Microplastics in the aquatic environment:

How bad are they compared to the rest of the environmental impacts of a product over its life cycle?

Dr. Elena Corella-Puertas

54th webinar of the Hebd'Eau series, June 9, 2022

CIRAIG™
International Reference Centre for the Life Cycle of Products, Processes and Services

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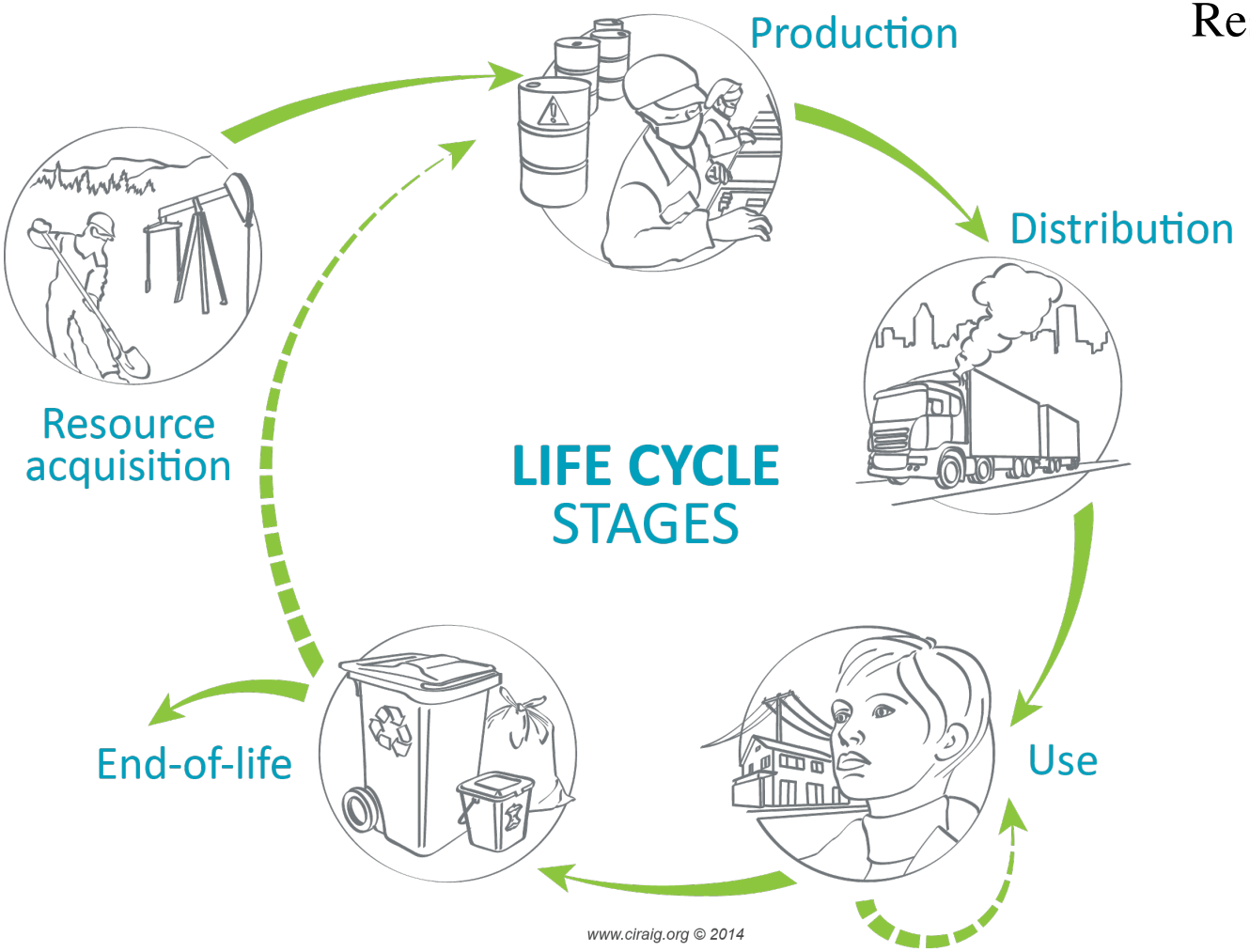
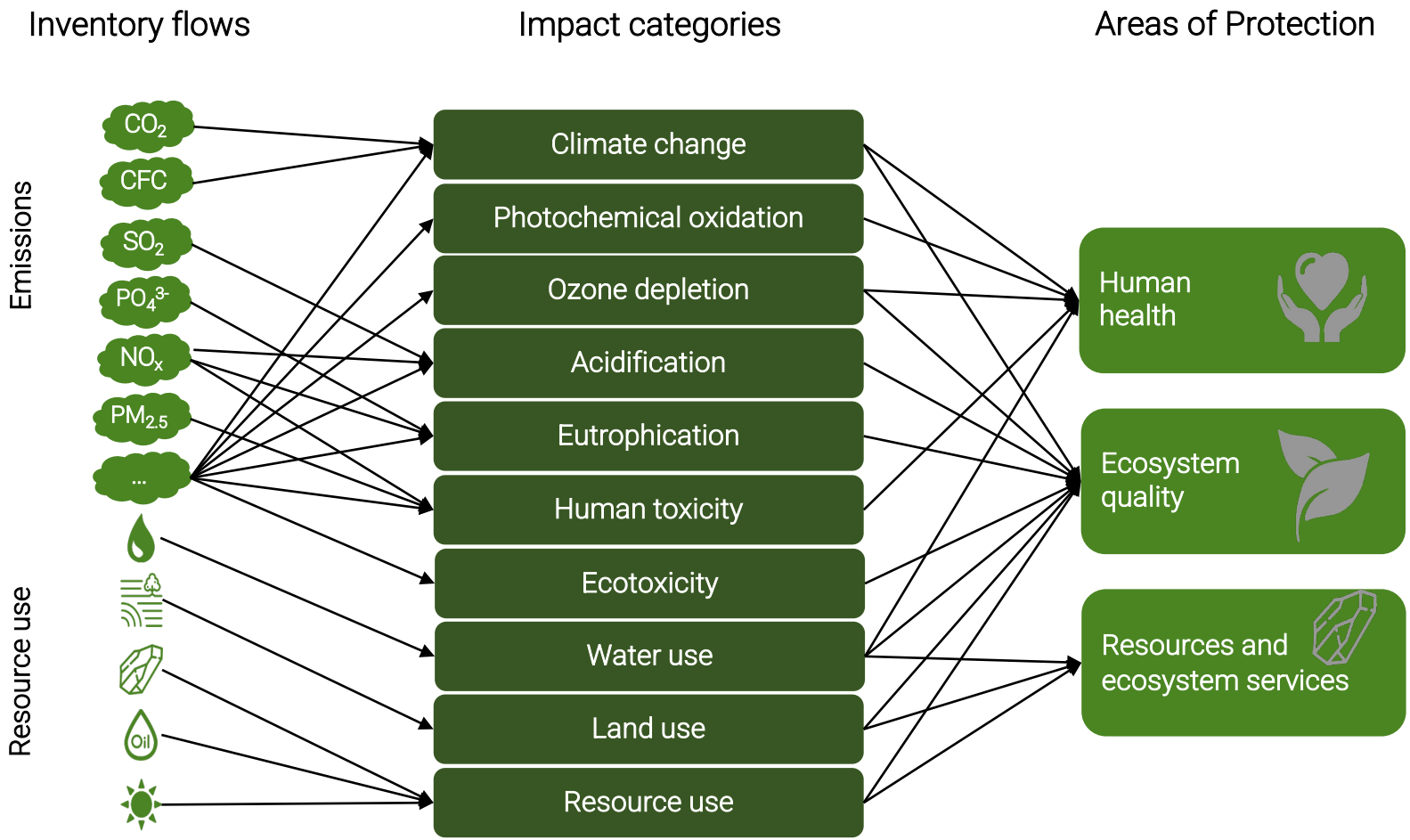
Stages in life cycle assessment (LCA)

Emissions

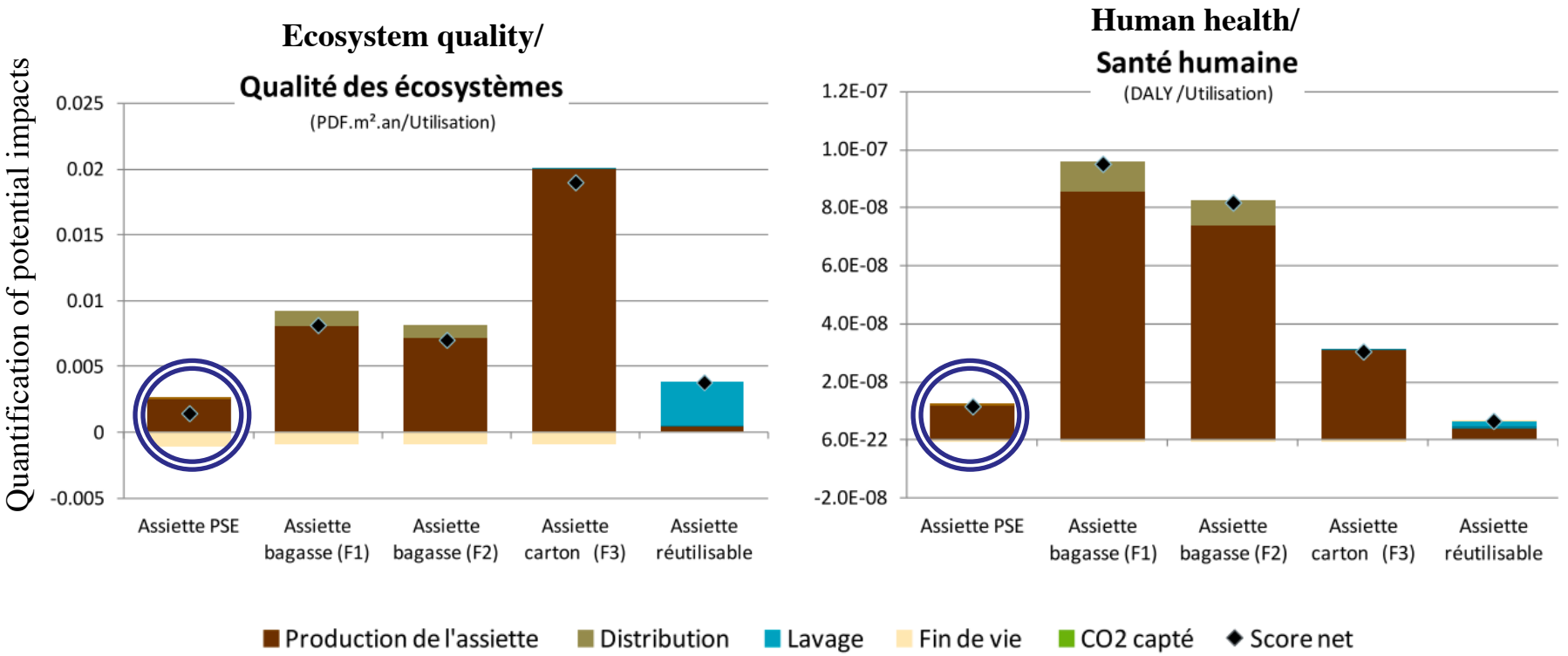
Resources



Life cycle assessment framework

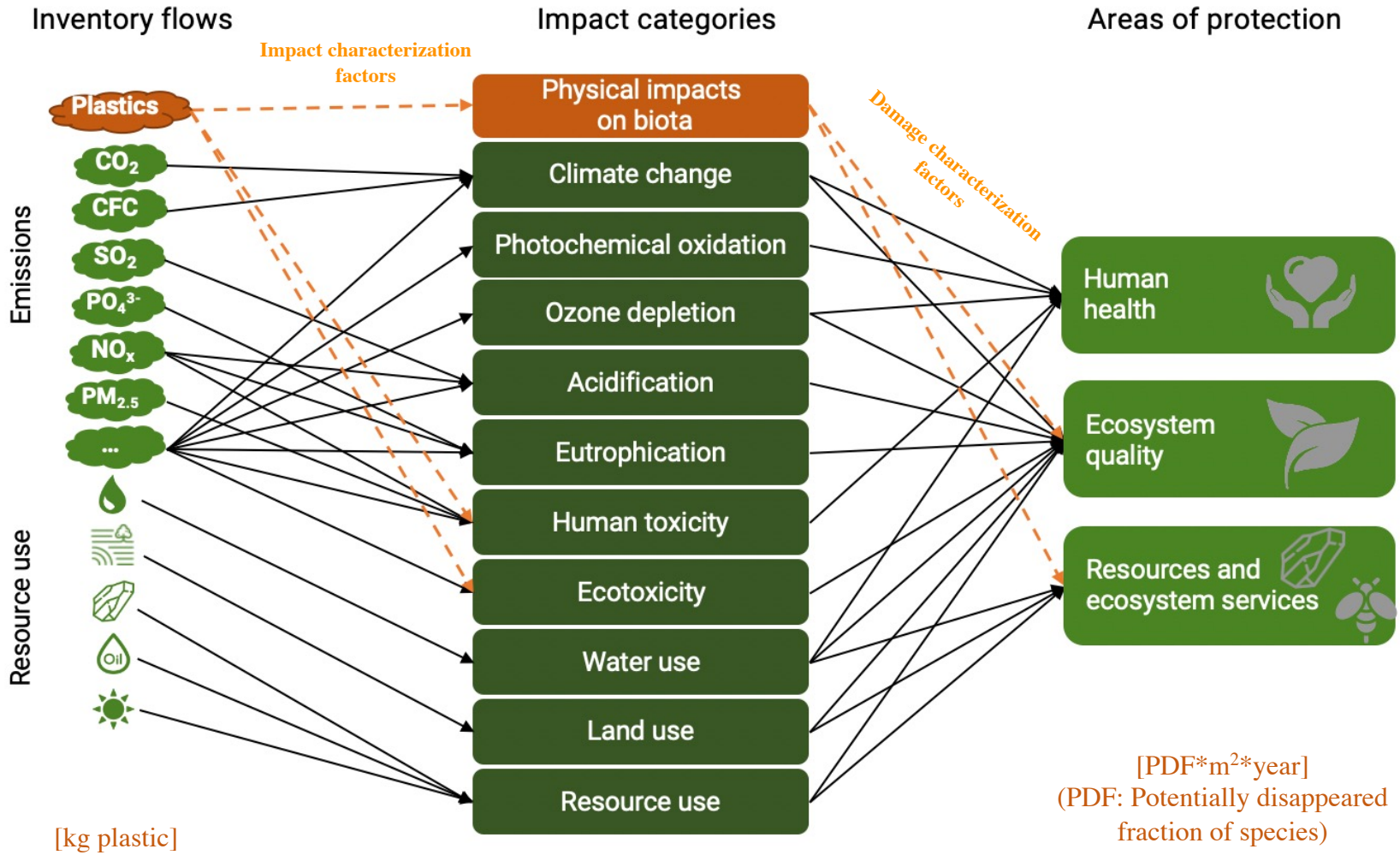


LCA case study of plastic, compostable and ceramic food plates



CIRAIG. (2017). Analyse du cycle de vie de différents types de vaisselle et de scénarios d'opération des aires de service alimentaire de Polytechnique Montréal. Montréal, Canada.

Life cycle assessment framework



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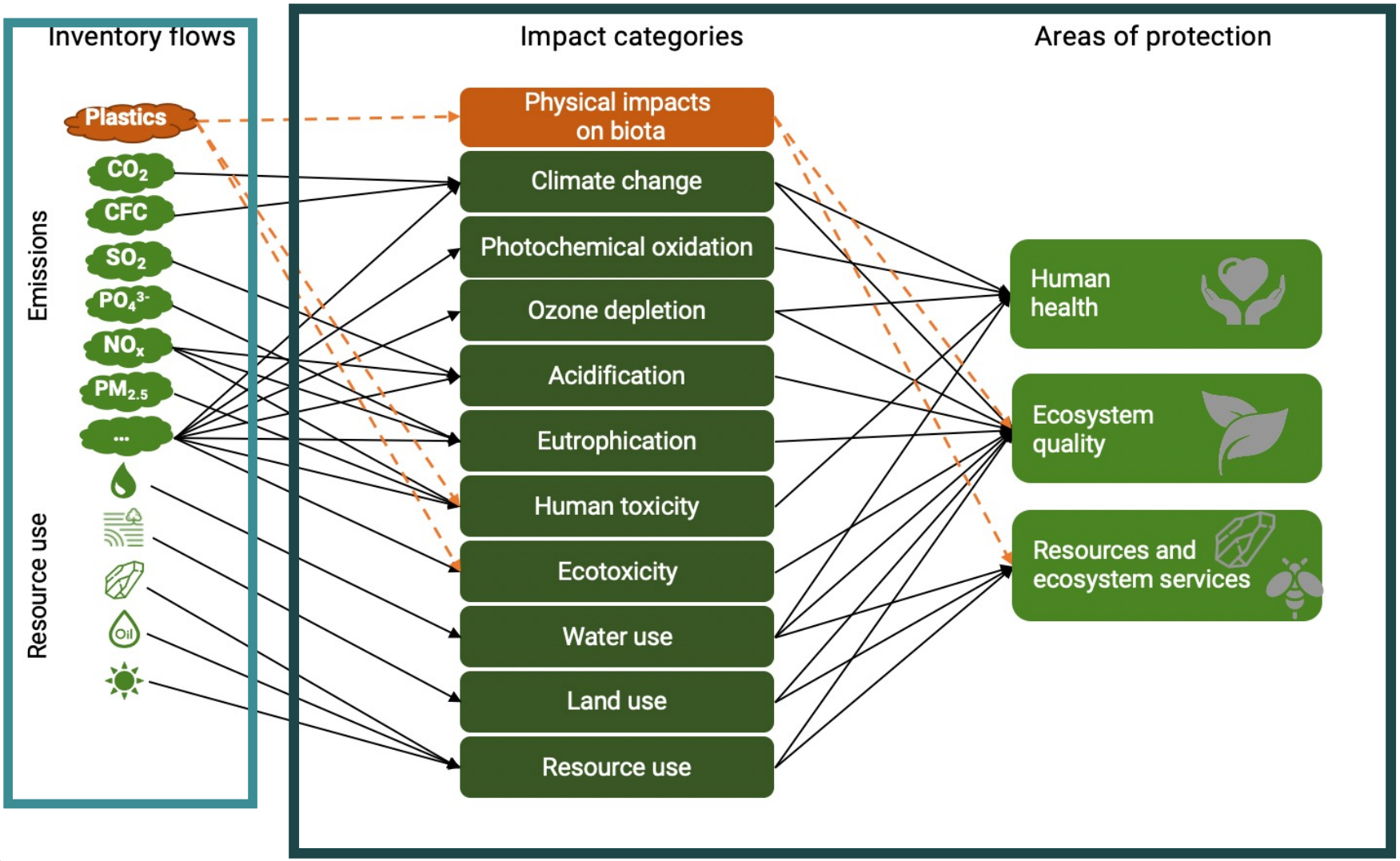
Life cycle inventory (LCI)

Life cycle impact assessment (LCIA)



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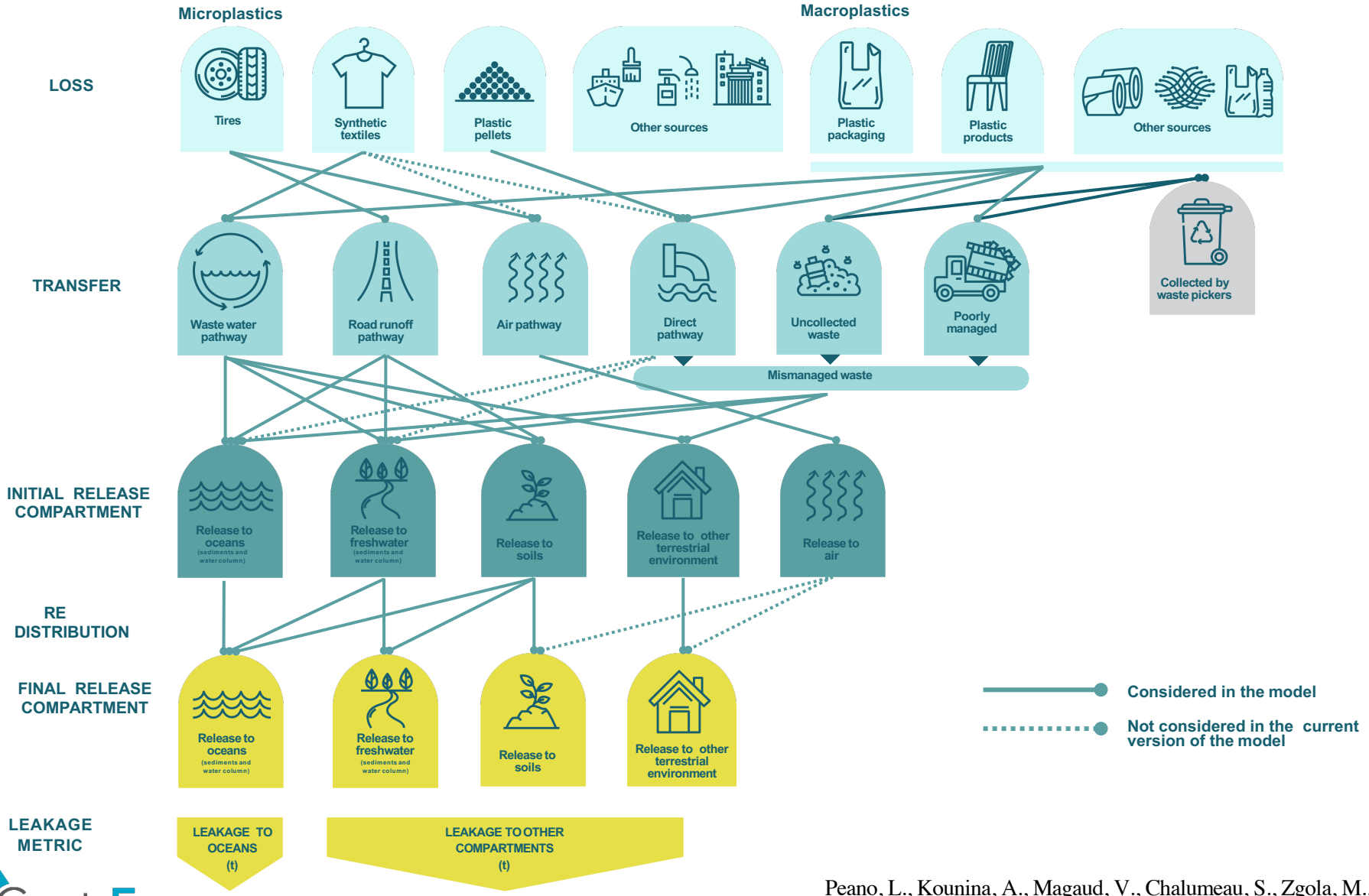
Life cycle inventory of plastic emissions – Plastic Leak Project (PLP)



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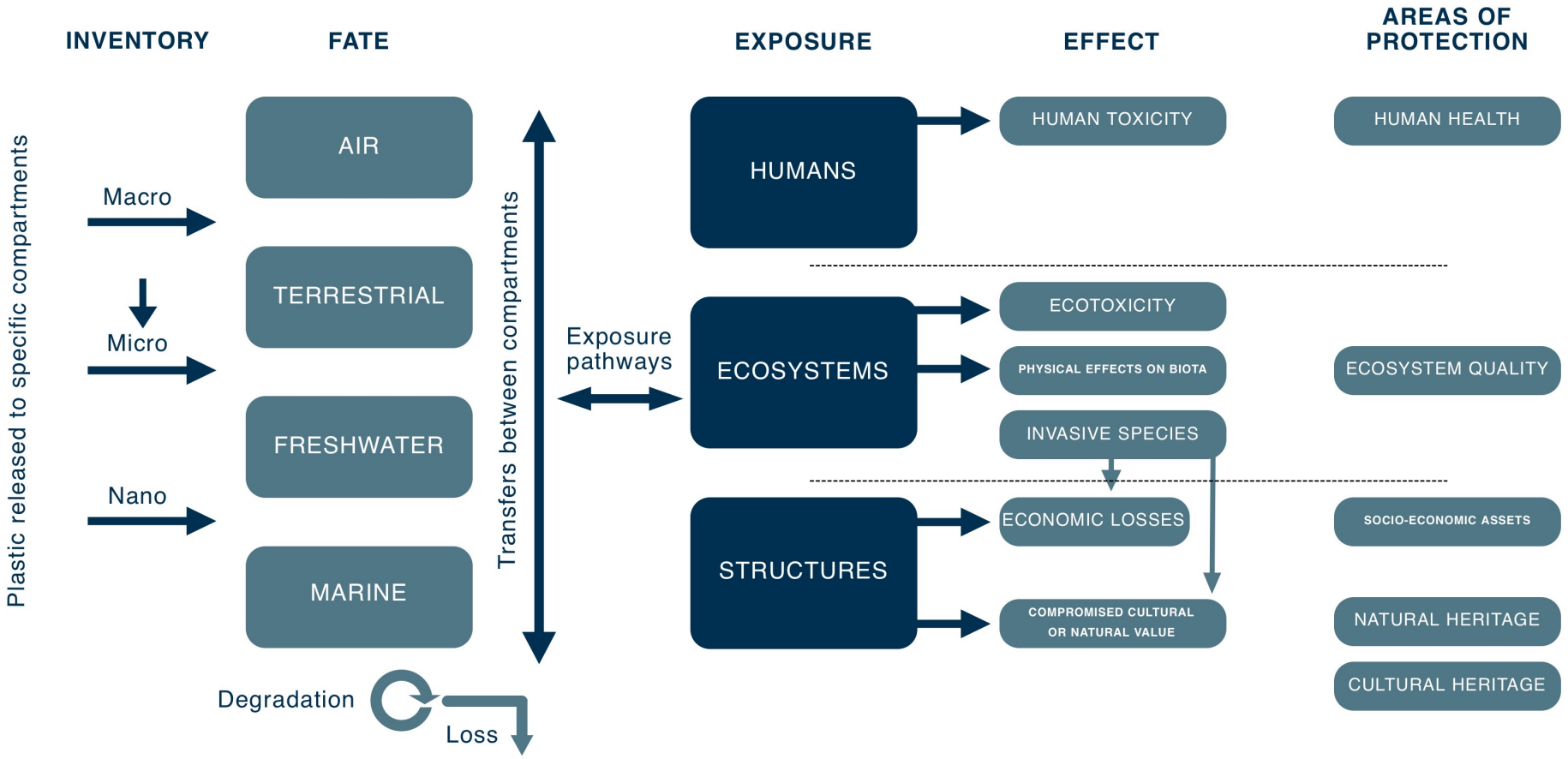
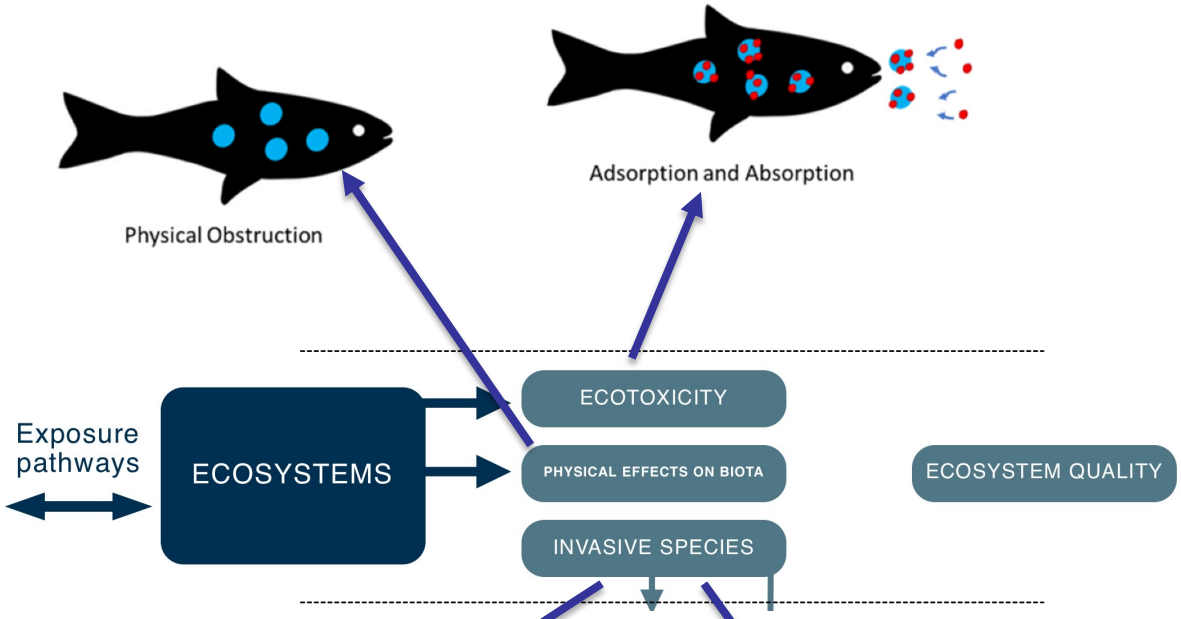
Peano, L., Kounina, A., Magaud, V., Chalumeau, S., Zgola, M., & Boucher, J. (2020). Plastic Leak Project - Methodological Guidelines. *Quantis and EA*, *v1.3*(May).

Life cycle impact assessment of plastic emissions - MarILCA

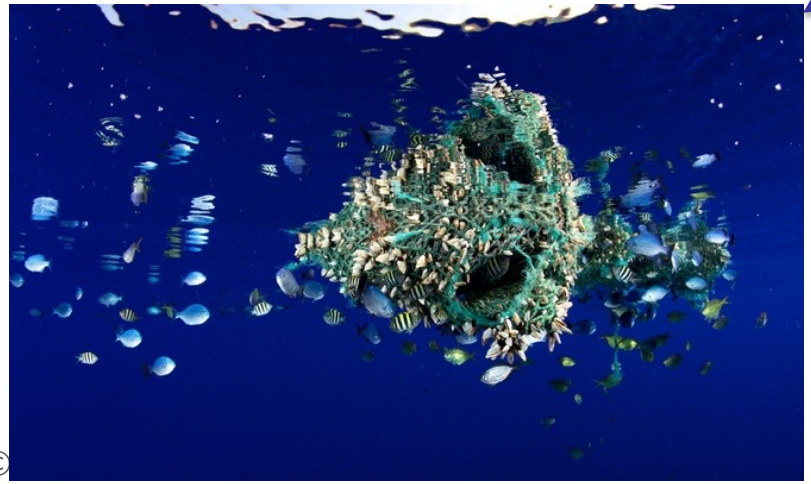


Adapted from Woods, J. S., Verones, F., Jolliet, O., Vázquez-Rowe, I., & Boulay, A. (2021). A framework for the assessment of marine litter impacts in life cycle impact assessment. *Ecological Indicators*, *129*, 107918.

Area of protection: Ecosystem quality



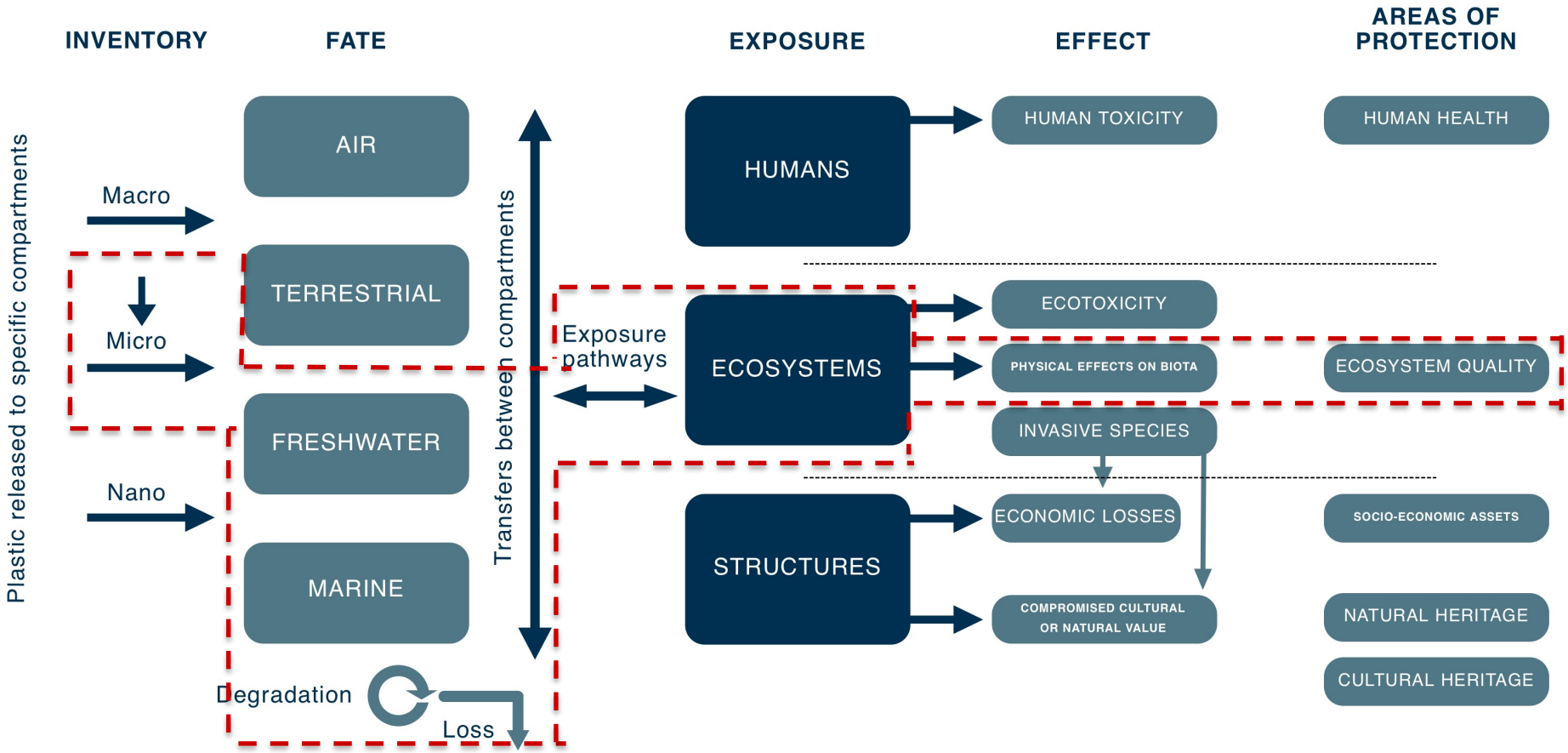
"Rafting"



Biofilm

Adapted from Woods et al., 2021

Life cycle impact assessment of plastic emissions - MarILCA



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Physical effects on biota: Characterization factors (CFs)

*Microplastic emission * CF = Damage on ecosystems quality*

[kg plastic] **[PDF*m²*year]**

*CF = Fate factor * Exposure factor *Effect factor*

Distribution and longevity of microplastics

Ingestion of microplastics

Animal health issues, reproductive impairment

Lavoie et al. (2021) for aquatic ecosystems ✓

Lavoie, J., Boulay, A., & Bulle, C. (2021). Aquatic micro- and nano-plastics in life cycle assessment: Development of an effect factor for the quantification of their physical impact on biota. *Journal of Industrial Ecology*, (2015), 1–13.

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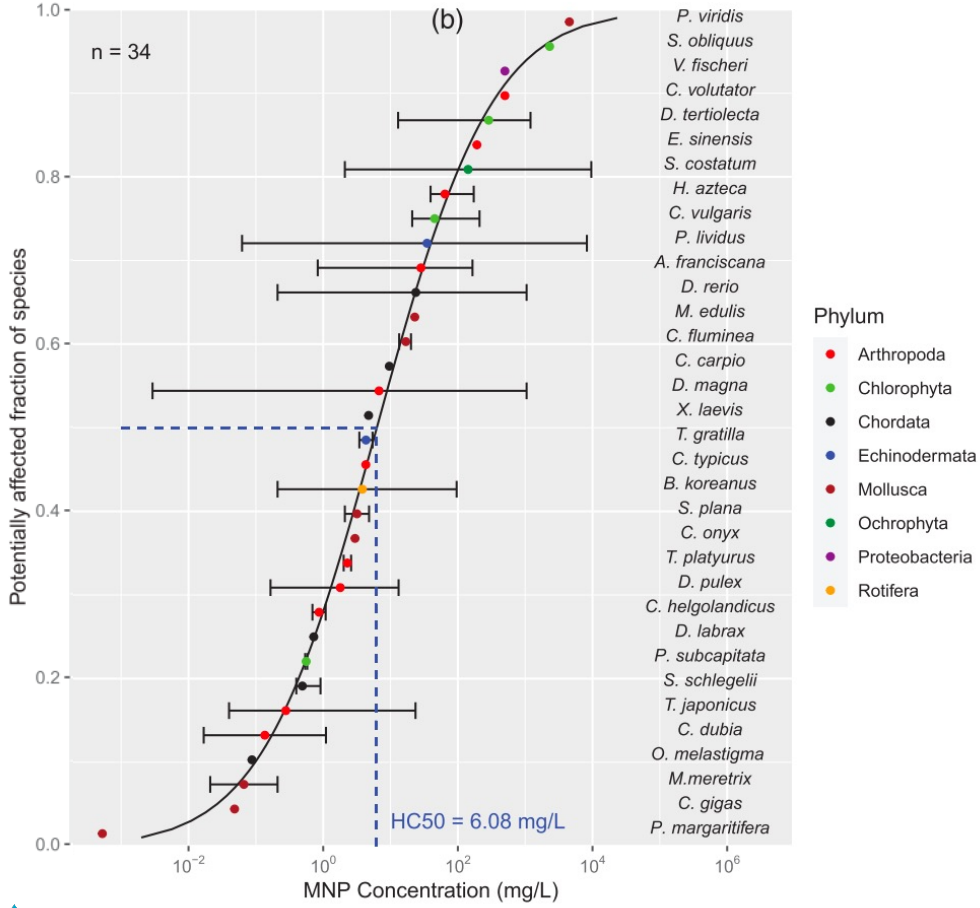

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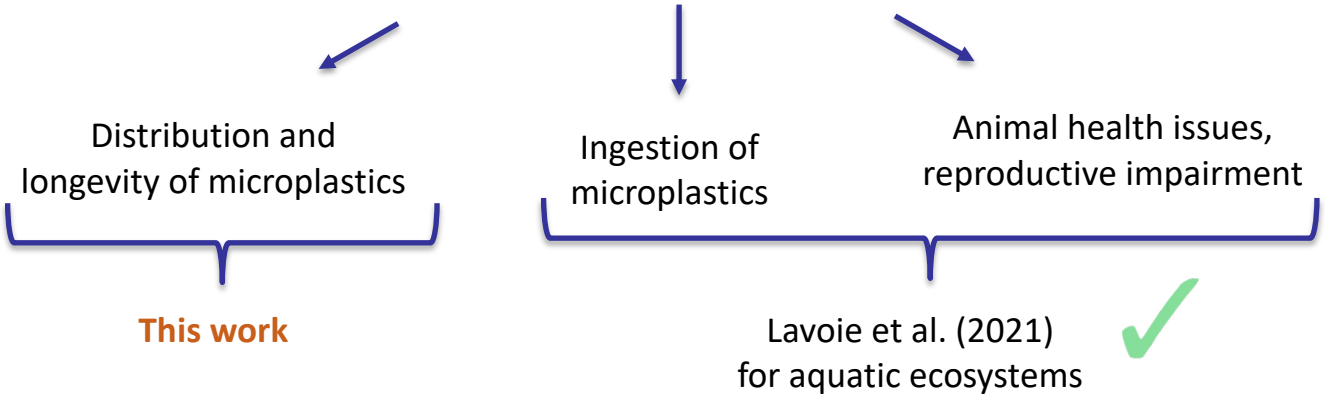

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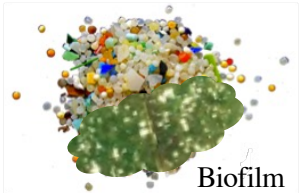
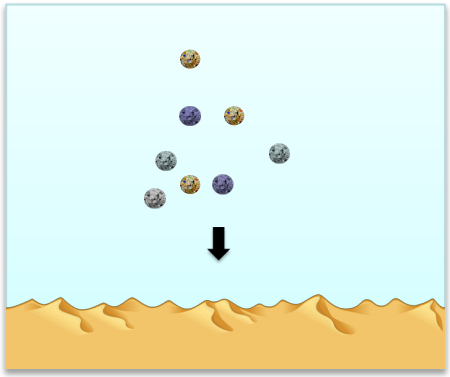
Preliminary marine fate modelling

Fragmentation

Degradation



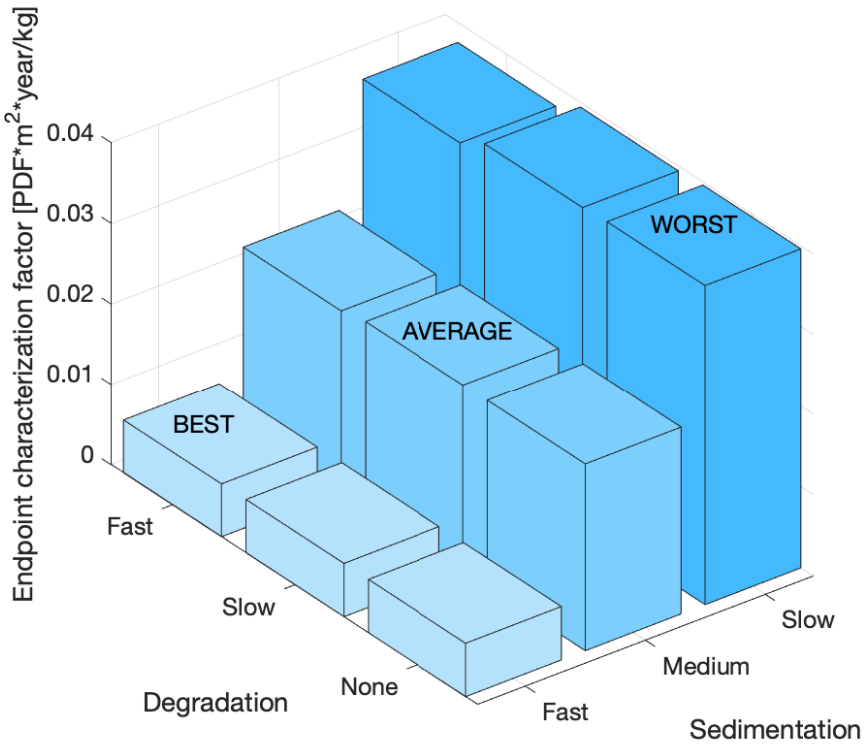
Sedimentation



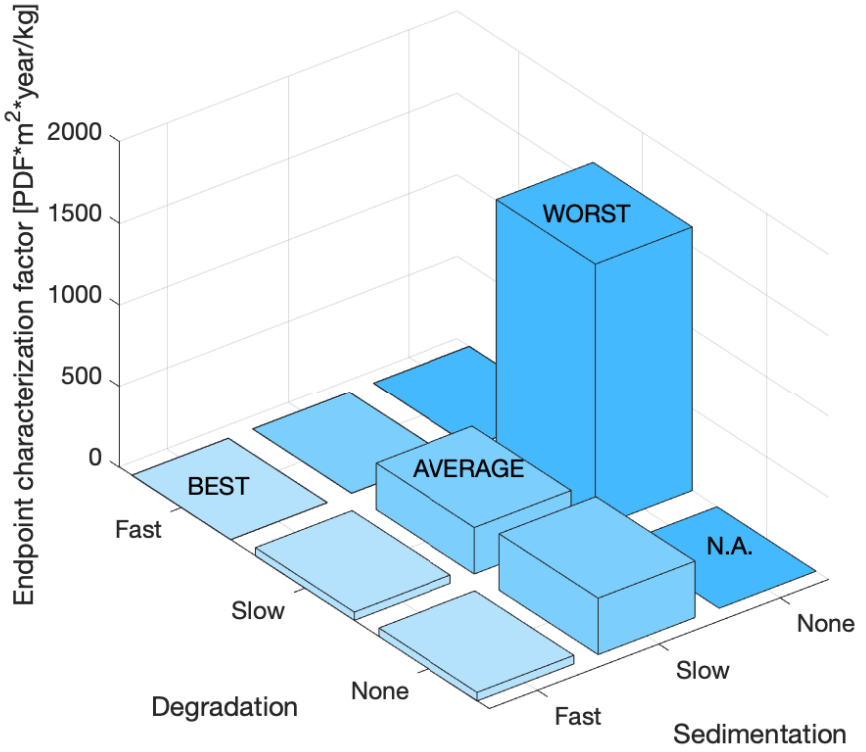
Scenarios: worst, average, best

Preliminary characterization factors

TRWP:



EPS:



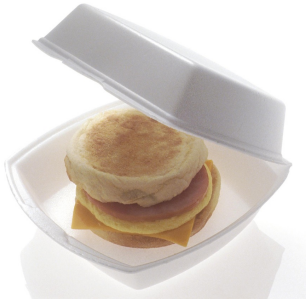
Corella-Puertas, E., et al. (2022). Development of simplified characterization factors for the assessment of expanded polystyrene and tire wear microplastic emissions applied in a food container LCA. *Journal of Industrial Ecology*.

LCA case study: To-go food containers

Functional unit: **“Using one container to carry a meal for one person in a food court in Montréal, Québec, Canada, in 2021 ”**

Single-use containers:

- Expanded polystyrene (Ontario, Canada)
- Bagasse (China)
- Wood pulp (Québec, Canada)

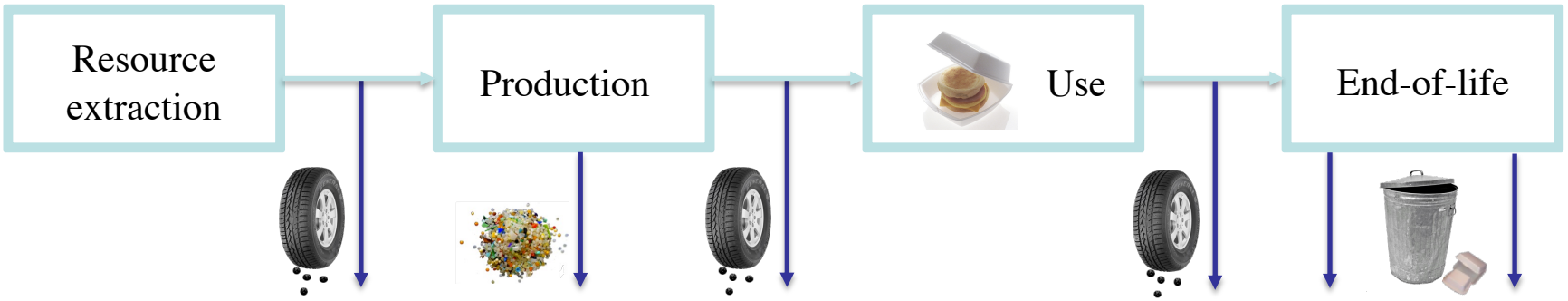


Reusable plate:

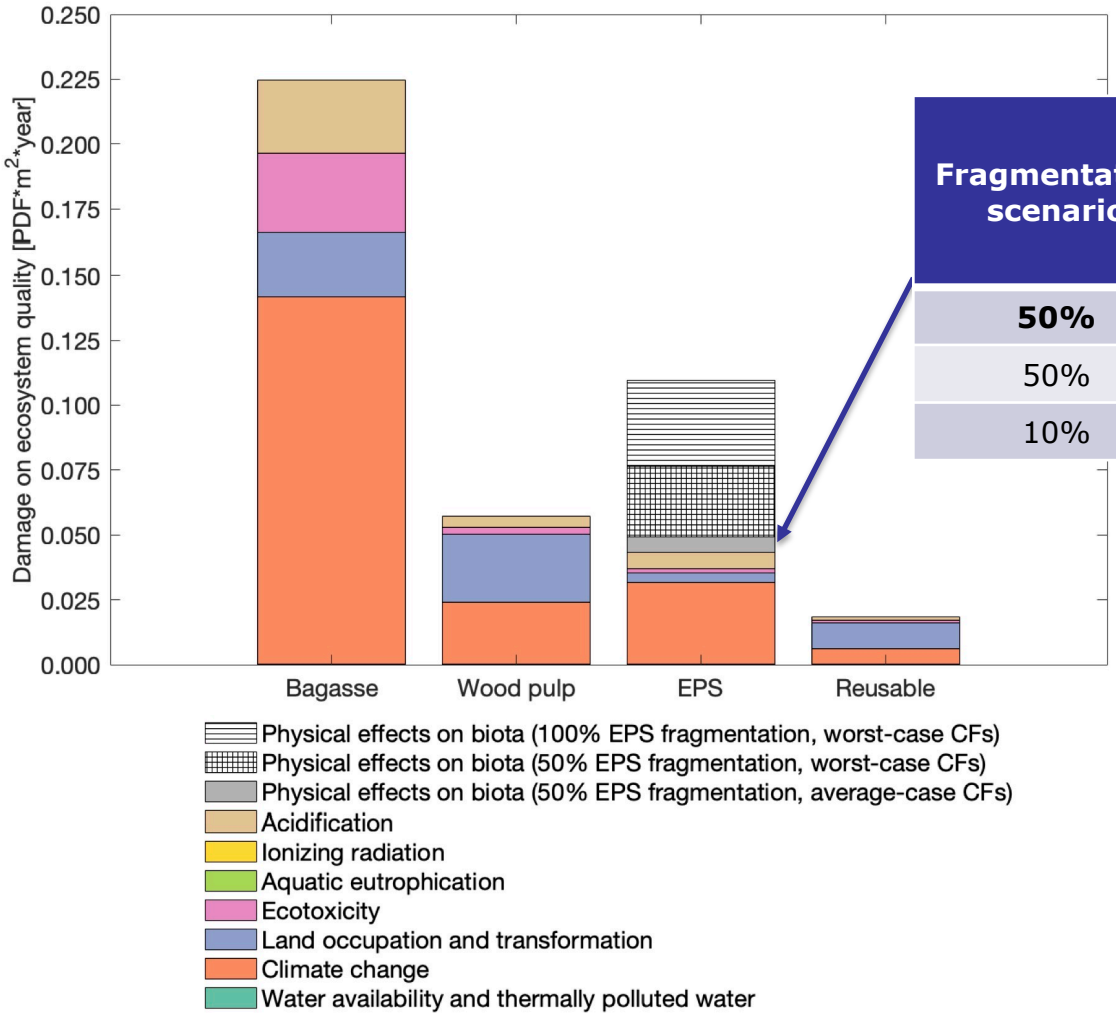
- Ceramic (China)

Plastic inventory (Plastic Leak Project guidelines)

Process	Production (PS pellet loss)	Transportation (TRWP)	End-of-life (EPS in landfill)	End-of-life (EPS littering)
Unit	kg microplastic emitted/kg produced	kg emitted/(kg product*km)	kg macroplastic emitted/kg waste	kg macroplastic emitted/kg waste
Leakage	0.000012	5.17E-10	0.00245	0.005



Ecosystem quality results



Fragmentation scenario	CF scenario	Physical effects on biota (PDF*m²*year)
50%	**average**	**5.86E-03**
50%	best	3.23E-05
10%	best	6.54E-06

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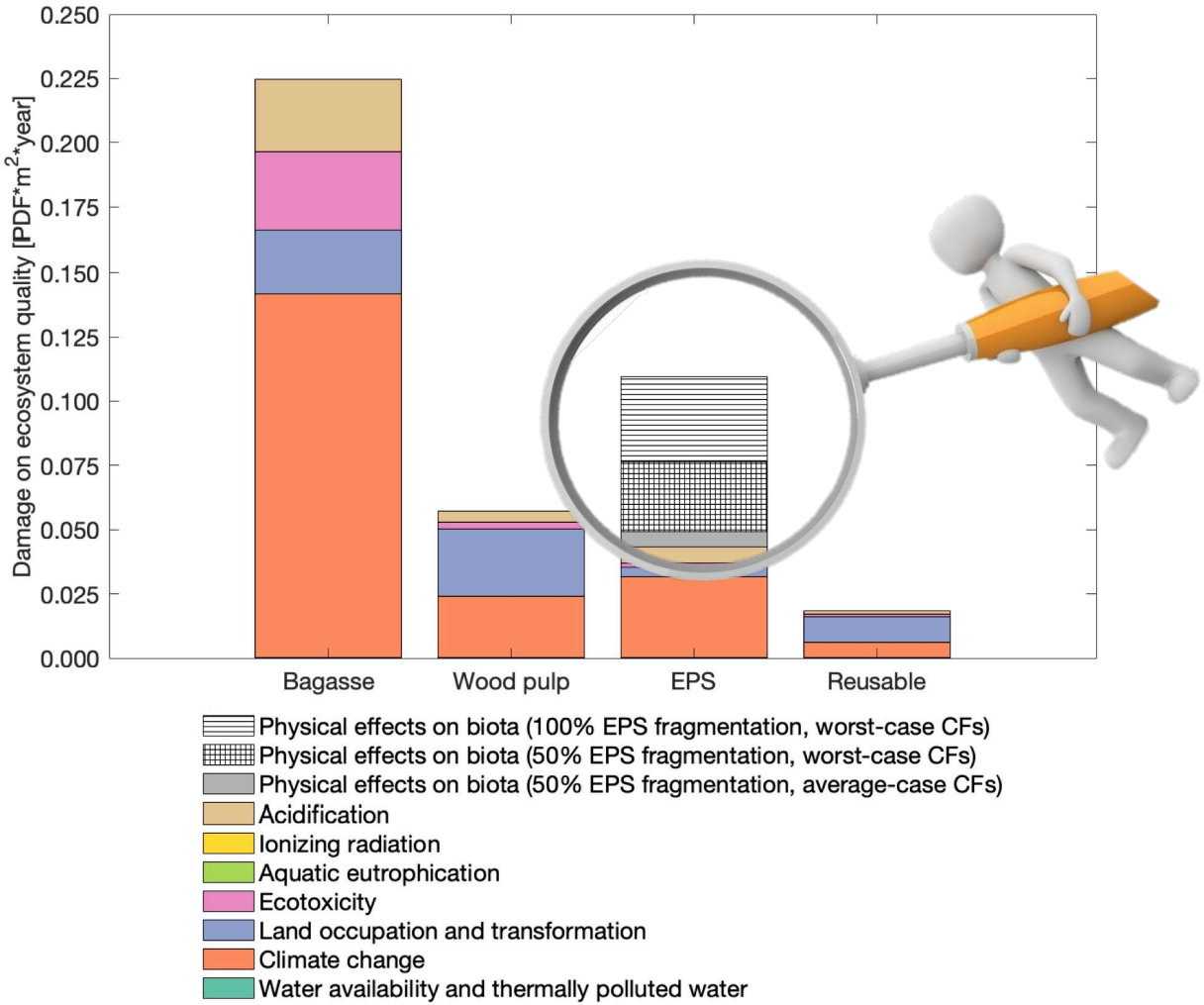

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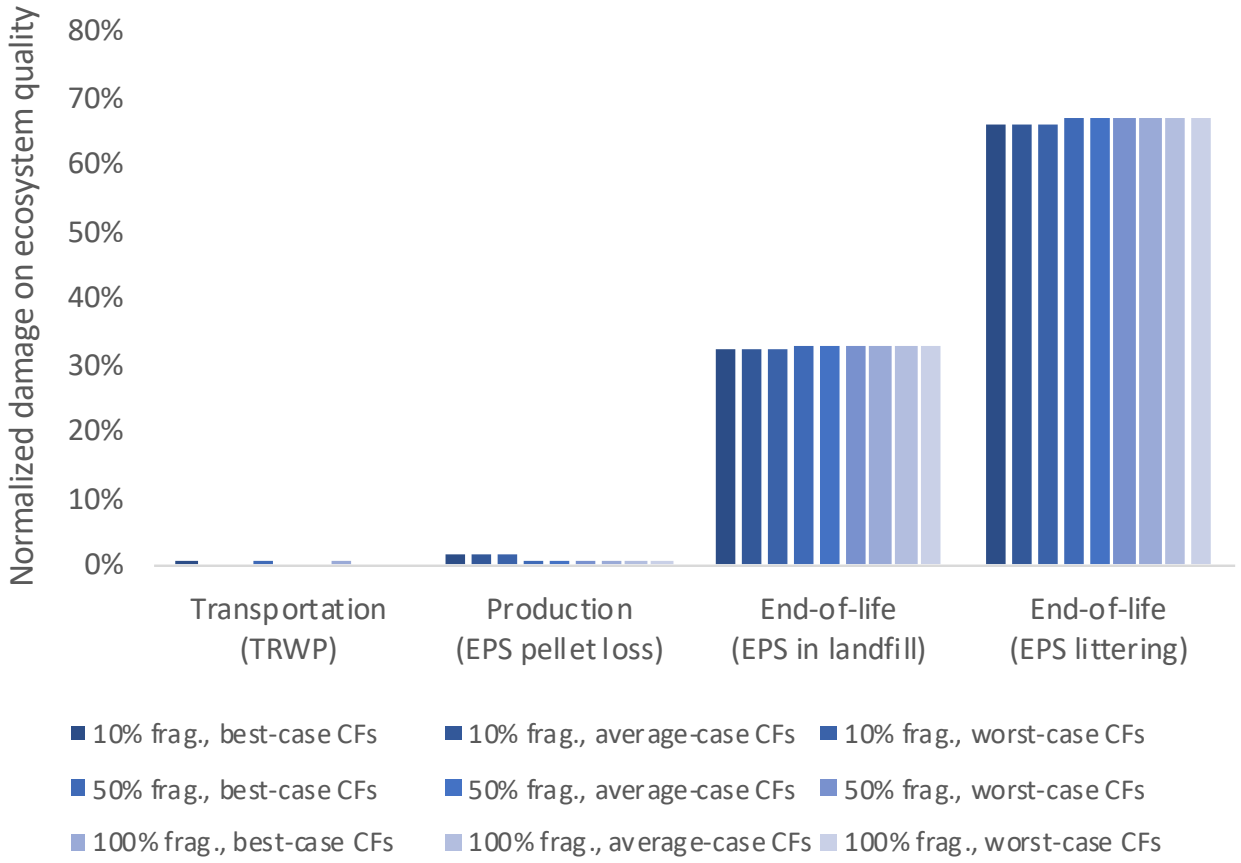
Physical effects on biota by life cycle stage (EPS container)



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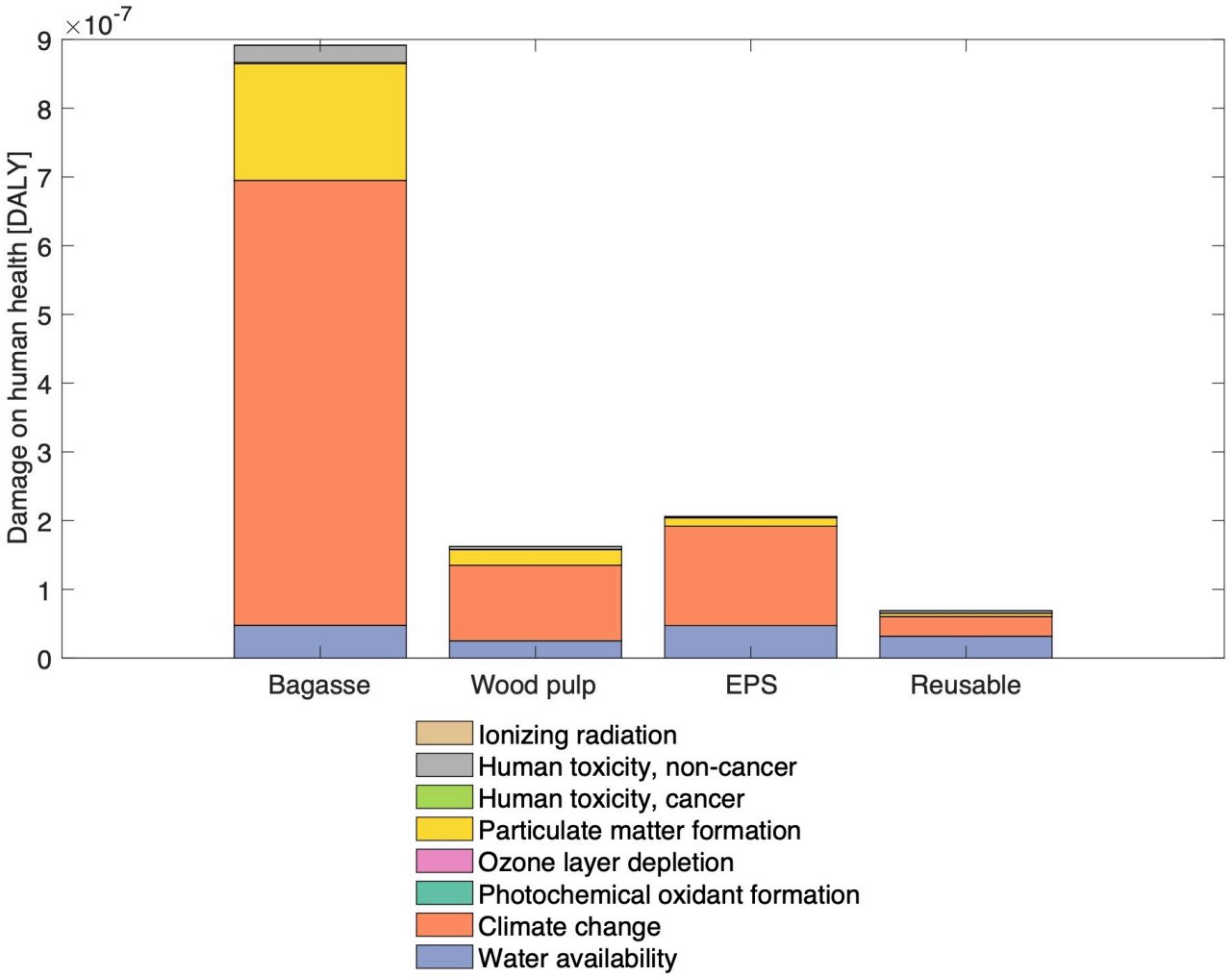
Human health results



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Conclusions

Methodology:

- Detailed modelling of different types of microplastics needed to reduce uncertainty
- Research needed for other environmental compartments (freshwater, soil, air) and other impact categories (invasive species, ecotoxicity,…)

Case study:

- A compostable alternative may not always have lower environmental impacts

Impacts

<<

THANKS TO CENTREAU & OUR DEDICATED PARTNERS

QUESTIONS?

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