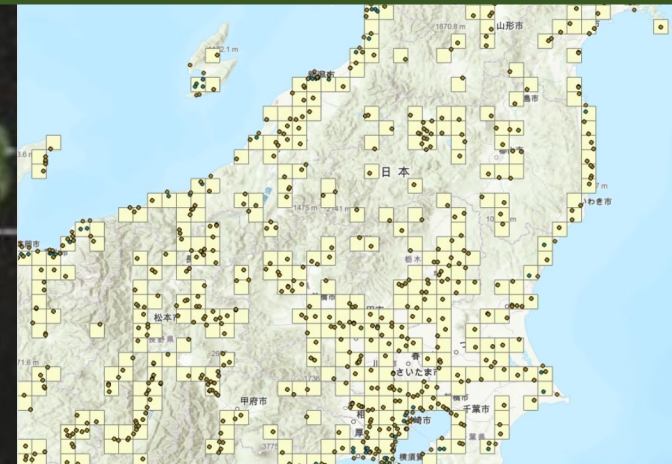
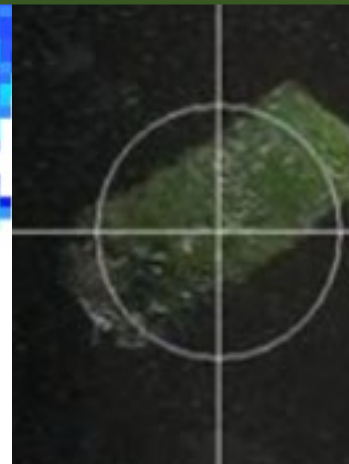
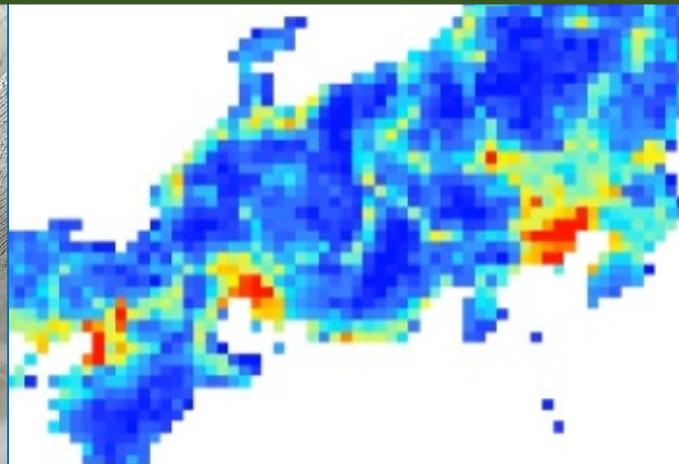


Life Cycle Inventory and Environmental Fate of Tire-Wear Particle and Textile Washing Microfiber in Japan

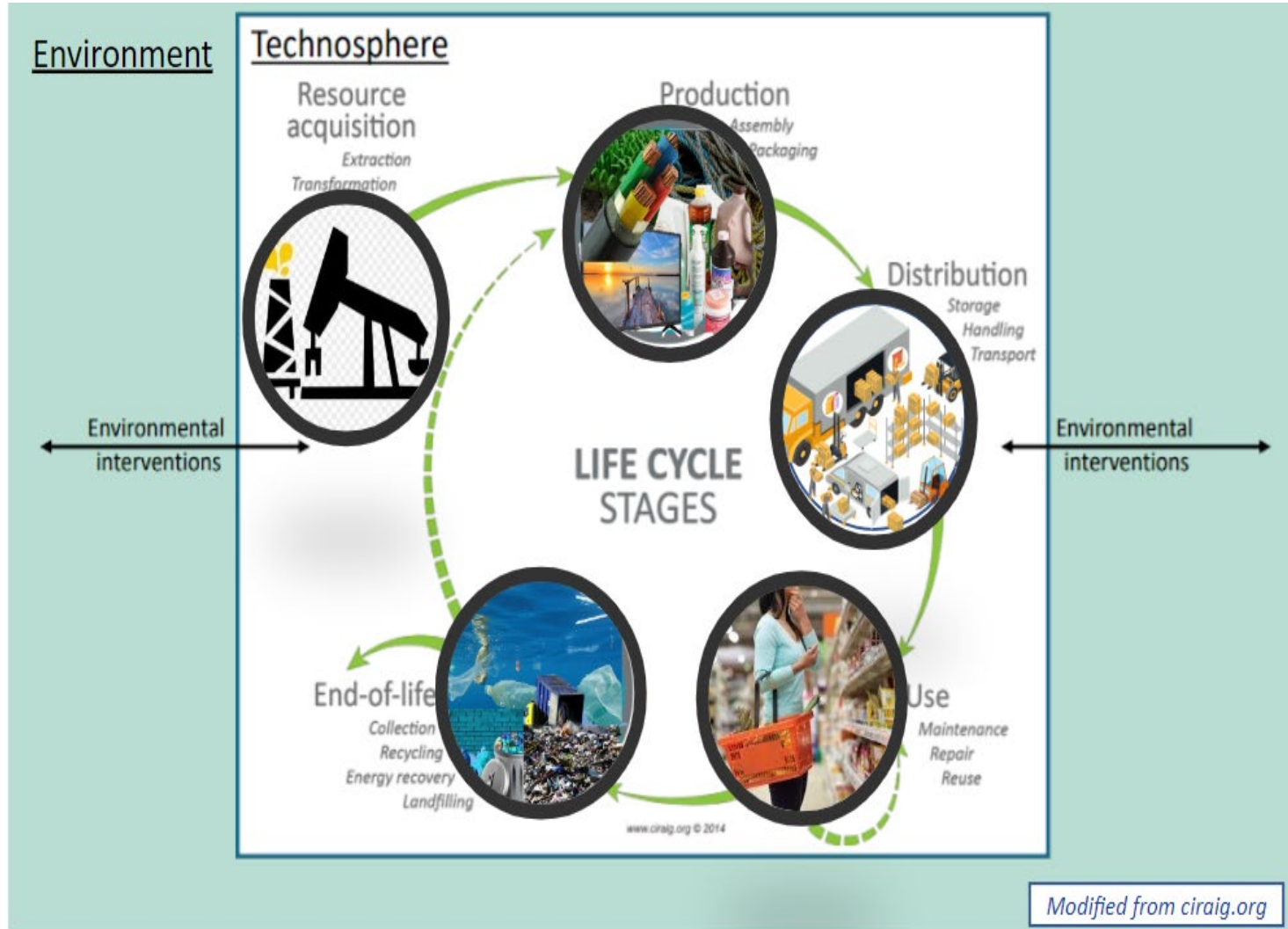
May-1, 2023

Amila Abeynayaka and Norihiro Isubo

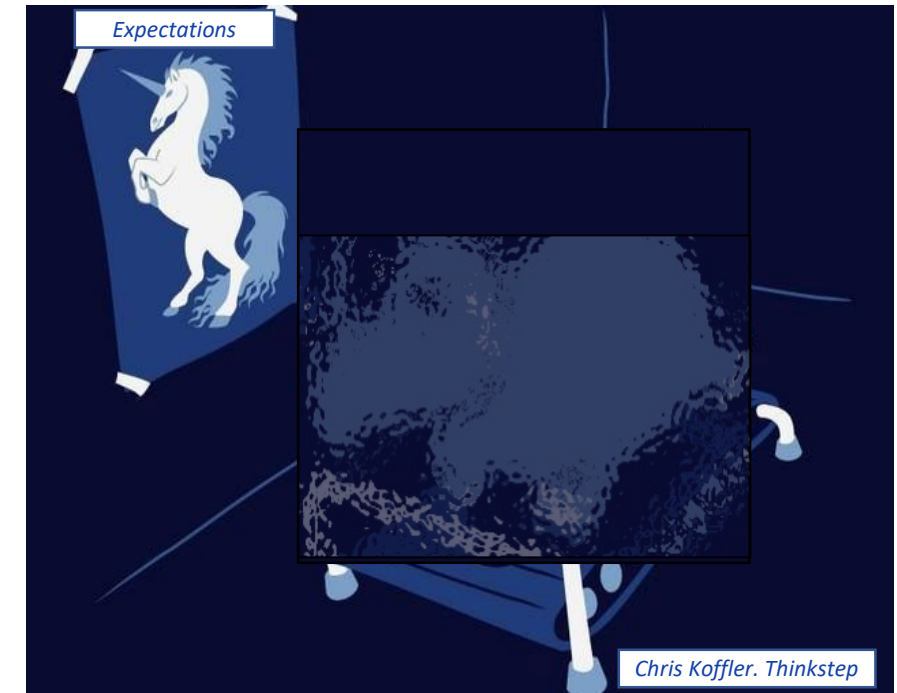
Institute for Global Environmental Strategies



LCA and Impacts of Microplastics in Environment

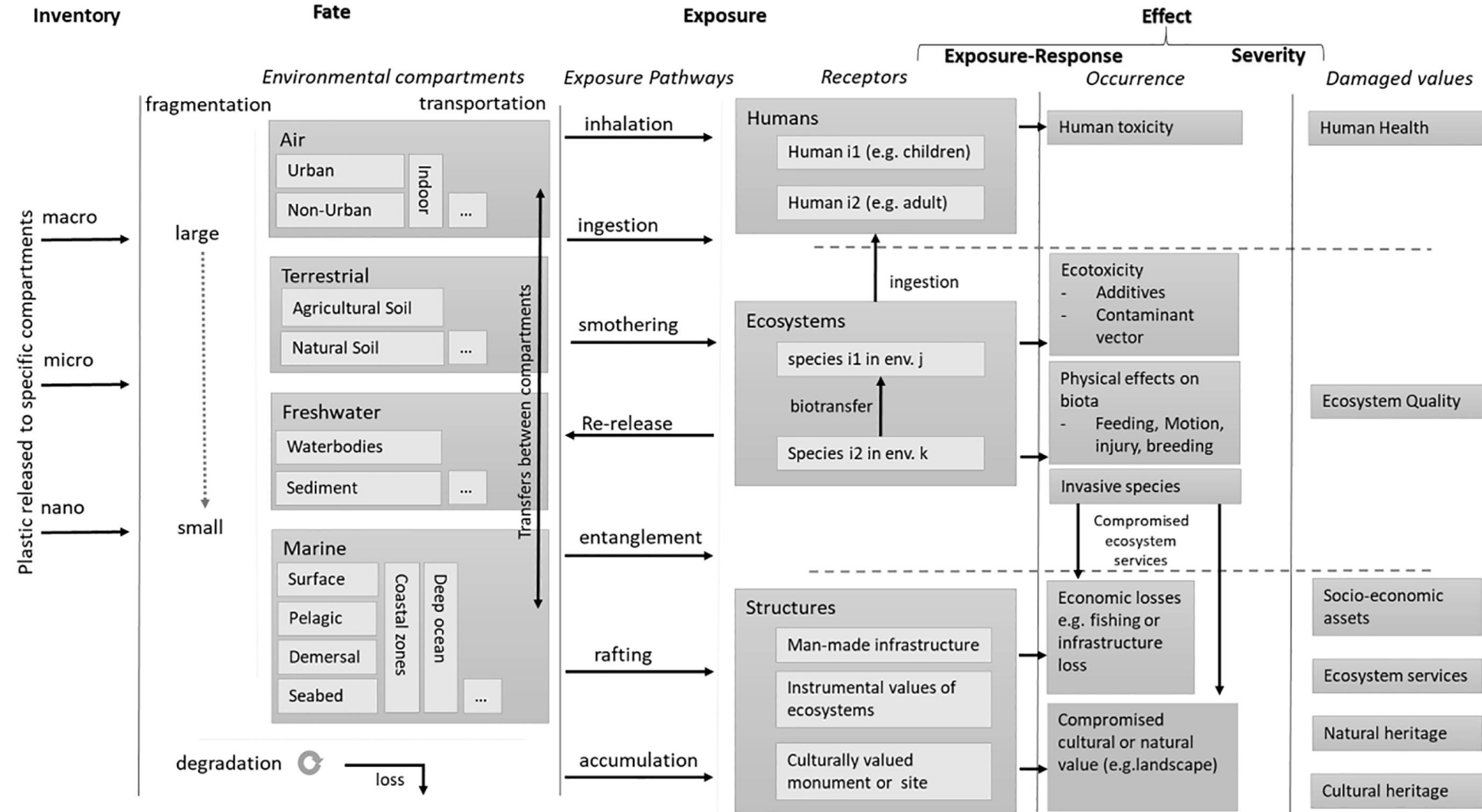


EU Environment, 2022



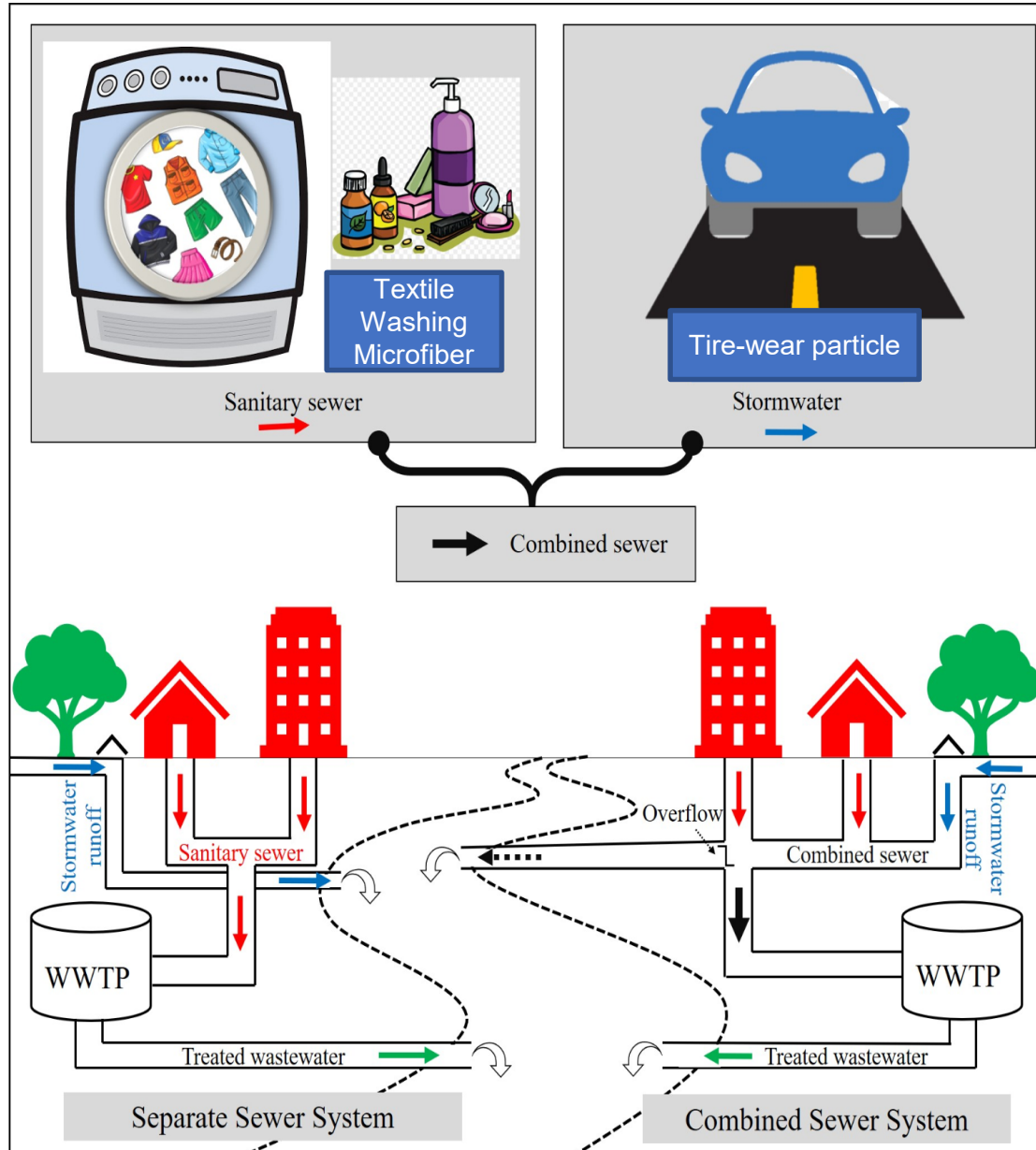
Integration of Impacts of Microplastics in Environment into LCA

- Life Cycle Inventory
- Fate (need of fate modelling; this includes spatial distribution, degradation, etc.)
- Exposure pathways
- Damage occurrence



Source: Woods, J.S., Verones, F., Jolliet, O., Vázquez-Rowe, I. and Boulay, A.M., 2021. A framework for the assessment of marine litter impacts in life cycle impact assessment. *Ecological Indicators*, 129, p.107918. (MariLCA)

Tire-wear Particle and Textile Microfiber



$$ATE_i = AUE_i * ATDi$$

Annual average tire-wear particle per each vehicle class (i): ATE_i

Average tire-wear particle emission per unit distance vehicle class (i): AUE_i

Annual vehicle travel distance: $ATDi$

Annual Vehicle Travel Distances
Data (Six Classes)

Vehicle gas Emissions at 10
km Grid & Prefectural Levels

Vehicle Travel Distances at 10 km
Grid and Prefectural Levels

Tire-wear Particle Emissions
Per 1 km Vehicle Travel

Annual Tire Abrasion Particle Emissions (at road) at 10 km
Grid and Prefectural Levels

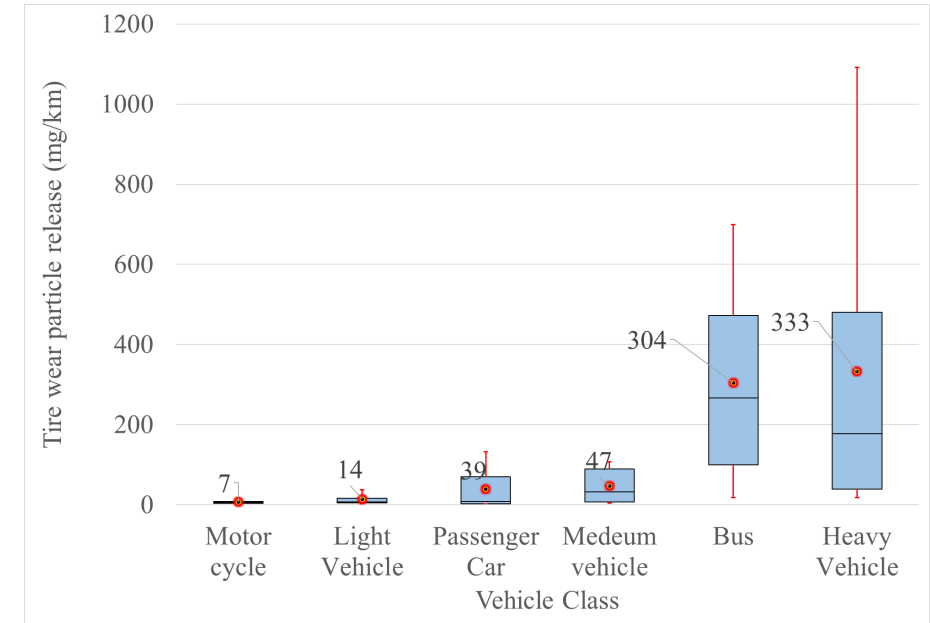
Wastewater treatment plants (WWTPs): 2114 + Decentralized
Treatment Capacity, Combined Sewer Capacity, Treatment Level,
Location

Treatment Level Vs Microplastic Removal (Secondary data Meta-
analysis)

Distribution in Different Compartments (Air, Water, Soil) and short
term/long term

Life Cycle Inventory: Tire-wear Particle

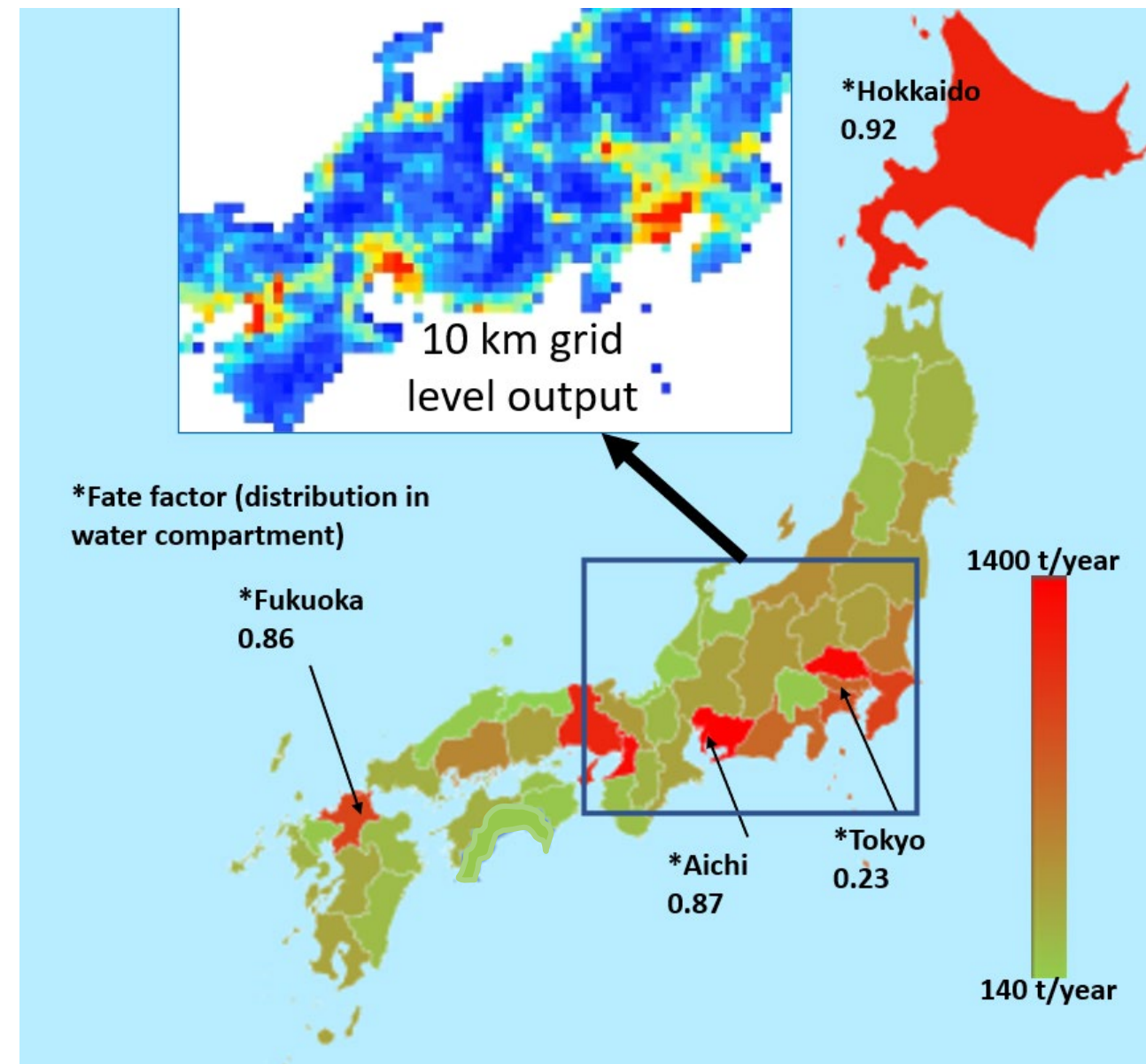
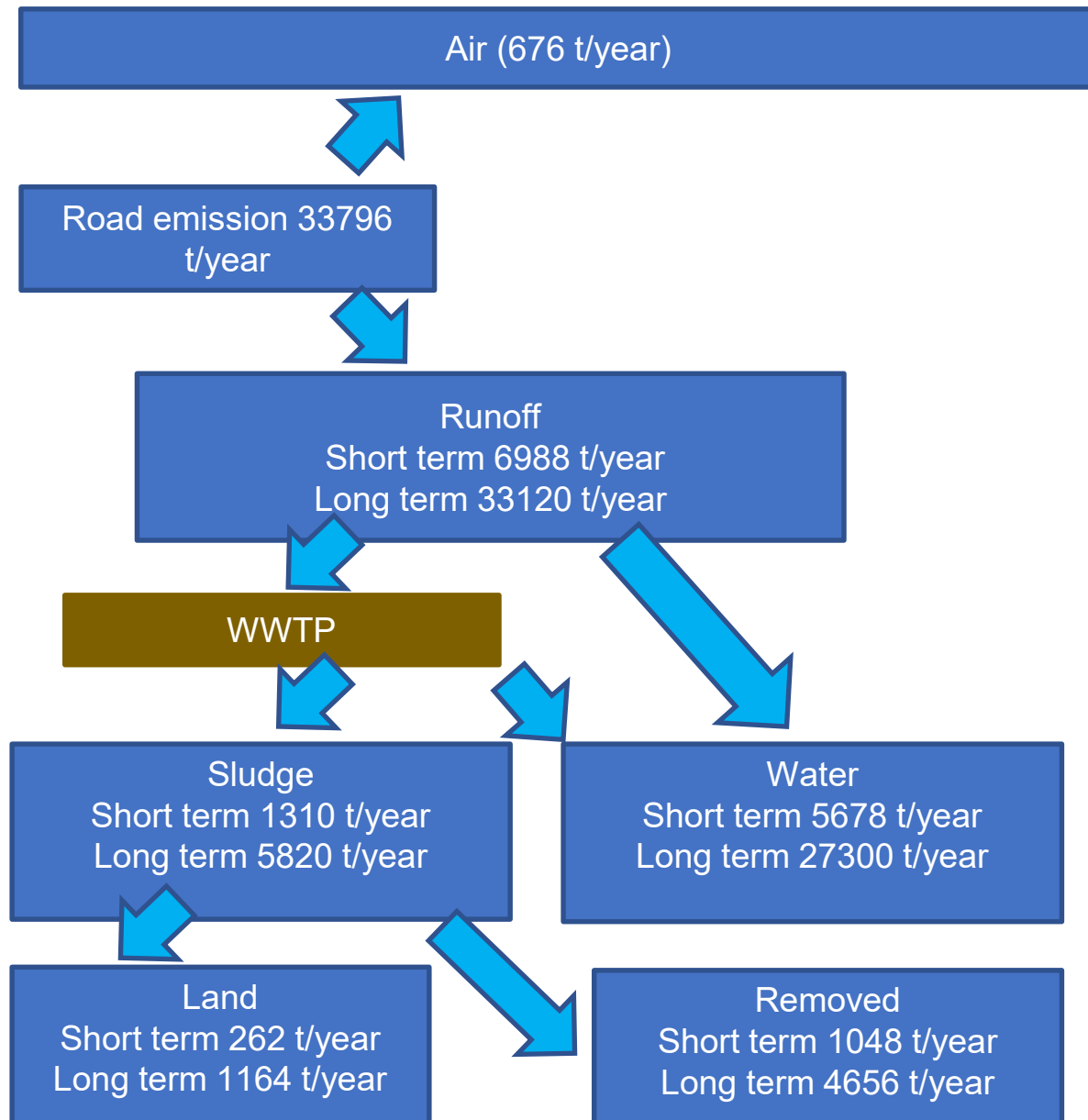
- Meta-analysis for the six vehicle classes
- The emissions vary in a larger range for the Bus and Heavy vehicles class
- The road conditions, nature of travel (Speeding/breaking, the load carrying, etc.) the condition of the tire can be affecting the tire-wear particle emissions



- The average tire-wear particle emission at the road estimation is 33,796. metric ton (t)/year for Japan.

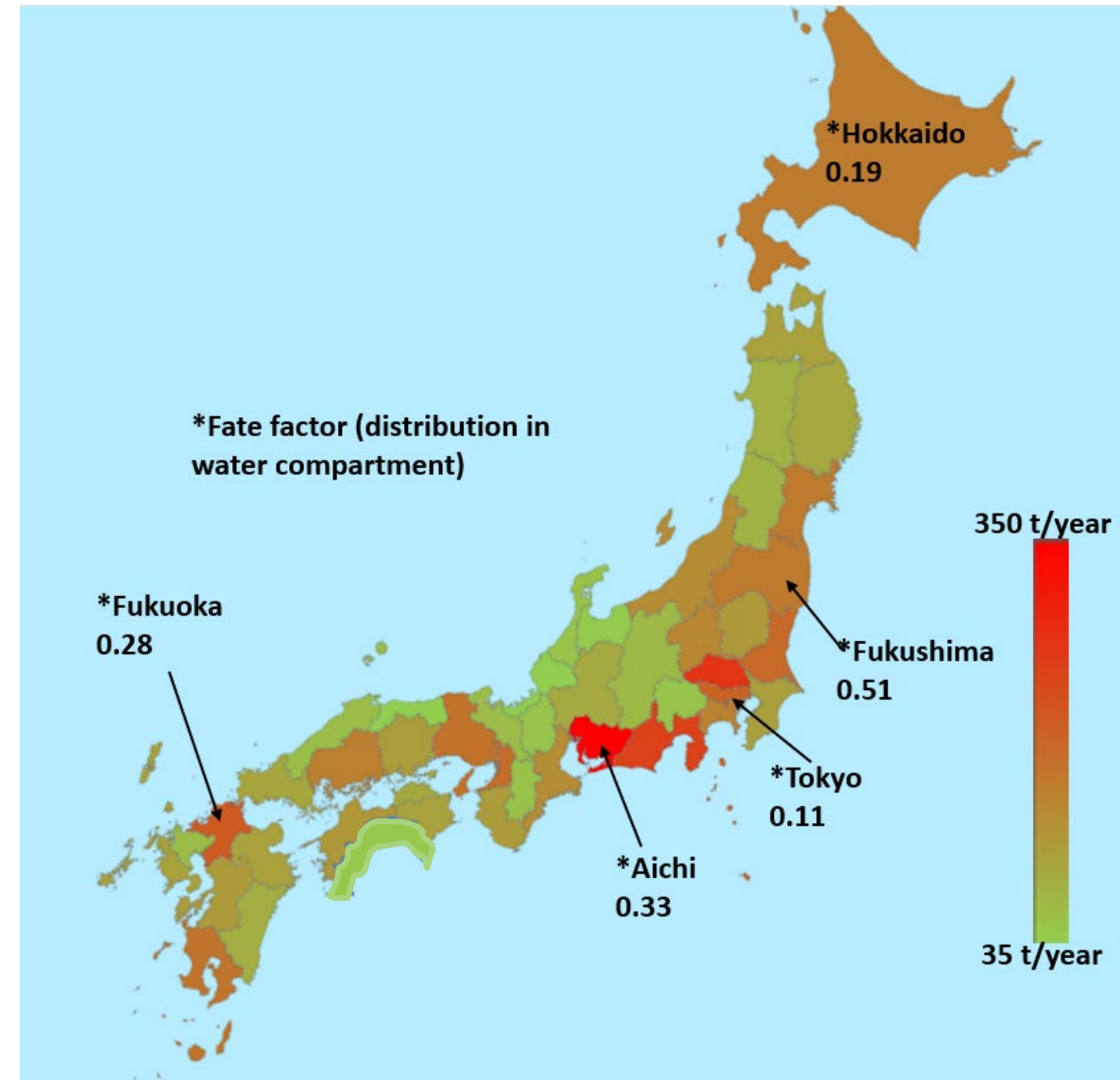
Vehicle class	Distance (km)	Tire-wear particle emissions (Metric Ton/year)	Tire-wear particle emissions (g/product life)
Motorcycle	1.2757.E+11	946.6	111.3
Light Vehicle	2.5514.E+11	3536.9	104.0
Passenger Car	4.0601.E+10	1581.3	292.1
Medium vehicle	4.1193.E+11	19463.7	354.4
Bus	5.6973.E+09	1732.4	1520.4
Heavy Vehicle	1.9637.E+10	6535.1	1664.0
Total		33796.0	-

Tire-wear Particle FF at Prefectural Level (Water)



Textile microfiber FF at Prefectural Level (Water)

- Annually 17612 t/year leaked into at the source
- 5246 t/year leaked into water environment
- 12348 t/year transfer into the sludge at the WWTPs
- Emissions are depending on the population and the level of treatment.
- Even though Tokyo population is higher, the WWTP coverage and the level of treatment is higher. Hence the emissions to the freshwater becomes lower.
- Major fraction of microfiber transferred into sludge (12348 t/year) is avoided from the environmental contamination due to effective sludge management.



Recommendations

Microplastic	Factors Limiting Leakage to Environment (Downstream Only)	Recommendations
Textile Microfiber from Washing	<ul style="list-style-type: none"> Wastewater Treatment Coverage Level of the Wastewater Treatment Plant and Coverage Sludge management practices (i.e. landfill vs incineration) 	<ul style="list-style-type: none"> Washing process improvement to intervene at the source. Technologies to Capture microfiber at the source Innovative textile
Tire-wear Particles	<ul style="list-style-type: none"> Combine Sewer Coverage Sludge Management practices (i.e. landfill vs incineration) 	<ul style="list-style-type: none"> Public transport where no rubber tire is used, specially in high braking-speeding areas like cities. Innovations to capture/reduce tire-wear particles at the source Combined sewer converge at hotspots Appropriate WWTP sludge management



Thank You!



Amila Abeynayaka

@litterlifecycle



abeynayaka@iges.or.jp

IGES

CCET

IGES Centre Collaborating with
UNEP on Environmental Technologies

LCA

Amila Abeynayaka

Policy Researcher,

IGES Centre Collaborating with UNEP on Environmental Technologies (CCET),
Institute for Global Environmental Strategies (IGES), Japan