Sustainability of water treatment and consumption

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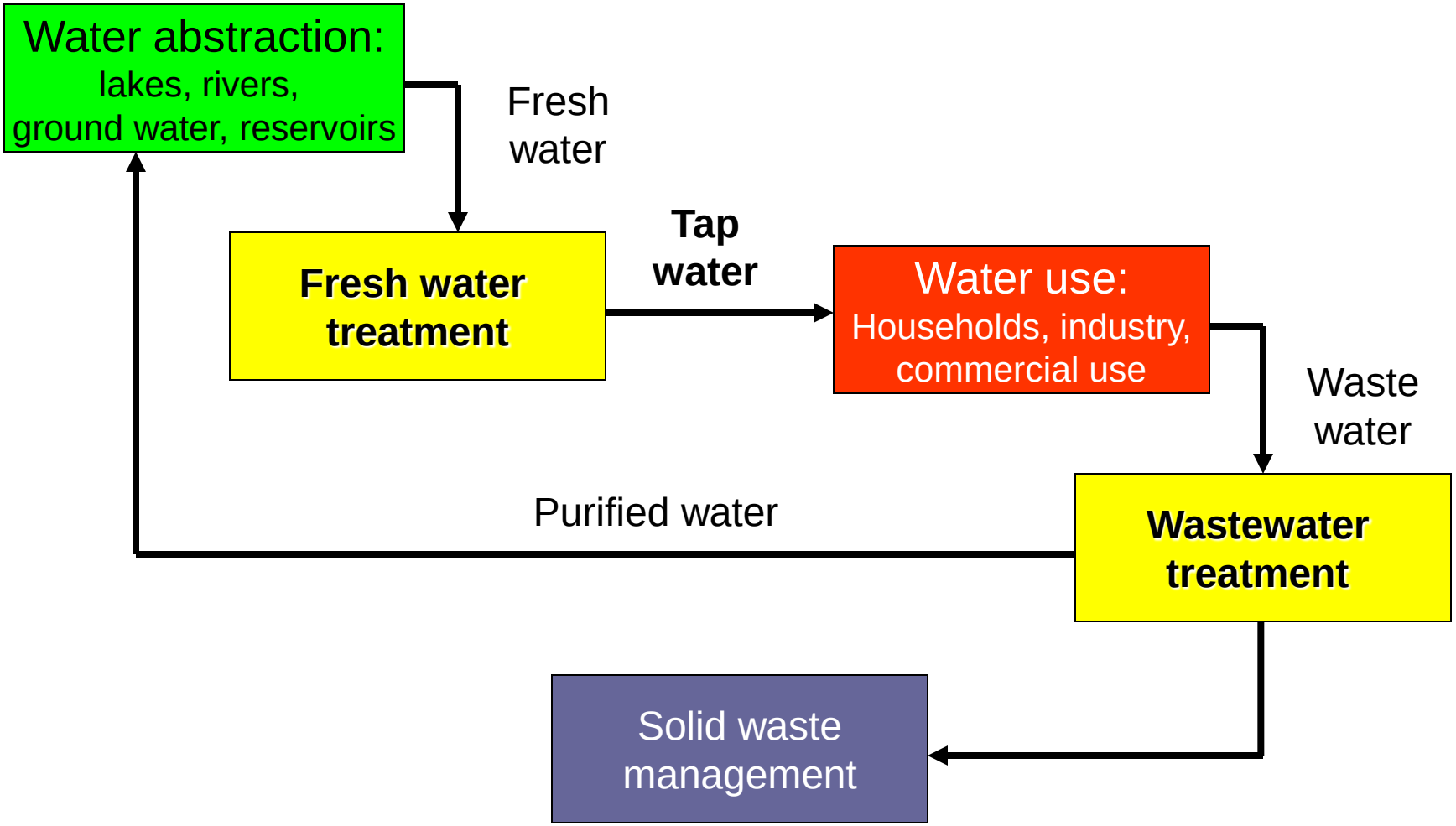
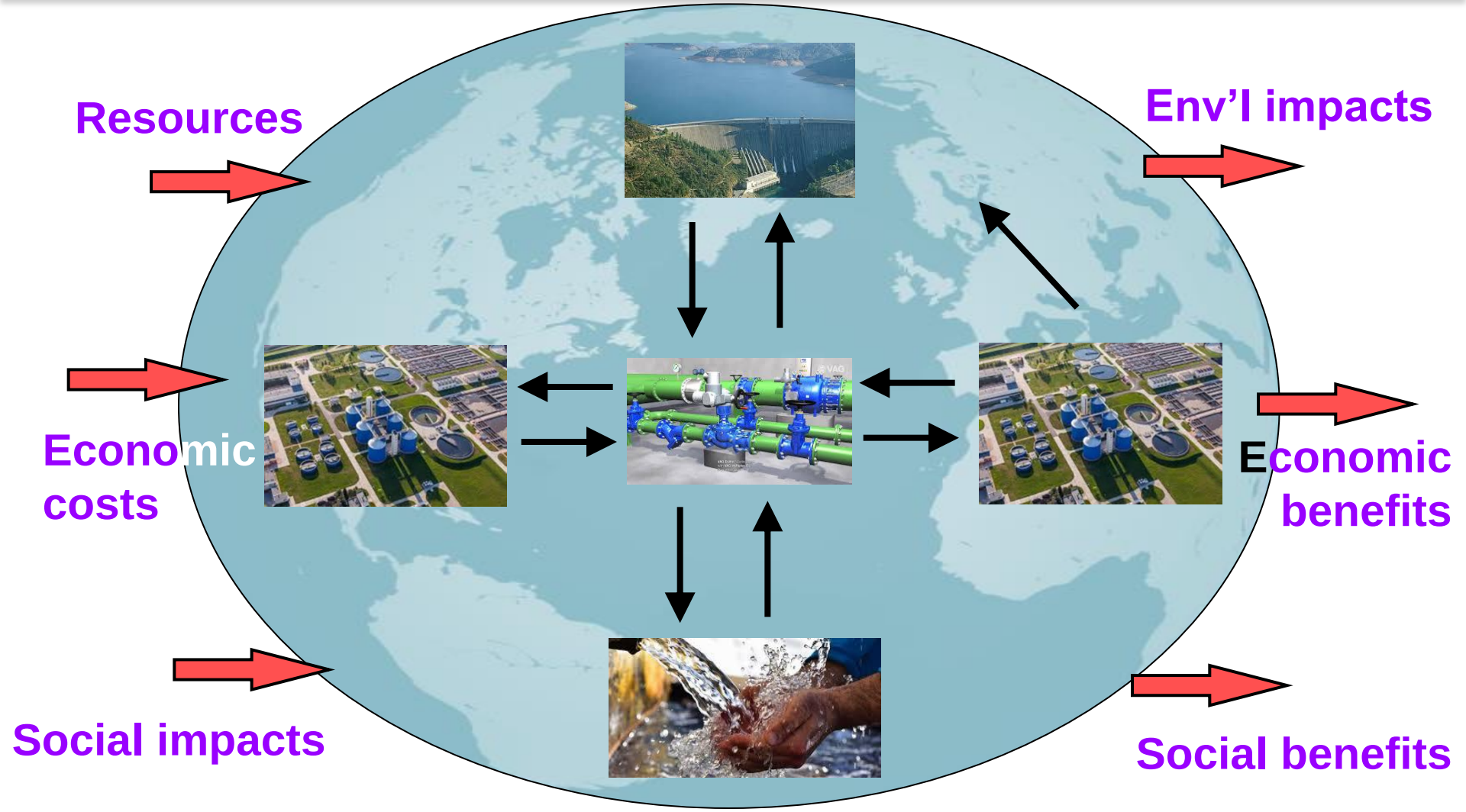
Outline

- The life cycle of water
- Life cycle sustainability
- Illustrative examples
- Conclusions

The life cycle of water



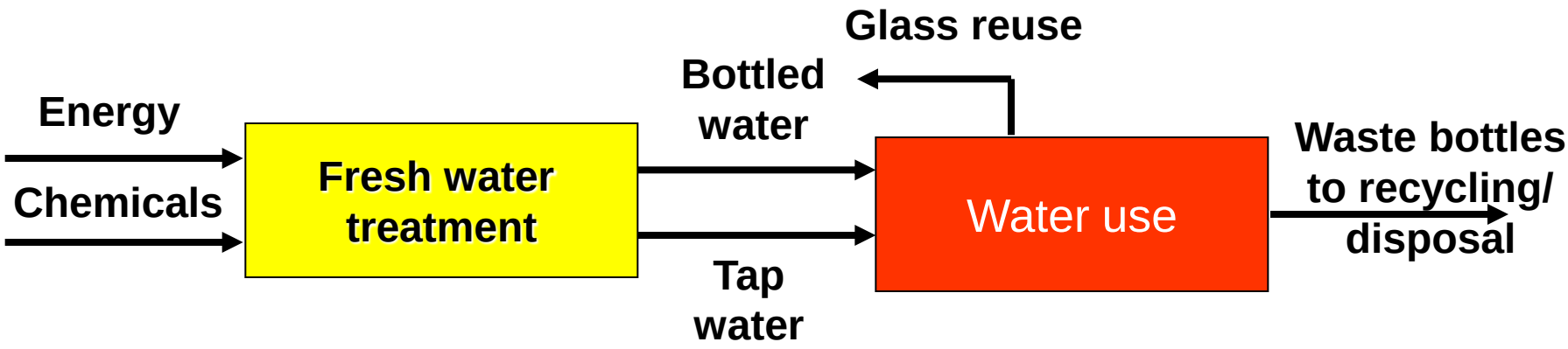
Life cycle sustainability of water



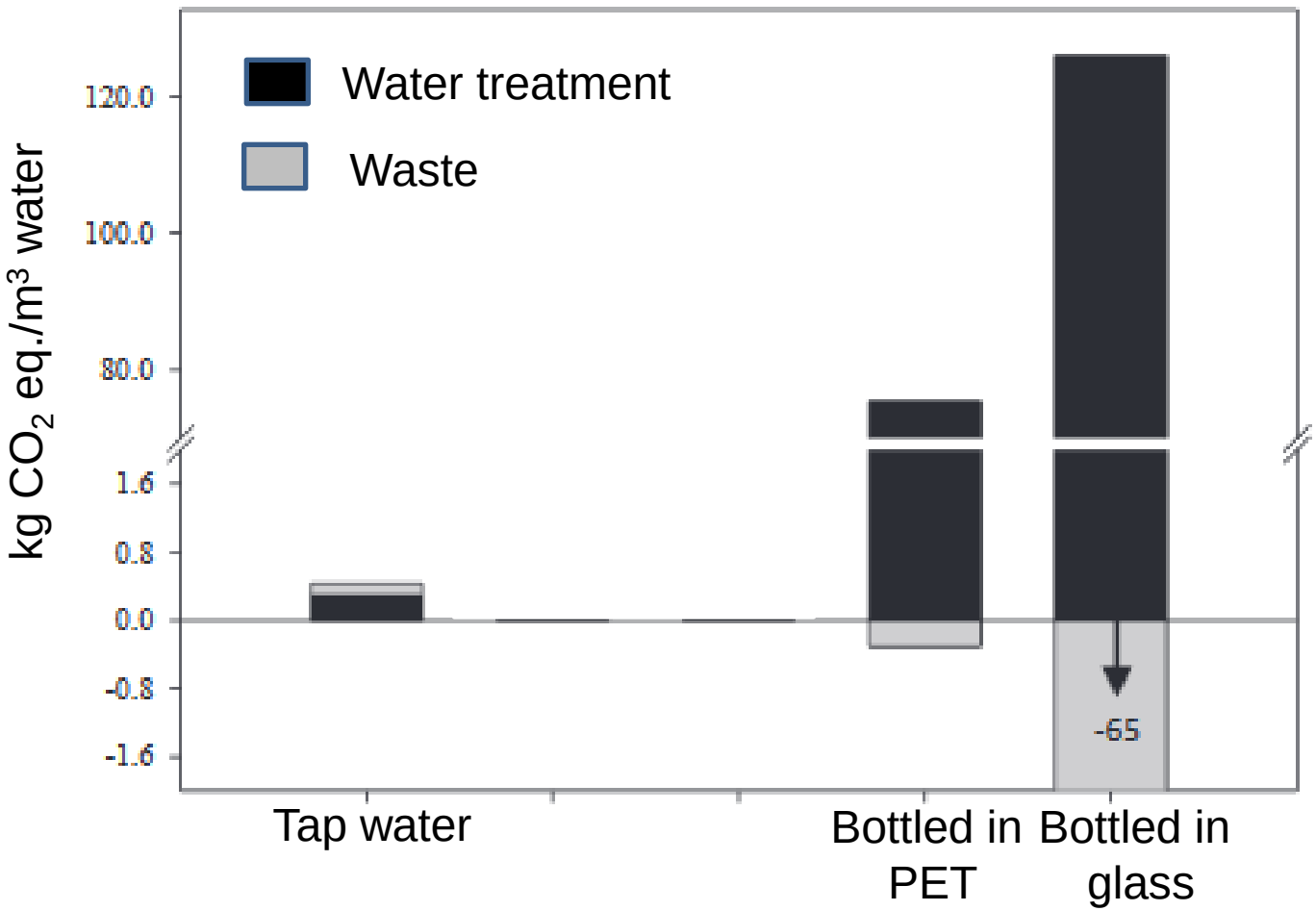
Environmetnal sustainability: Life cycle assessment

- Estimation of environmental impacts from ‘cradle to grave’
- Some impacts
  - Energy and resource use
  - Climate change (carbon footprint)
  - Acidification
  - Eutrophication
  - Ecotoxicity
  - ….

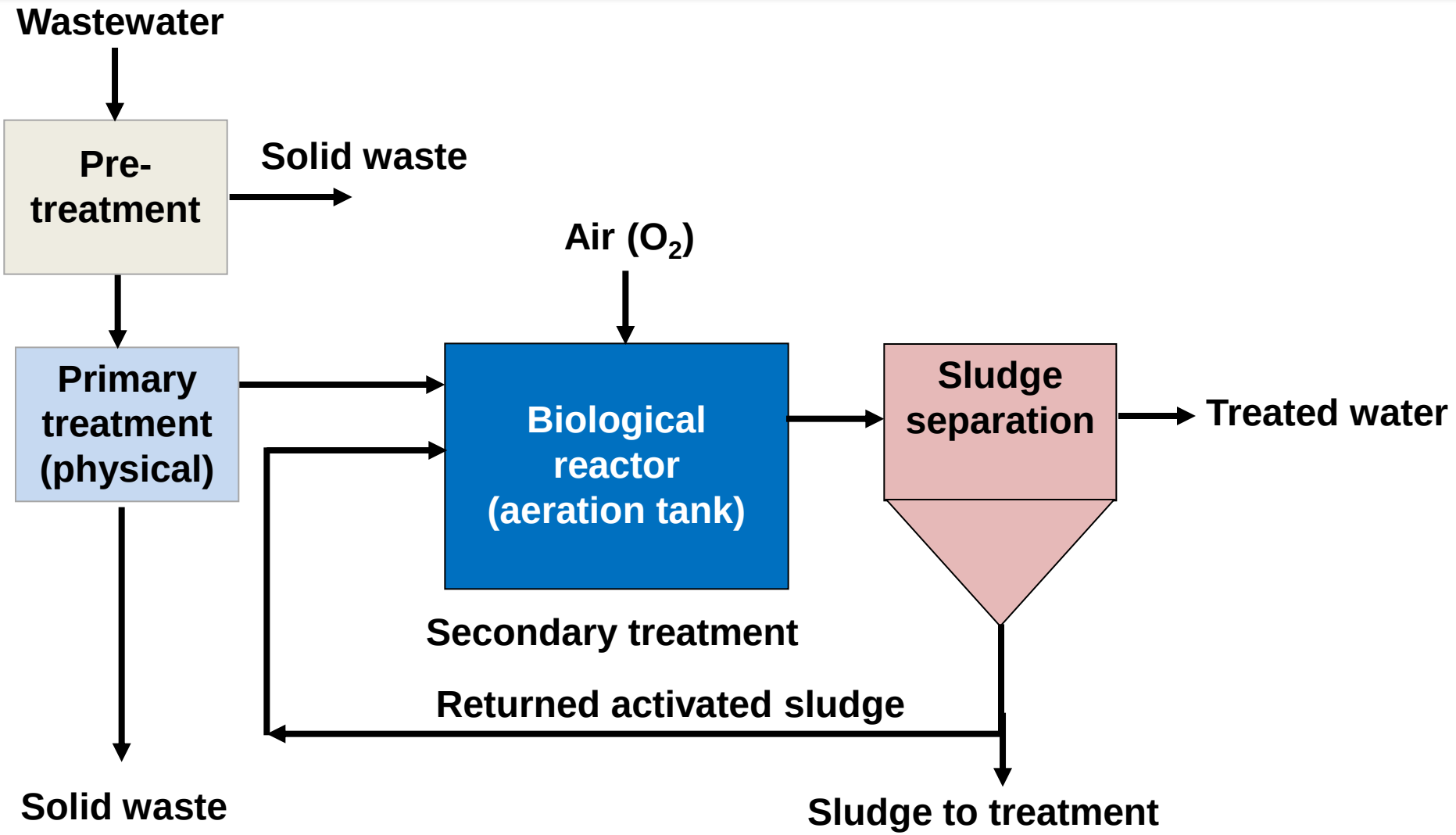
The life cycle of drinking water



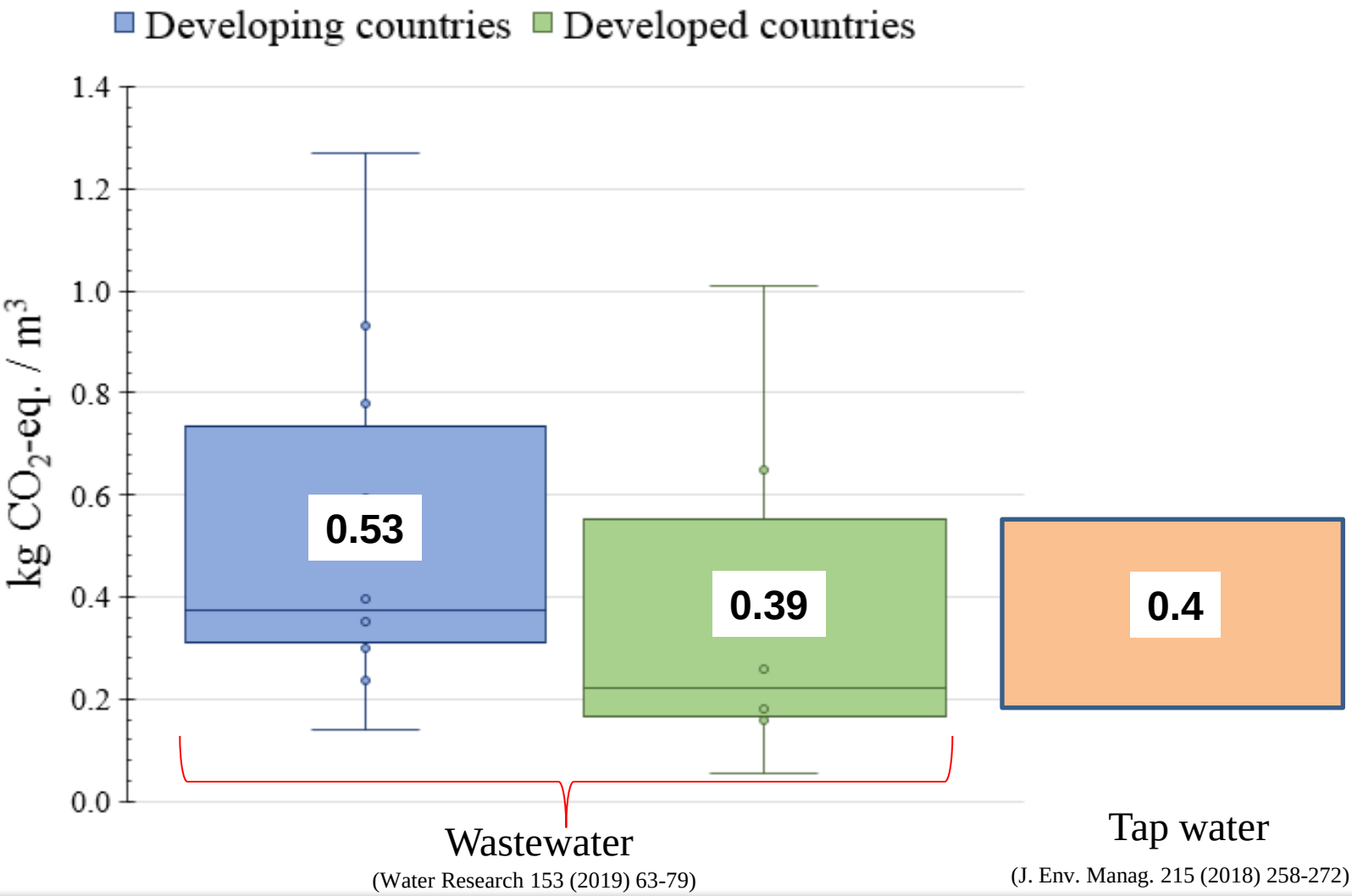
Carbon footprint of drinking water



The life cycle of wastewater



Carbon footprint of wastewater treatment



(Water Research 153 (2019) 63-79)

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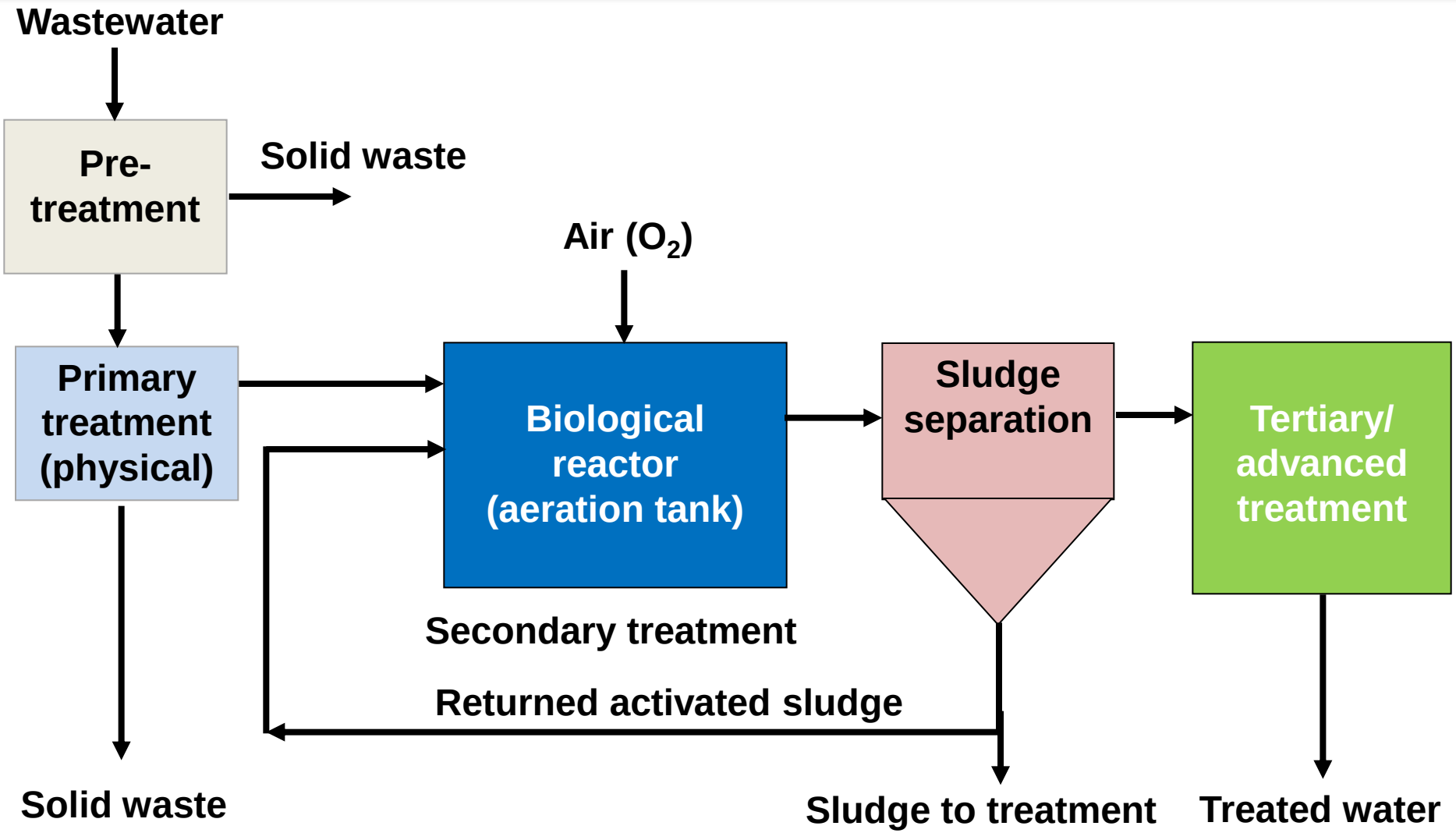
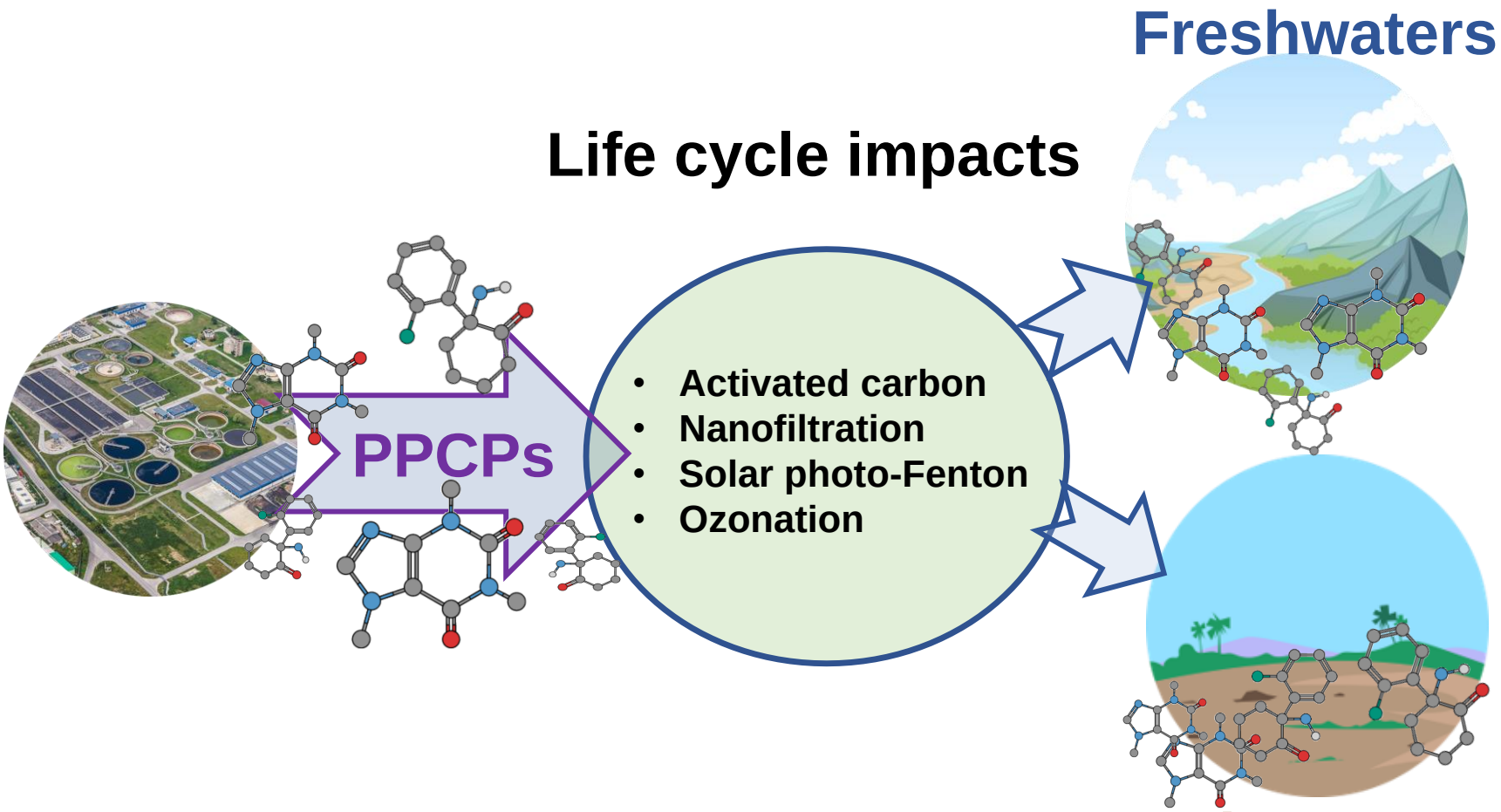
The life cycle of wastewater



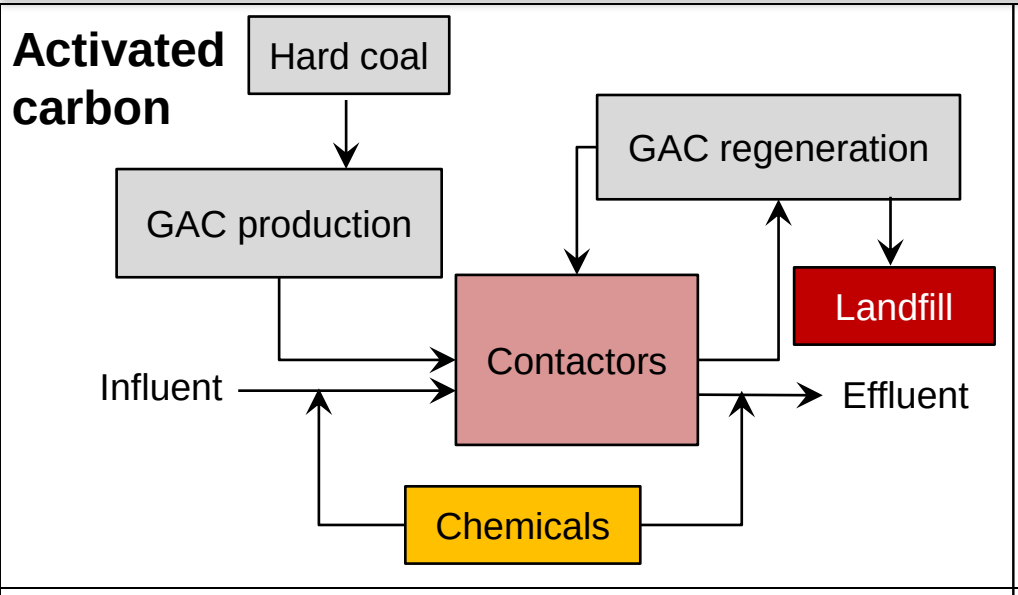
Advanced wastewater treatment

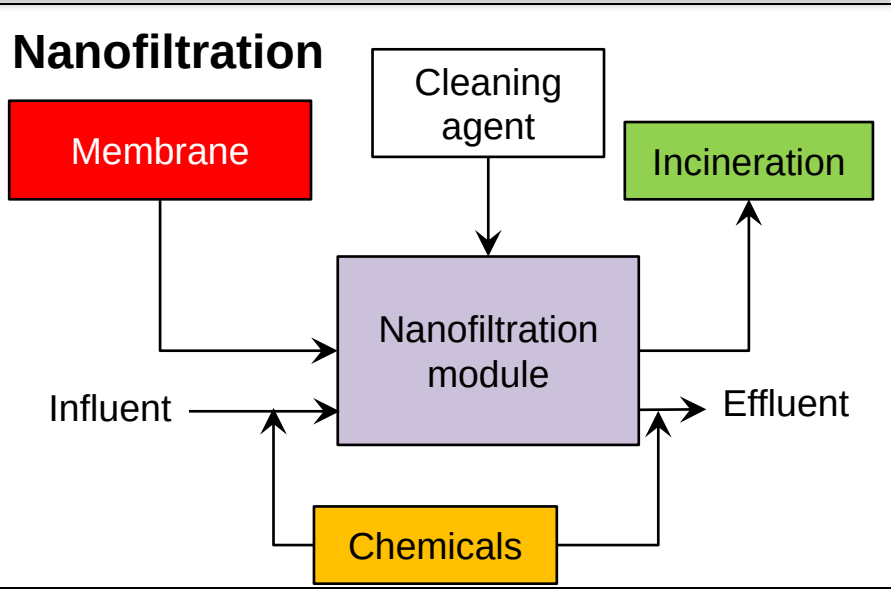
- Emerging pollutants
  - Food additives, hormones, metals, pharmaceutical and personal care products (PPCPs)
- Over 3000 chemicals used for PPCPs and they eventually reach the environment
- One of the main pathways are wastewater treatment plants

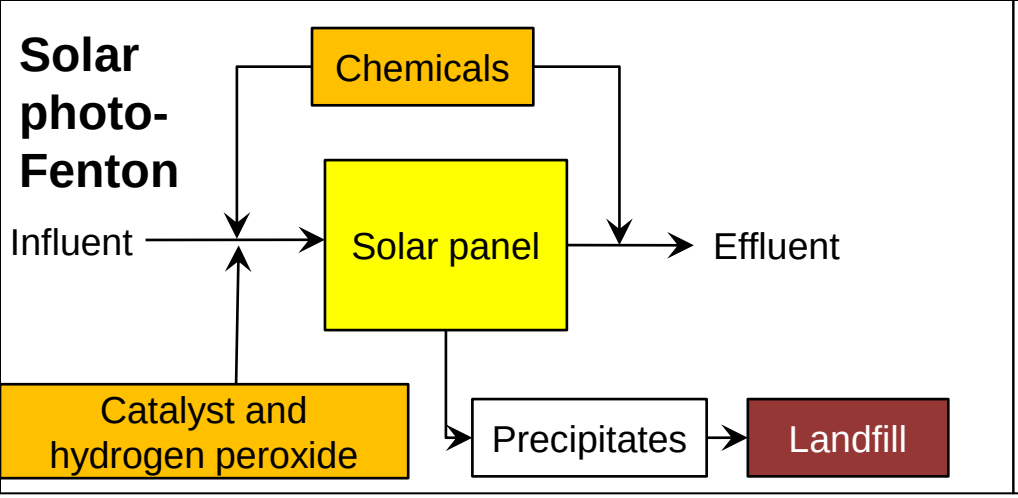
Advanced wastewater treatment

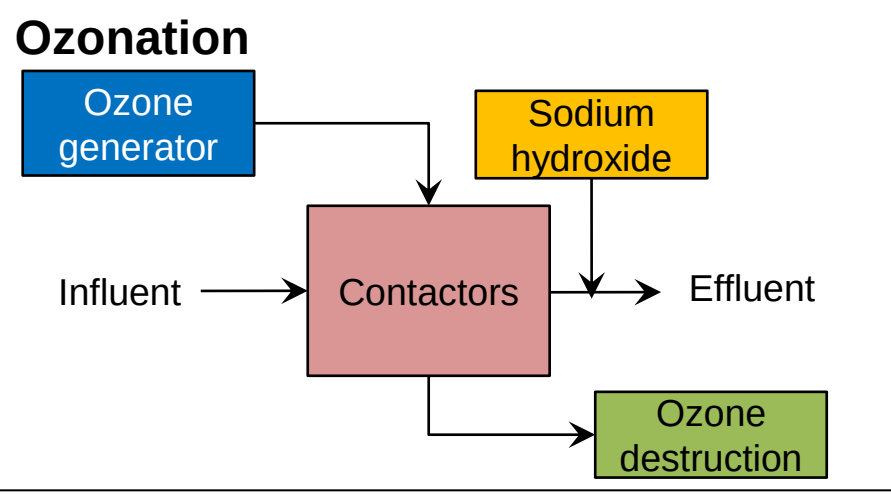


Advanced treatment methods

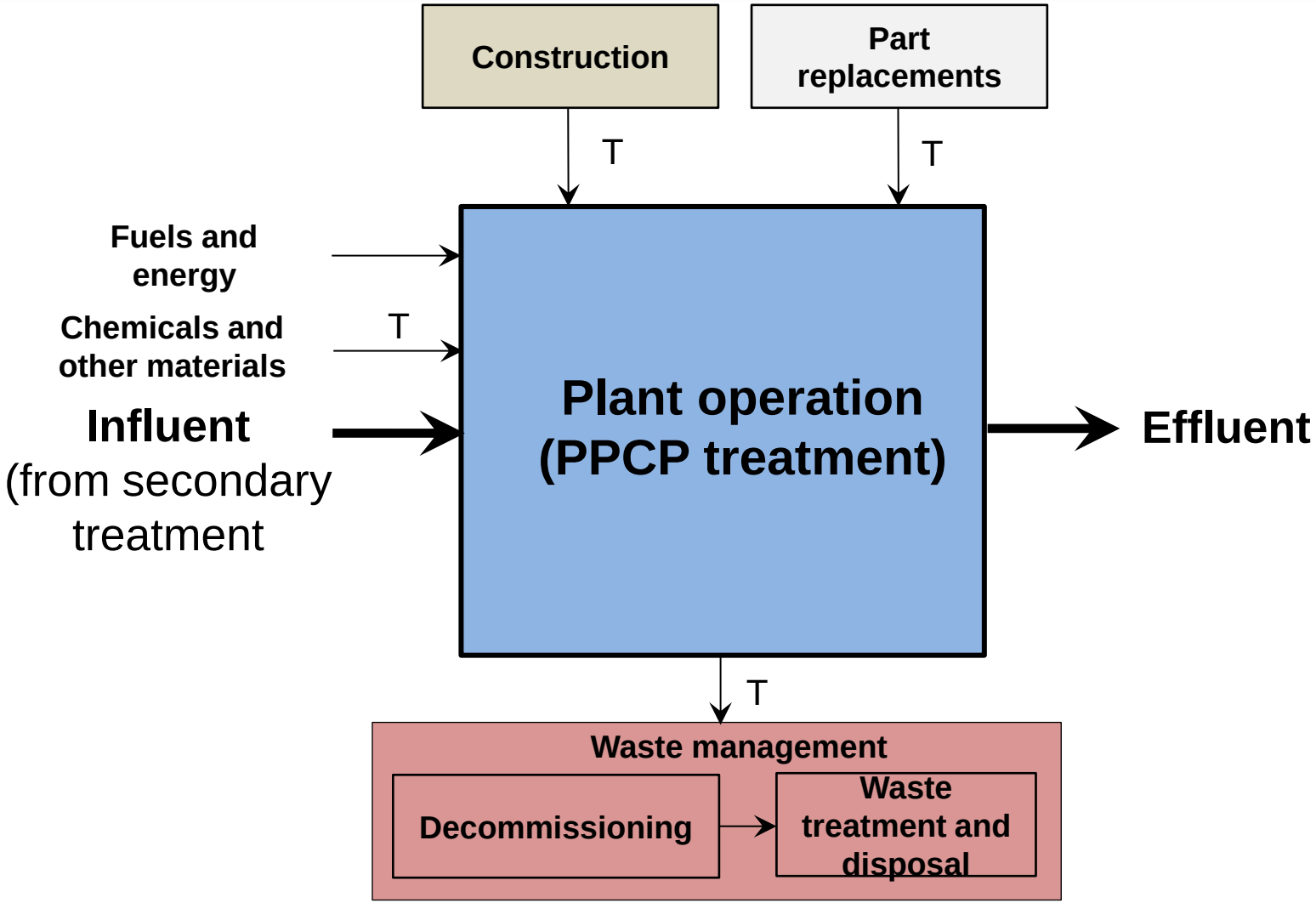




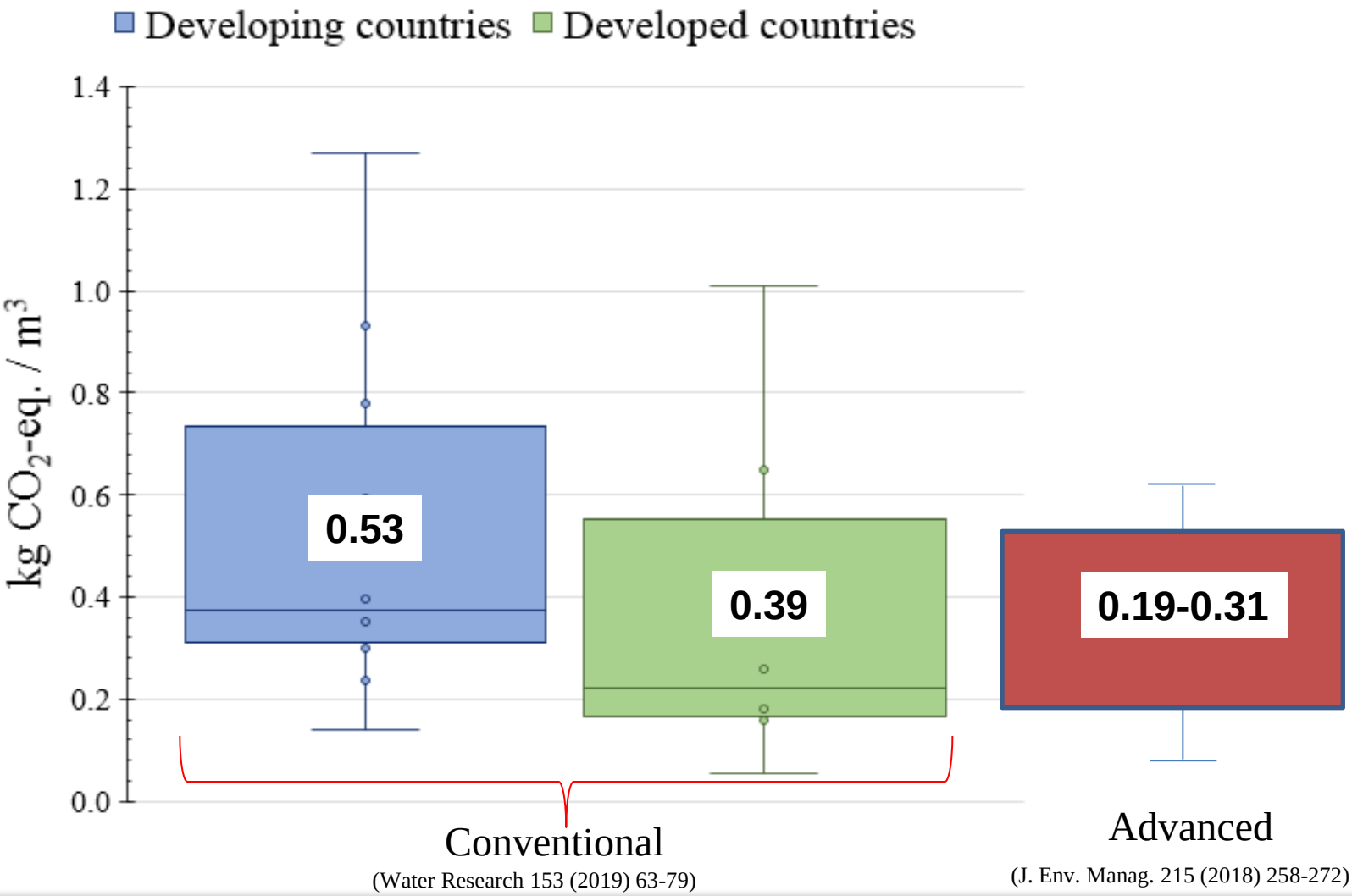




System boundaries



Carbon footprint of conventional and advanced wastewater treatment



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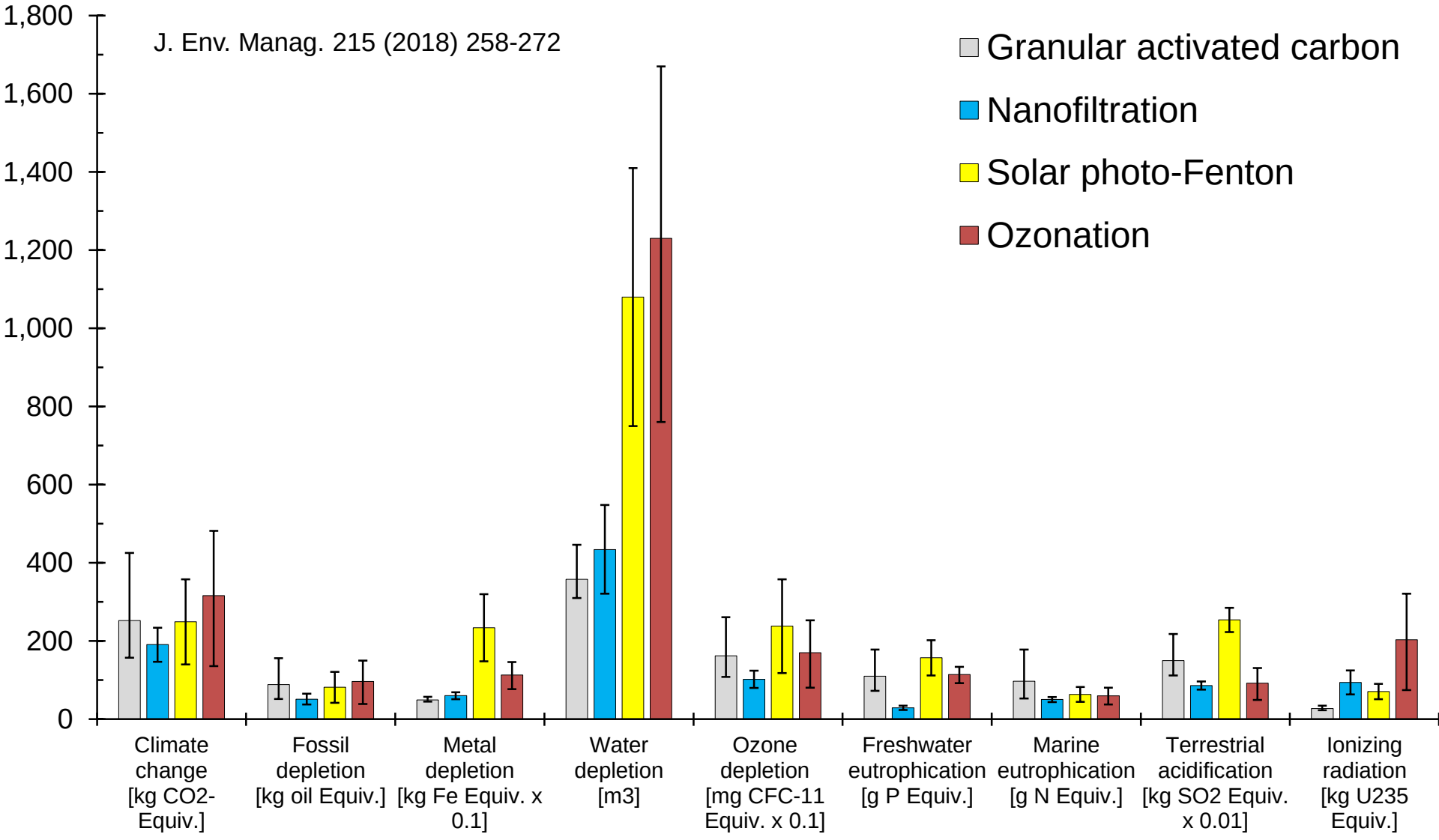
Life cycle impacts (per 1000 m^3)



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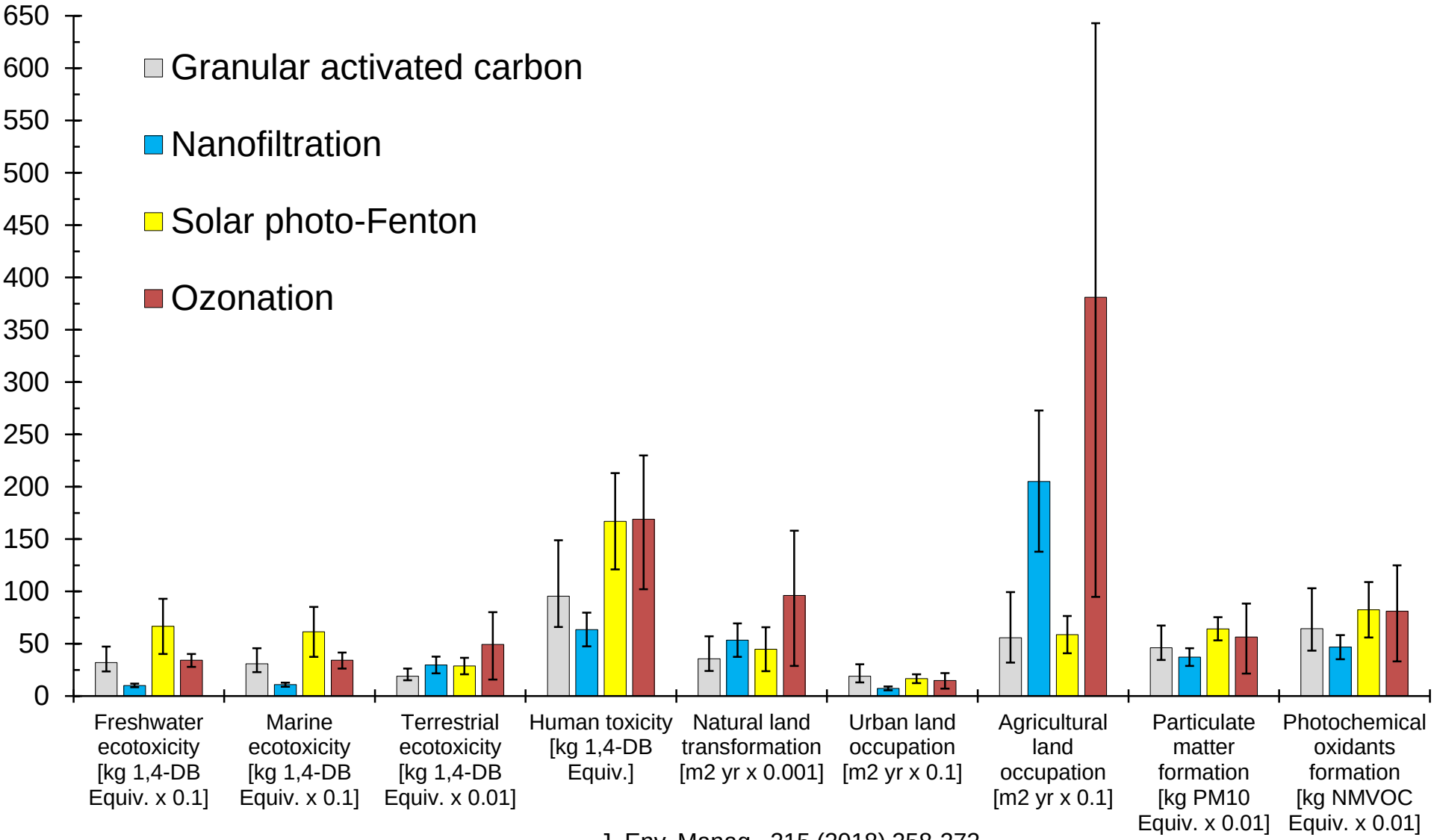

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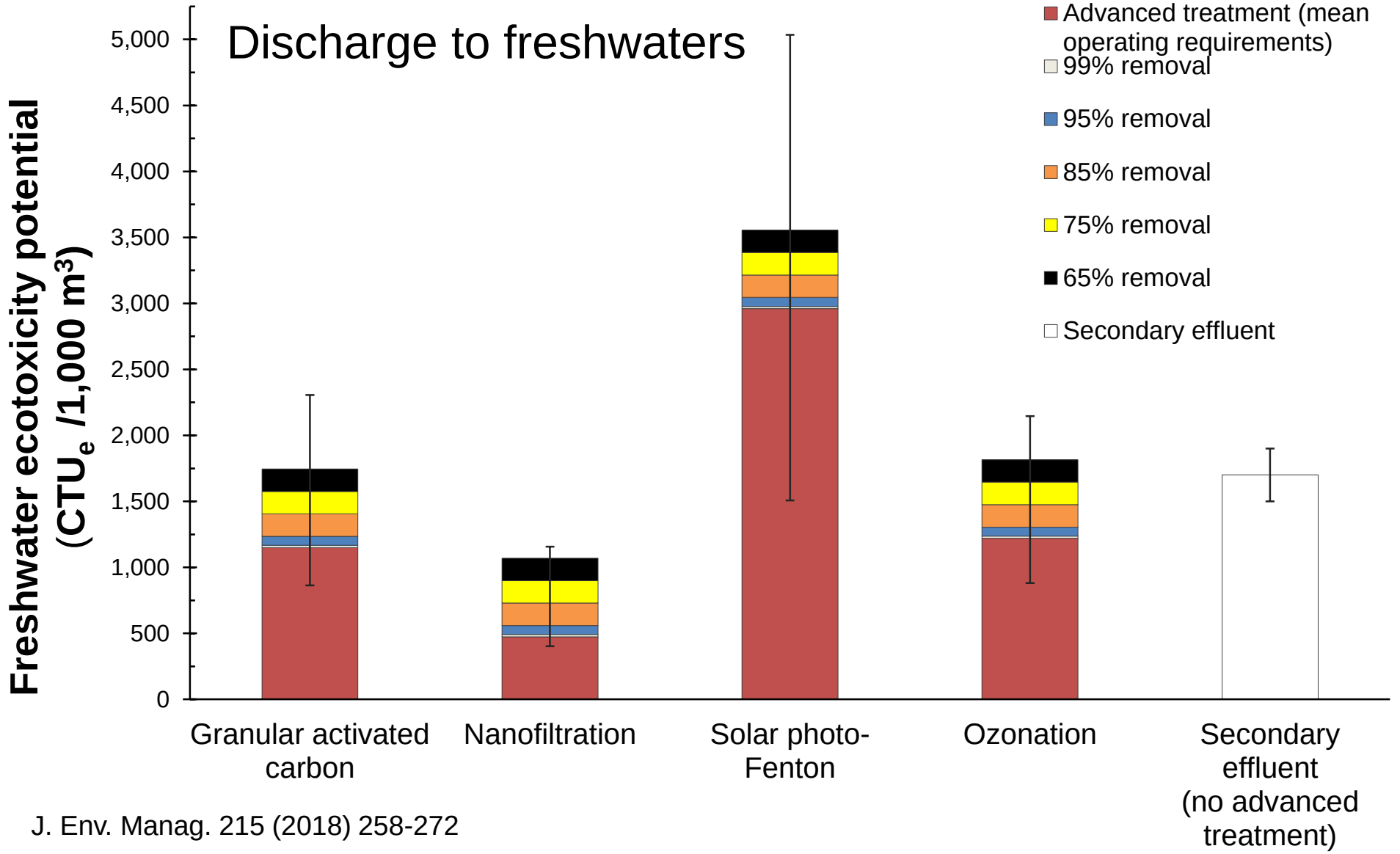
Advanced treatment summary

- Nanofiltration (NF) has the lowest impacts for 13 out of 18 categories
- Granular activated carbon (GAC) is the best alternative for 5 impacts but it has the highest marine eutrophication
- Solar photo-Fenton and ozonation are the least sustainable for eight impacts, including ecotoxicity and climate change
- GAC and NF are more efficient in treating heavy metals - more suitable for potable reuse of wastewater

Water ecotoxicity: To treat or not to treat?



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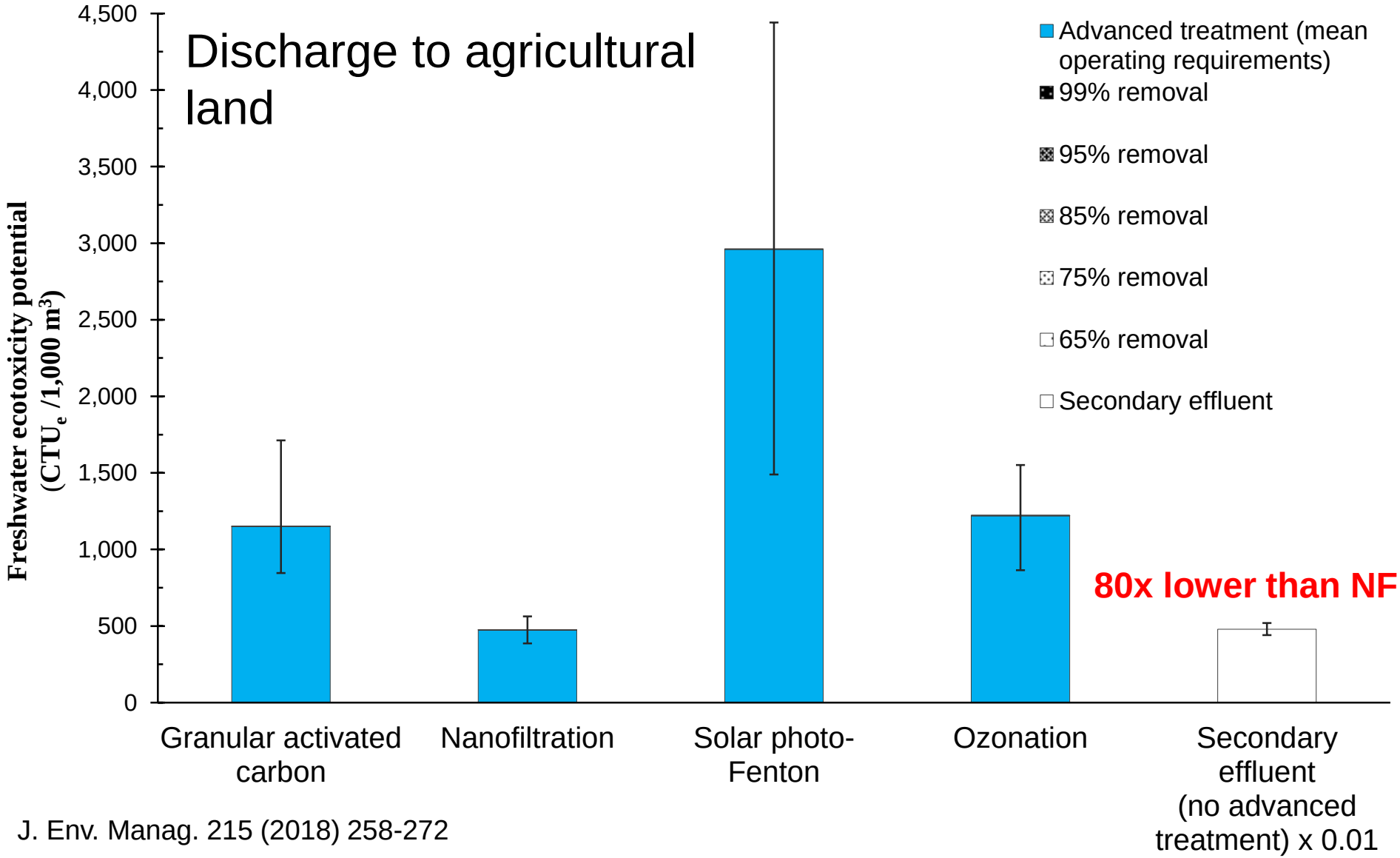
Water ecotoxicity: To treat or not to treat?



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Advanced treatment summary

- Releasing the effluent without advanced treatment to agricultural land reduces freshwater ecotoxicity much more than treating it

- Therefore, the use of advanced effluent treatment for agricultural purposes is not recommended

Conclusions

- A life cycle approach is essential for understanding the full impacts and benefits of water production and consumption
- Life cycle assessment is a powerful tool for identifying environmentally sustainable water provision options
- Much more work is needed on reducing the consumption of water

Acknowledgements

- Raphael Tarpani
- Alejandro Gallego Schmid

- Manel Poch
- Sebastiá Puig