et al. (2015)

EFSA CONTAM Panel (2016)

Microplastic in Air

Food Type	Study	Country	Item	MPs per g/L/m³	n	Blank included
Air	Dris et al. 2017	France	Apartment Air	1.64	24	No
	Dris et al. 2017	France	Office Air	4.80	12	No
	Dris et al. 2017	France	Outdoor Air	0.30	12	No
	Kaya et al. 2018	Turkey	Campus Air	14.27	NA	Yes
	Kaya et al. 2018	Turkey	Bus Terminal	23.95	NA	Yes

Cox et al. (2019)

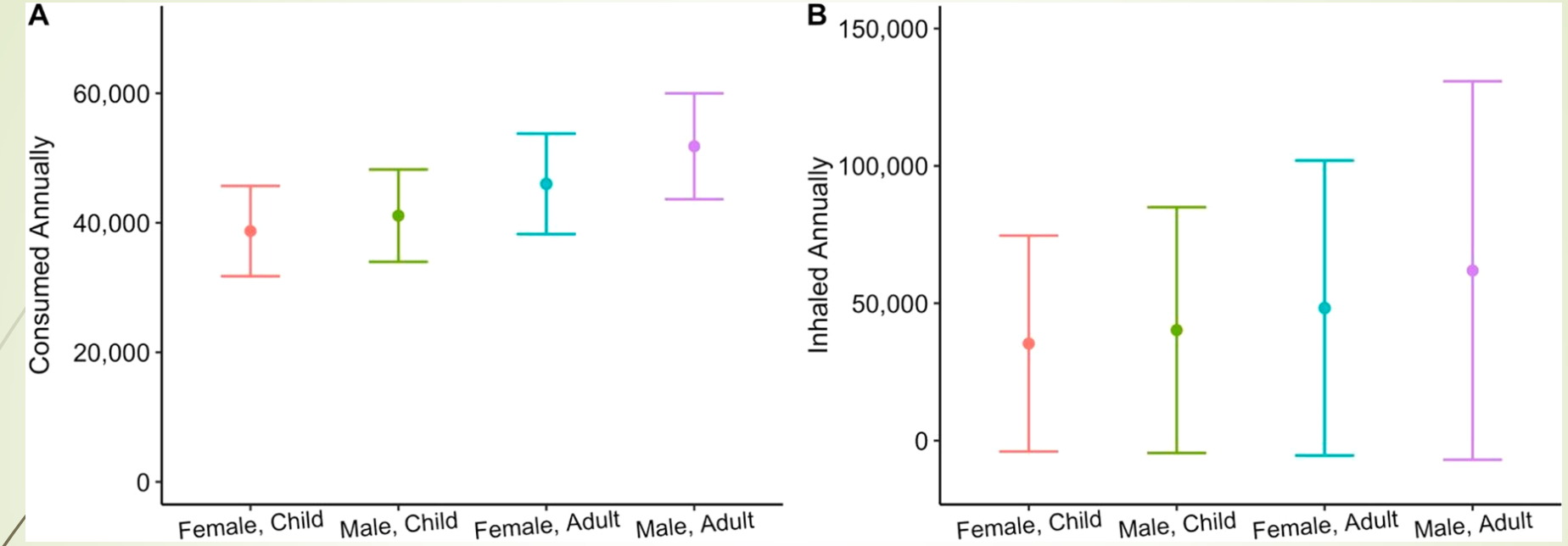
Microplastic in Drinking Water

Table 2.3 Summary of reported microplastic or microplastic-like particle numbers[a] and particle characteristics from drinking-water studies

Author	Water type	Lower size bound (µm)	Particles/L in sample (average)	Particles/L in blanks (average)	Particle size (µm)	Predominant particle shape	Predominant polymer type	Quality score (TAS)[b,c]	Author
Oßmann et al. (2018)	Bottled (mineral water) • Glass • Single use PET • Reusable PET	1	 3074–6292 2649 4889	384	Most particles smaller than 5 (>75% in glass and >95% in plastic bottles)	No discussion of shapes	PET in plastic bottles, PE, and styrene butadiene copolymer in glass	13	Oßmann et al. (2018)
Pivokonsky et al. (2018)	DWTP from surface water sources (3 sites)	1	628 338 369	< 5% of counts in samples	Most particles were in 1–10 range (up to 95%)	Fragments closely followed by fibres	PET but also PP, PE, polyacrylamide	11	Pivokonsky et al. (2018)
Schymanski et al. (2018)	Bottled • Single use • Returnable • Glass • Beverage carton	5–20	 14 118 50 11	14 ± 13	40–50% in 5–10 range; over 80% <20	No discussion on shape; described as fragments	PET but also PP, PE	14	Schymanski et al. (2018)
Mason, Welch and Neratko (2018)	Bottled	6.5–100 lower bound based on microscope and software	315	23.5	Not specified		No characterization	14	Mason, Welch and Neratko (2018)
Strand et al. (2018)	Tap from ground-water sources	10–100	0.2, 0.8 and 0.0 (LoD = 0.3)[d]	Unknown	Mainly 20–100	Fragments	PET, PP, PS, acrylonitrile butadiene styrene, PUR	14	Strand et al. (2018)
Mintenig et al. (2019)	Tap from ground-water sources	20	0.0007	0.67 particles/L 0.3 fibres/L	In the range 50–150	Fragments	Polyester, PVC, PE, PA, epoxy resin	15	Mintenig et al. (2019)
Uhl, Eftekhardadkhah, and Svendsen (2018)	Tap form 24 sources	60	Average not reported since only a single result above LoQ (that result was 5.5)	0.5 (LoQ = 4.1 LoD[d] = 0.9)	Not specified	Not specified	No characterization	9	Uhl, Eftekhardadkhah, and Svendsen (2018)
Mason, Welch and Neratko (2018)	Bottled	>100	10.4	4.15	Not specified	Fragments (66%), fibres (13%), films (12%)	PP (54%)	14	Mason, Welch and Neratko (2018)
Strand et al. (2018)	Tap from ground-water sources	>100 (10 µm sieve size)	0.312 (LoD = 0.58)	0.26	Not specified	Fibres (82%), fragments (14%), films (4%)	PET, PP, PS	14	Strand et al. (2018)
Kosuth, Mason and Wattenberg (2018)	Tap from unspecified sources	100 lowest reported	5.45	0.33 (based on 5 particles in 30 blanks (ea. 500 mL)	Fibre lengths 100–5000	Mainly fibres (98.3%)	No characterization	8	Kosuth, Mason and Wattenberg (2018)

WHO (2019)

Human exposure to Microplastic



Cox et al. (2019)

In 'first study of its kind', researchers detect microplastics in human waste

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Anmar Frangoul

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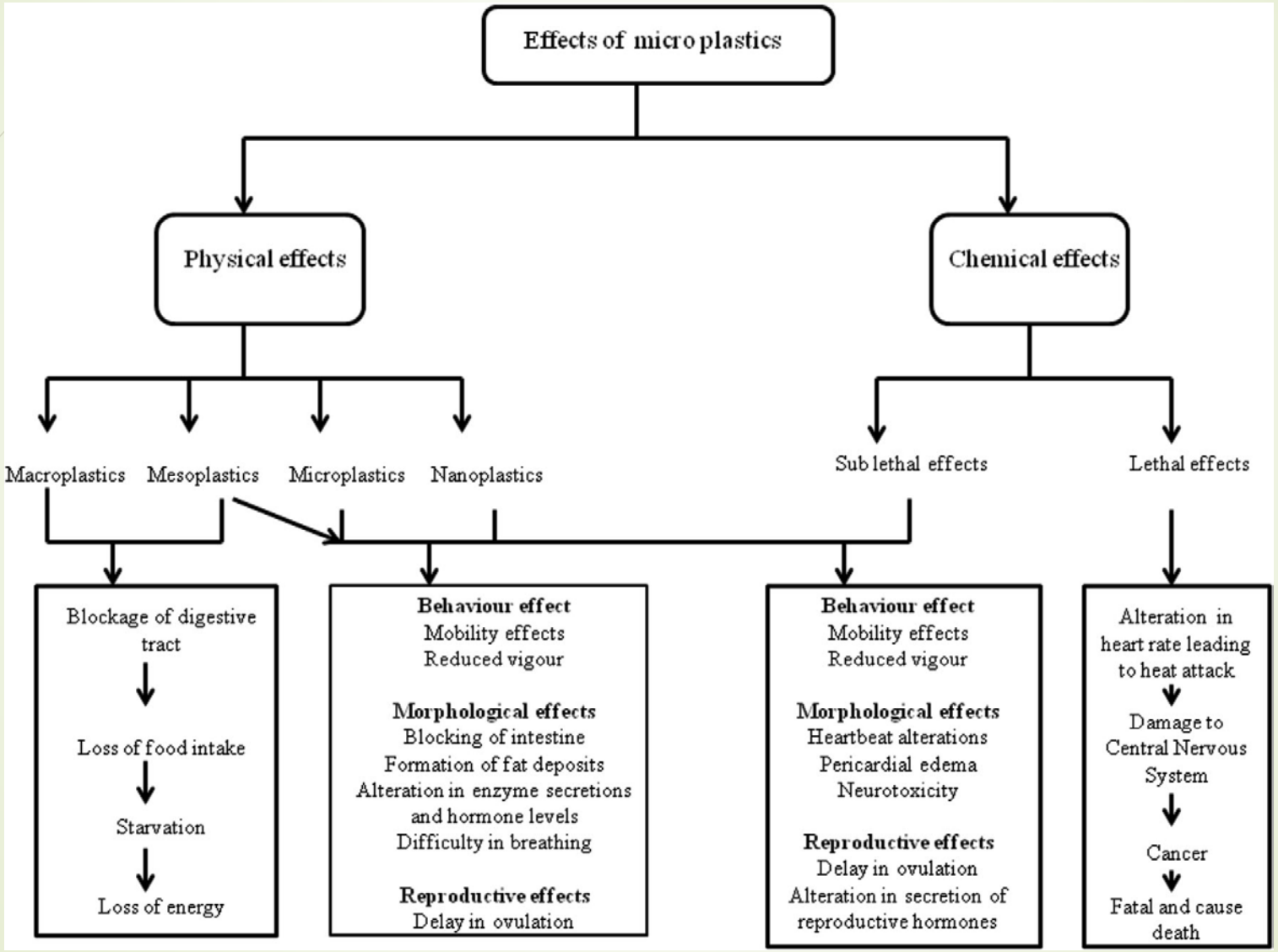
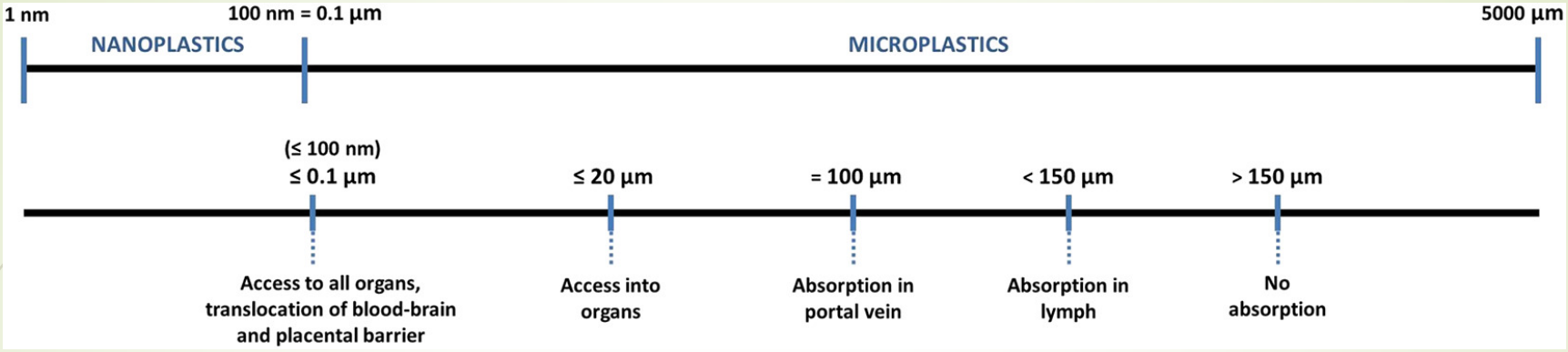
Evidences for health effects of Microplastic

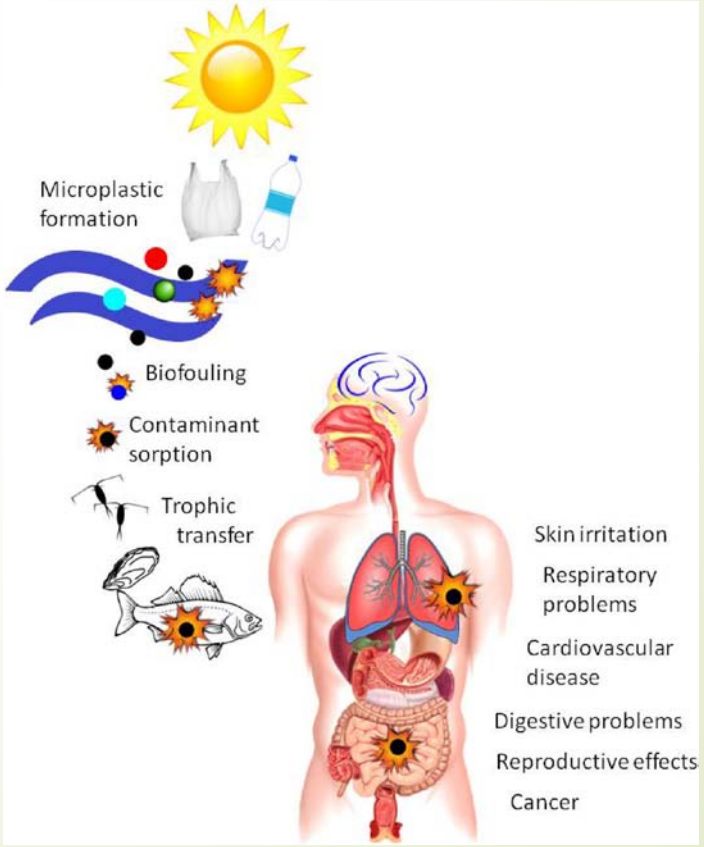


Sharma and Chatterjee (2017)

Effects on Humans



Barboza et al. (2018)



Carbery et al. (2018)

Effects on Humans: In Vitro Evidence

Schirinzi et al. (2017)

Table 2
EC_{50} values for the exposure of polyethylene and polystyrene to cerebral (T98G) and epithelial (HeLa) human cells for 24 h, as determined by HCA assay.

Compounds	EC_{50} (mg/L) (95% confidence intervals)	
	T98G	HeLa
Polyethylene	41.22 (12.8–133)	40.96 (17.8–178.8)
Polystyrene	9.617 (3.9–23.8)	13.56 (2–96)

Summary

- Enough evidence is available on the presence of microplastics in different environmental matrices.
- Sufficient data is available to suggest human exposure and ingestion of microplastics.
- Direct evidences are available for their health effects on different organisms. Potential mechanisms are also proposed.
- Direct evidence of health effects on humans is still not available, although many pathways are proposed.
- In Vitro studies do suggest cytotoxicity to humans.

Suggestions, Recommendations, and Discussion

- We need to minimize the loss of plastic and thus its environmental burden.
- More in-depth understanding is needed for the fate of the lost plastic and the associated consequences on economics, ecology, and human health.
- A more comprehensive human exposure assessment is needed.
- There is a need to establish health related hazards due to plastic/microplastic on human health with rigorous studies.
- More studies are required to perform a comprehensive risk assessment for better management of the associated concerns.

Thank You!

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