Mission Unflushable?

Understanding the Journey and Fate of 'Biodegradable' Wet Wipes in Rivers

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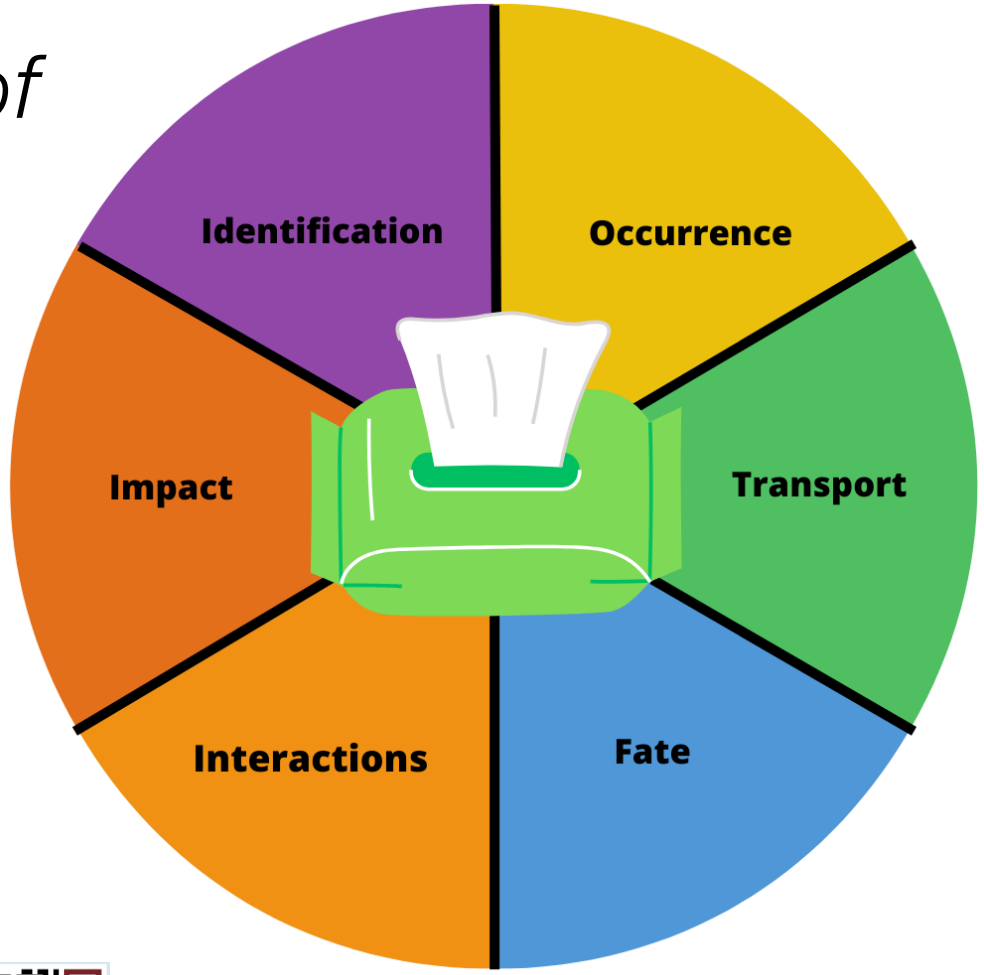

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Why wet wipes?

a.

b.

Besley and Cassidy 2023. J. Env. Man. 303. 114256


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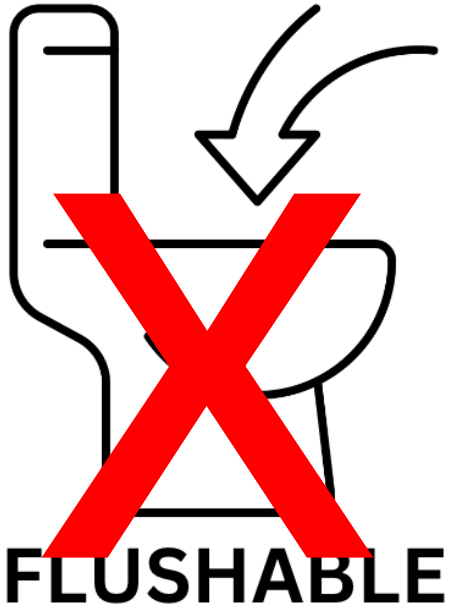
Big push towards alternatives



BUT...

Wet wipe pollution continues!

Why?

Understanding the full life-cycle of wet wipes

- Manufacturing, properties, disposal, environmental behaviour and fate of these new ‘biodegradable’ and ‘flushable’ wipes.

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Do flushed biodegradable wet wipes really degrade?

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Main conclusions

Mixed composition:

- >50% of 'biodegradable' wipes contain low degradable plastic fibres

Consumer confusion + convenience:

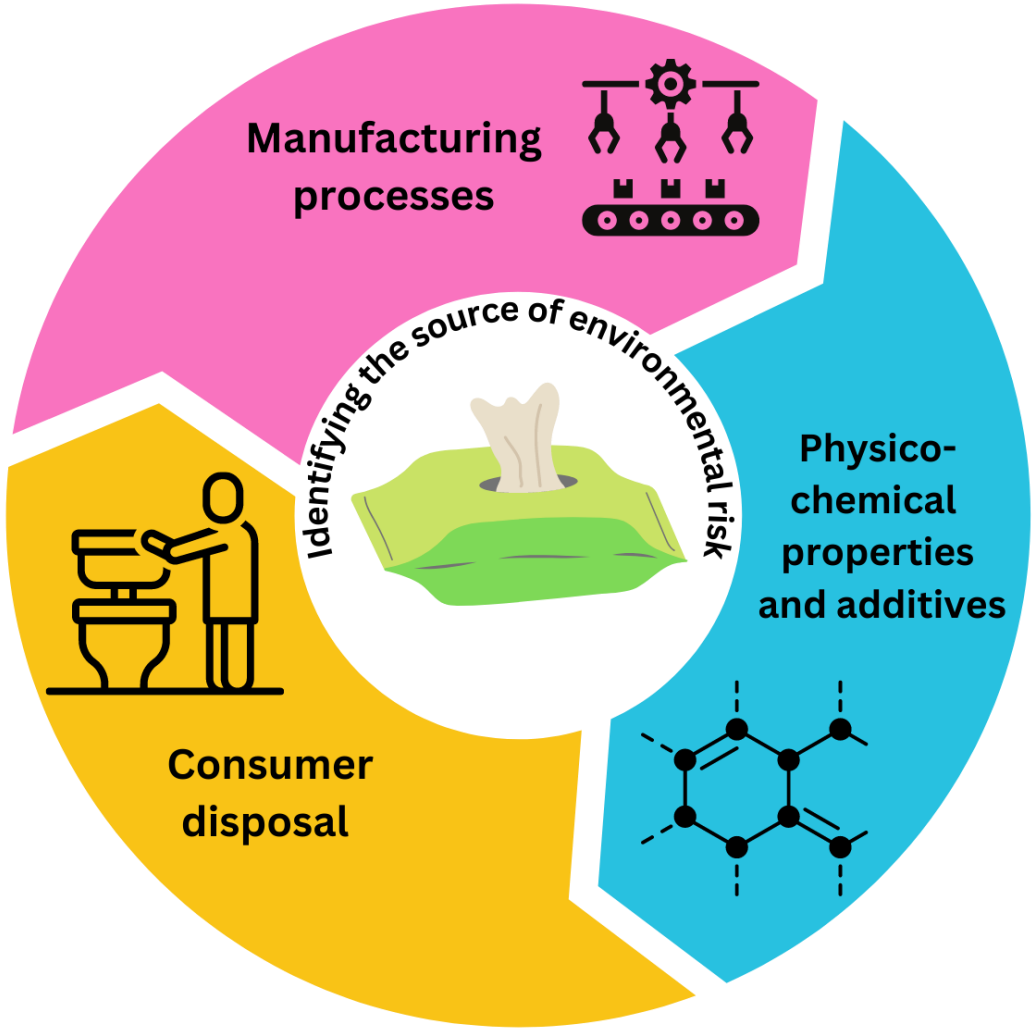
- Inconsistent labelling + absent regulations + convenience = more incorrect disposal

Microfibres but no breakdown:

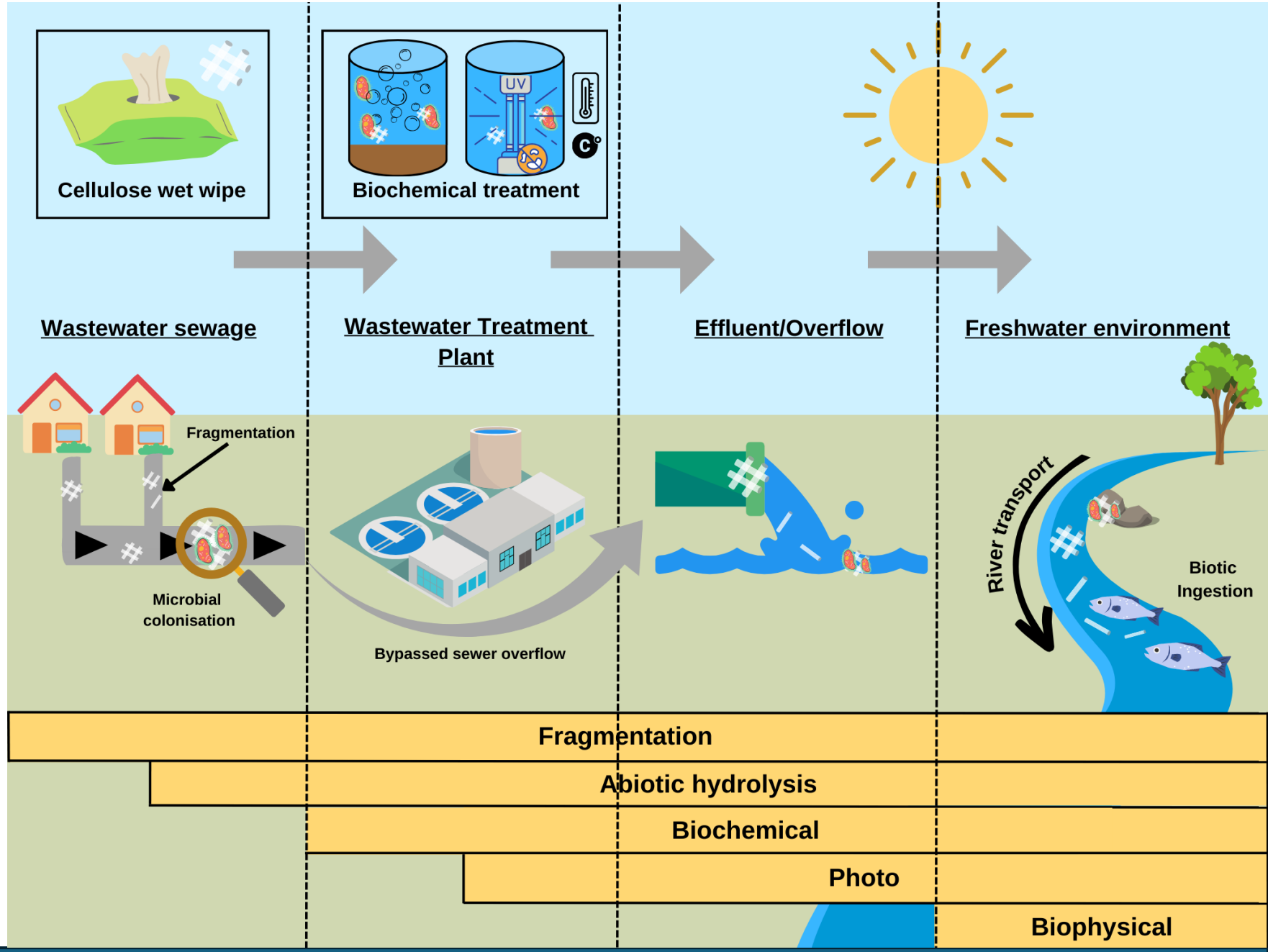
- Flushed cellulosic wipes fragment easily but complete molecular degradation is difficult

Environmental implications:

- Blockages, ingestion, chemical leaching, and pollutant vector risks



Likely degradation mechanisms:



Research gaps

1. Flushed transport pathways to rivers and abundance

2. In-situ investigations of environmental degradation behaviour

3. Influence of personal care additives on environmental fate

4. Biophysical interactions and transfer capability within and across ecosystems

Predicting flushed wet wipe emissions into rivers

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Predicting flushed wet wipe emissions into rivers

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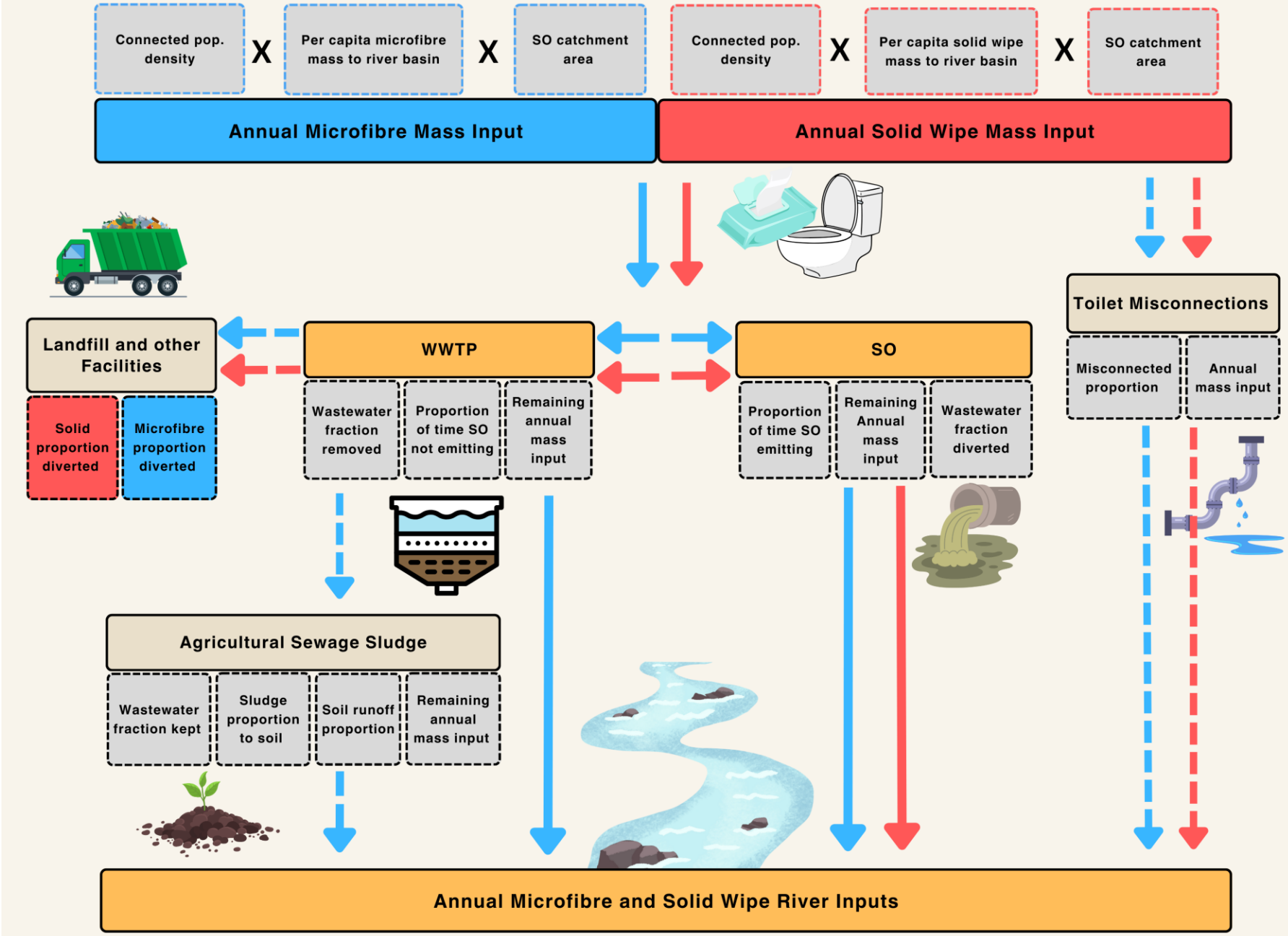
- Quantification needed to understand environmental risks
- Achievable by integrating emissions modelling with existing data!

Emission pathways and parameters

Solid wipe scenarios:
- Plastic and Cellulose

Microfibre scenarios:
- Plastic, Natural Cellulose, Regenerated Cellulose



	Total Mean
TOTAL (23%*)	2,500,000,000
Plastic containing (90%)	2,250,000,000
Non-plastic containing (10%)	250,000,000

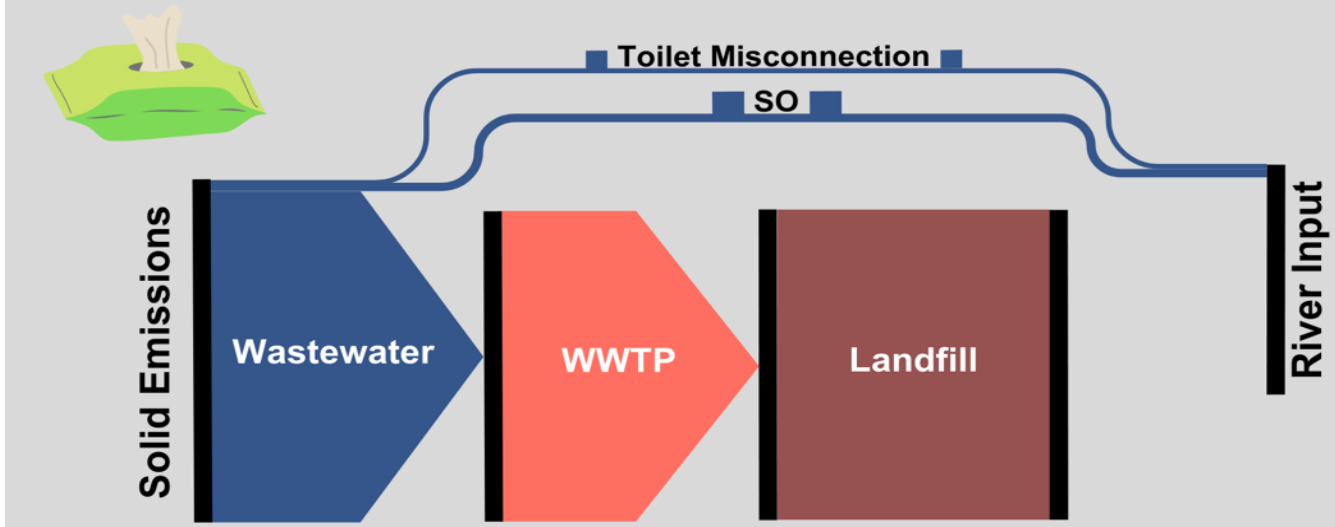
Flushed wipes per capita	Annually (no./cap/y)
Non Plastic	3.69
Plastic	33.2
Both	36.89

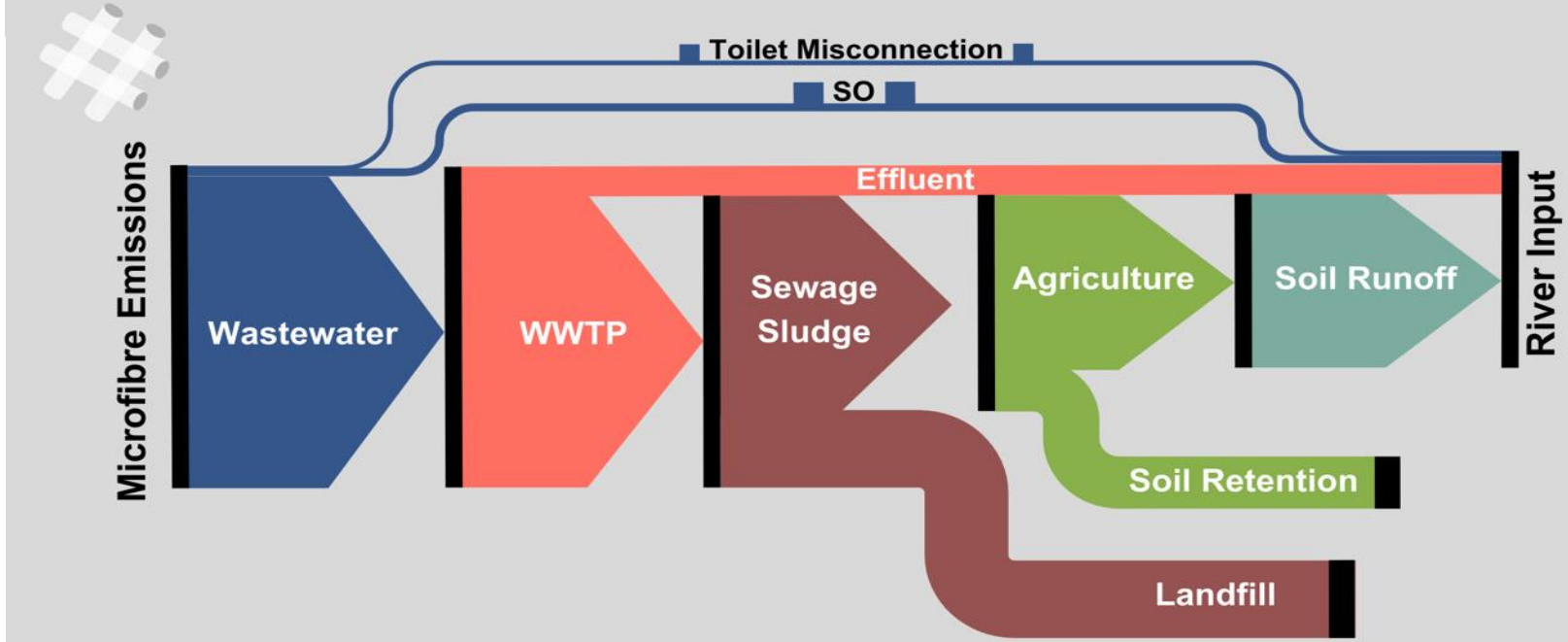
Fibre type	Microfibre generation (#/g wipe)[a]	Mass generation (mg/g wipe) [a]	Total microfibre generation (#/wipe)*	Total mass generation (g/wipe)*
Natural	548,000 (163,000 – 933,000)	28 (16–40)	2603,000 (774,250 – 4431,750)	0.133 (0.076 – 0.19)
Regenerated†	27,800 (15,000 – 40,600)	3.6 (0.4 – 6.8)	132,050 (71,250 – 192,850)	0.0171 (0.0019 – 0.0323)
Plastic	2940 (710 – 5170)	0.73 (0.24 – 1.22)	13,965 (3373 – 24,558)	0.0034 (0.0011 – 0.0058)

[a] Values derived from Kwon et al. (2022).

* Average wipe mass when wet of 4.75 g derived from Durukan and Karadagli (2019).

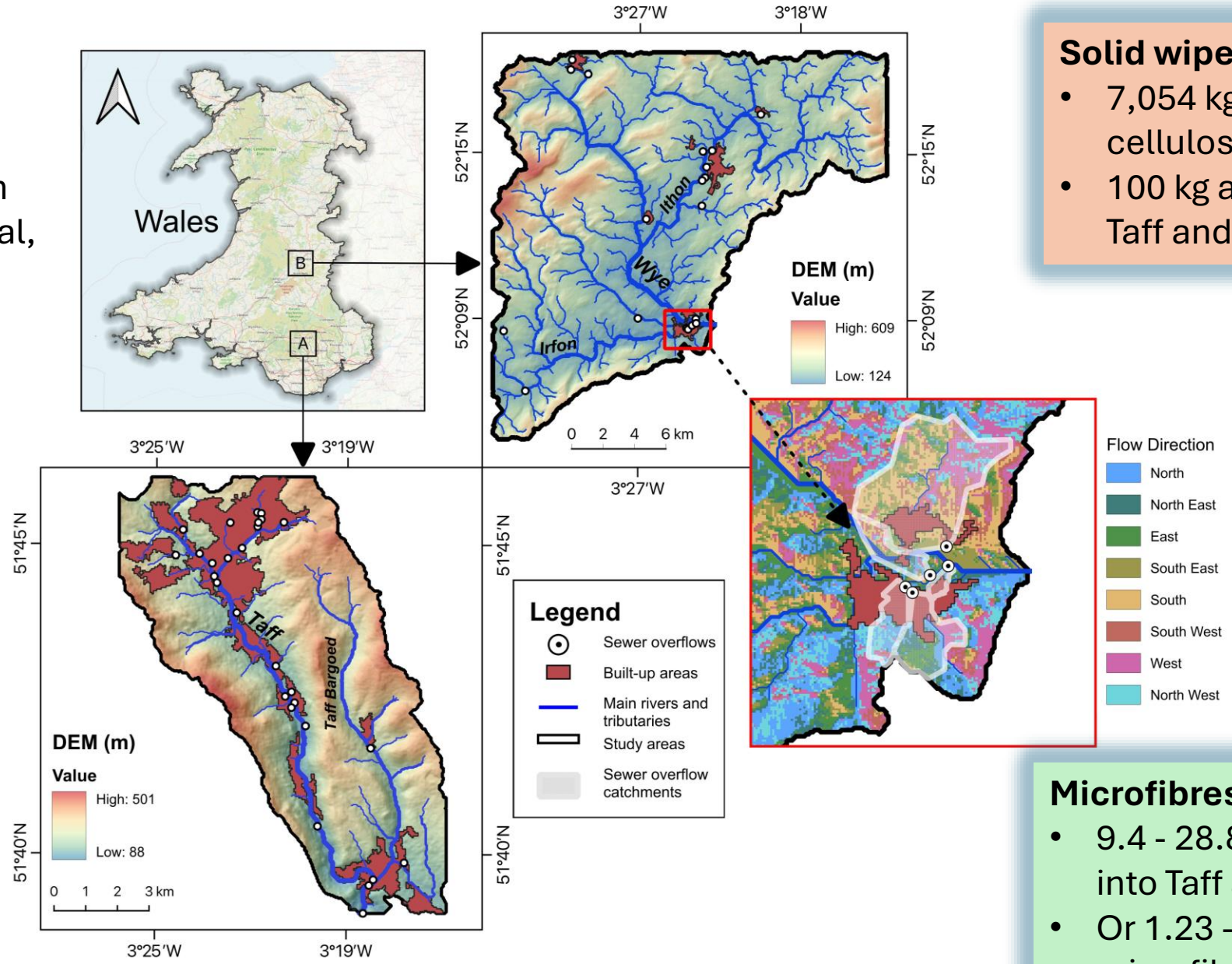
† Originally non-natural but relabelled as regenerated based on Zambrano et al. (2020).





Also created a novel method to link populations to wastewaters based on local geomorphological, hydrological, and SO data

Allowed for more precise and spatially-specific emission estimates



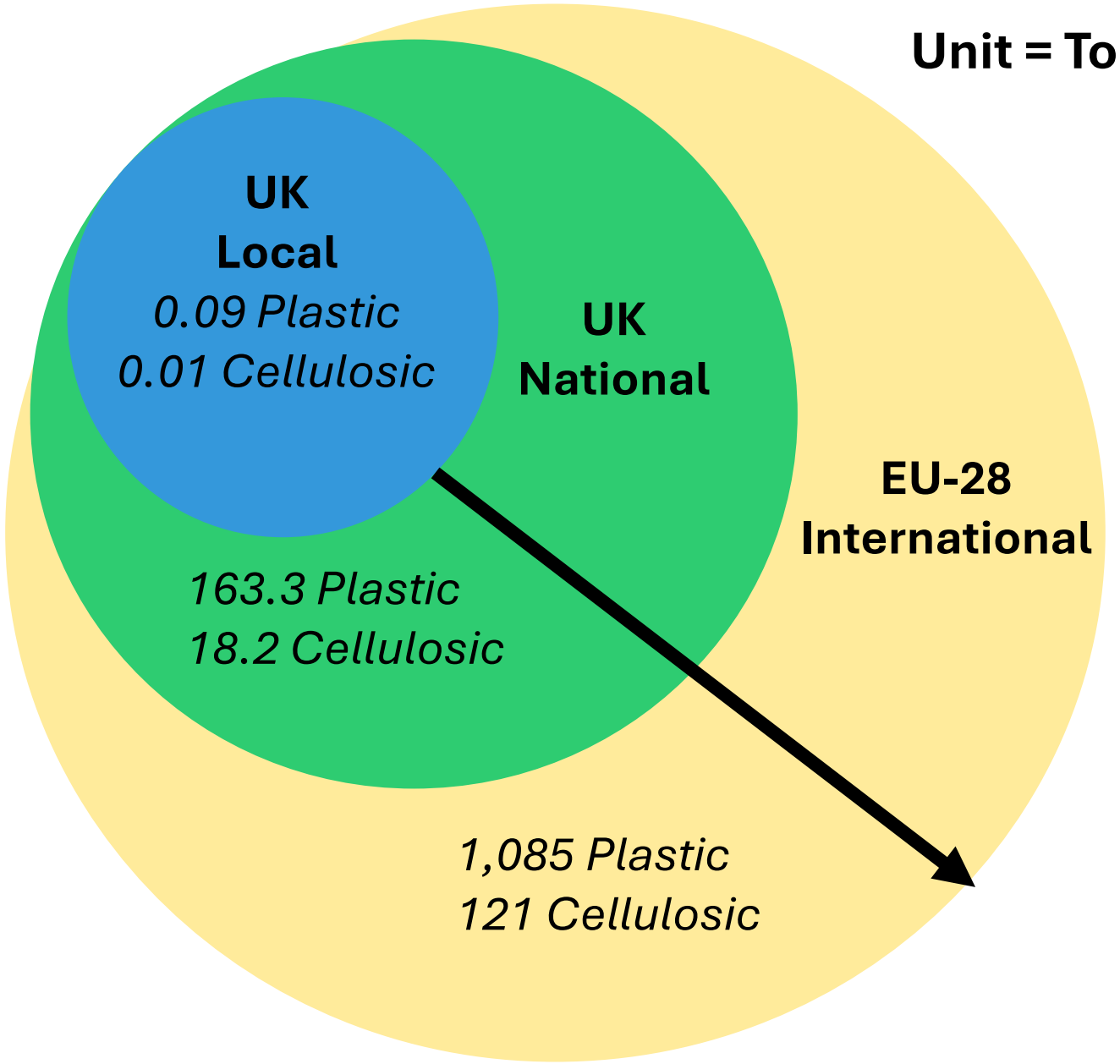
Solid wipes

- 7,054 kg plastic and 784 kg cellulosic to wastewater
- 100 kg and 6.49 kg total to Taff and Wye annually

Microfibres

- 9.4 - 28.8 kg microfibres into Taff and Wye annually
- Or 1.23 - 18.9 billion microfibres!

Unit = Tonne



UK:
Flushing rate of 23%
SO spill rate of 2.6%
Misconnection rate of 0.24%

EU:
Flushing rate of 29.5%
SO spill rate of 1.97%
Misconnection rate of 0.28%

Conclusions and recommendations

Both plastic and non-plastic flushed wipes pose significant pollution risks to wastewater and river systems at both macro and micro levels.

Addressing this issue requires:

- Manufacturing and consumer disposal behaviour as priority policy areas

Improved standards & transparency

- Universal labelling with realistic, diverse testing for biodegradability
- Full disclosure of materials and chemicals used in production

Careful assessment of alternatives

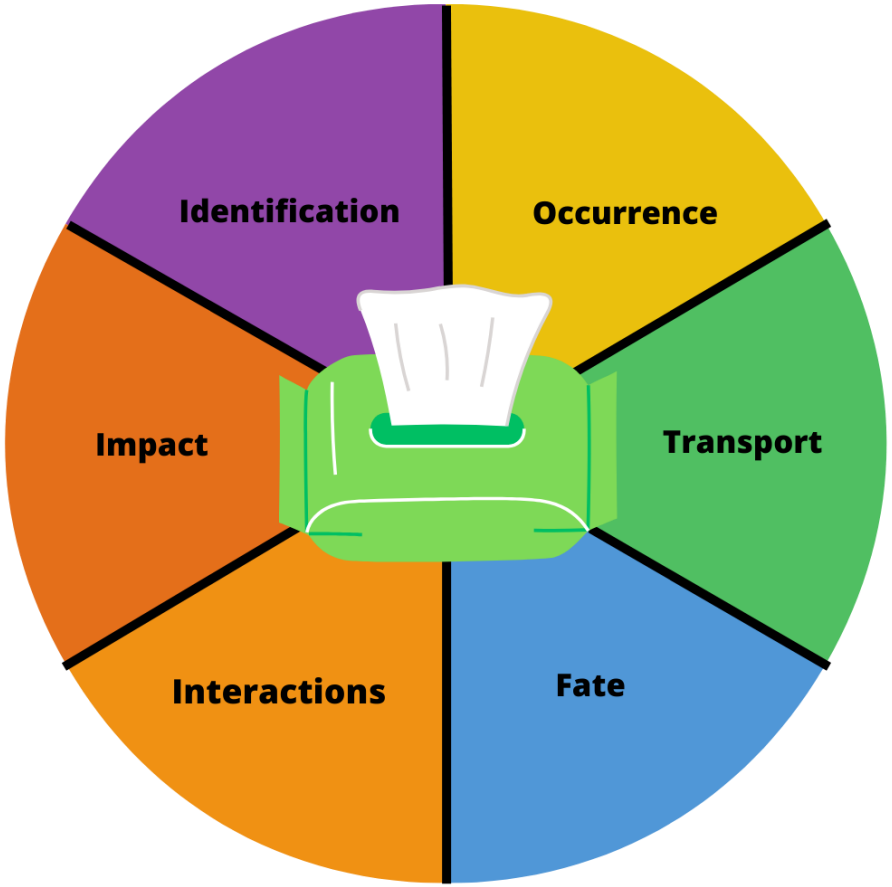
- Detailed life-cycle assessments before promoting plastic alternatives

Educating consumers

- More effective disposal and environmental impact education to address ”out of sight, out of mind” behaviours. Also to understand socio-cultural reasons underpinning flushing behaviour.

Enforce accountability

- EPR compliance on inappropriate disposal and pollution/damage?



Questions?

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