

Pathways for circular agri-food ecosystems

Excreta as a key to reconnect urban and rural areas

Transdisciplinary Research for a Healthy Planet

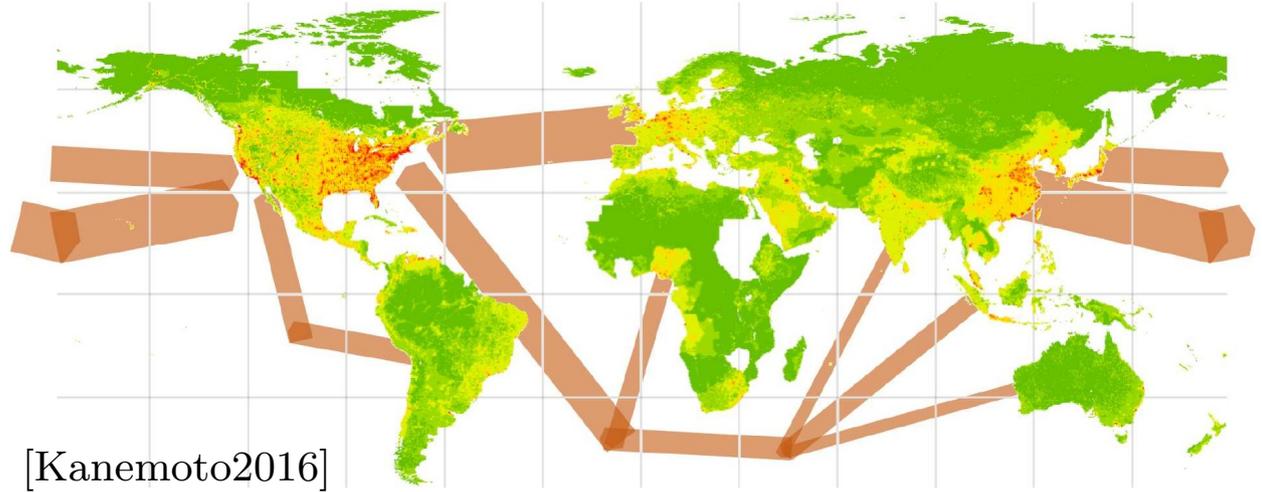
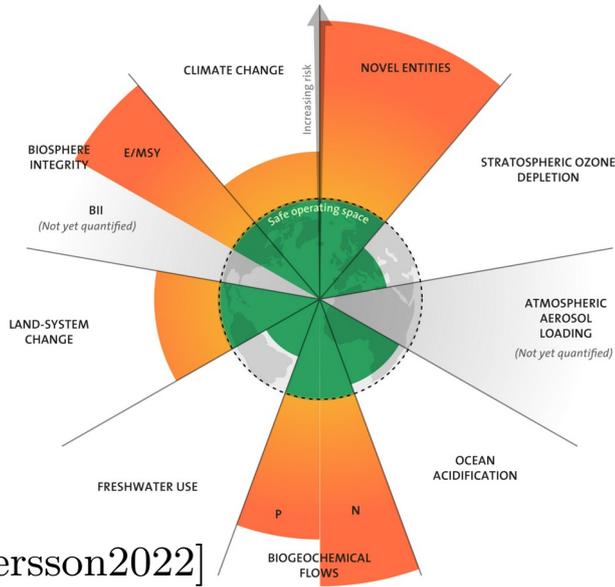
March 30, 2023

Tanguy Fardet

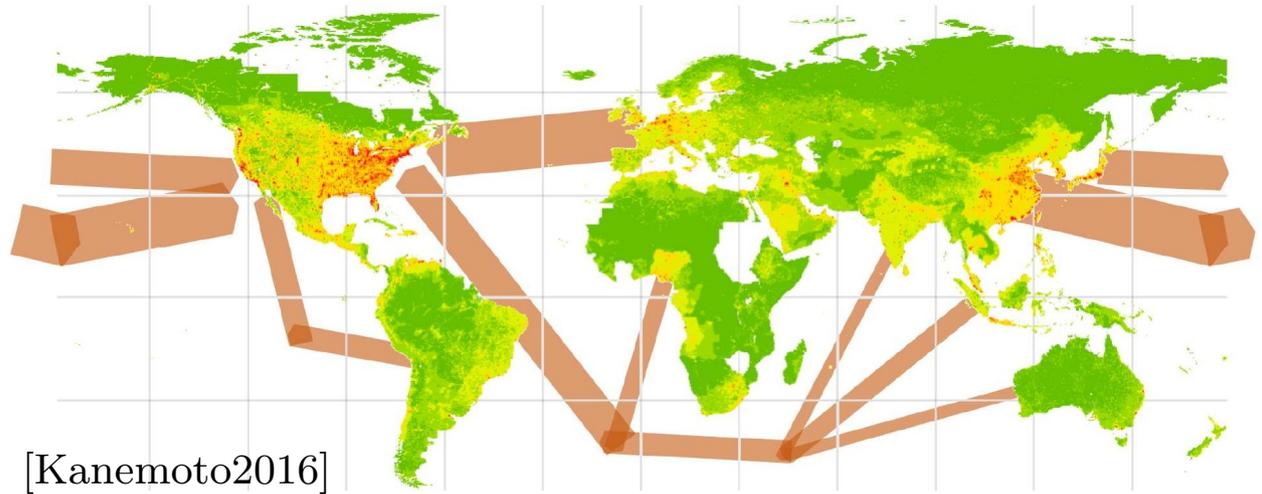
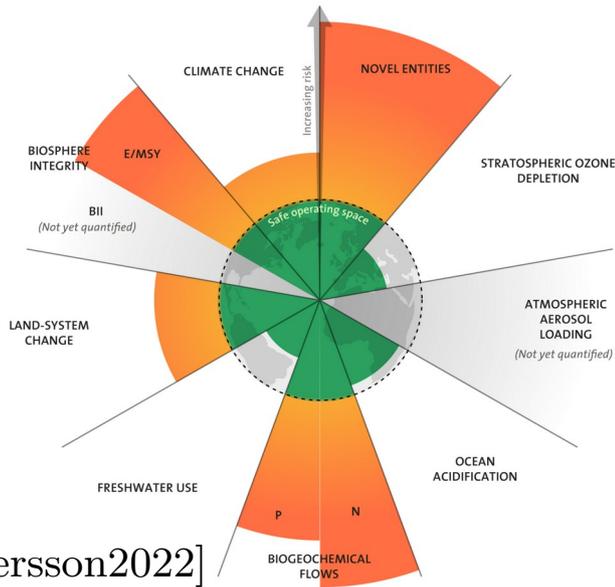


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PARIS-EST CRÉTEIL
VAL DE MARNE

A metabolic problem?

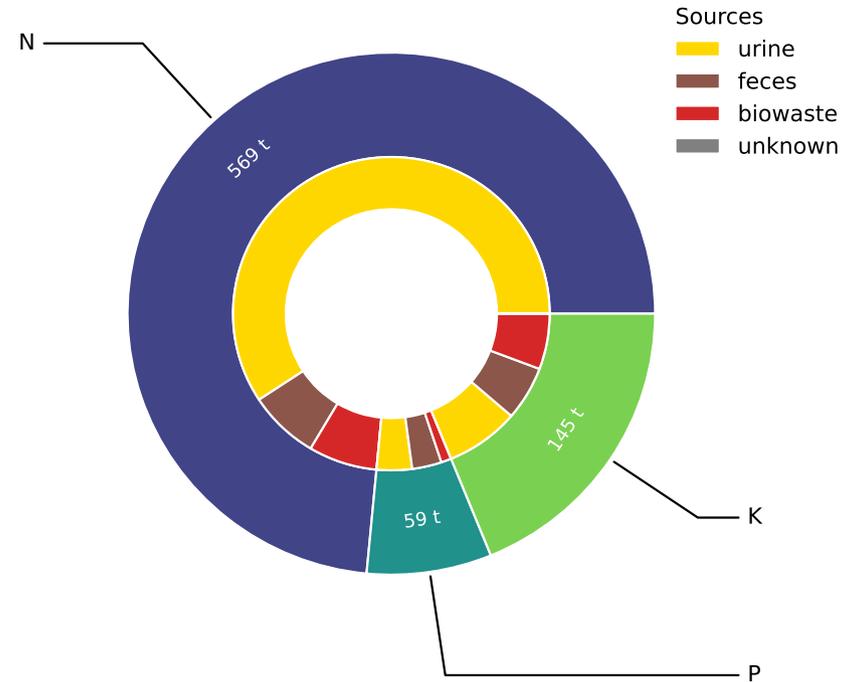


A metabolic problem?



- Western cities behave like their countries
- Import large amounts of valuable resources
- Export poorly reusable matter (“waste”)

Human excreta as a resource



Credits:

Louise Raguét

A week in Paris

A resource flushed down the drain



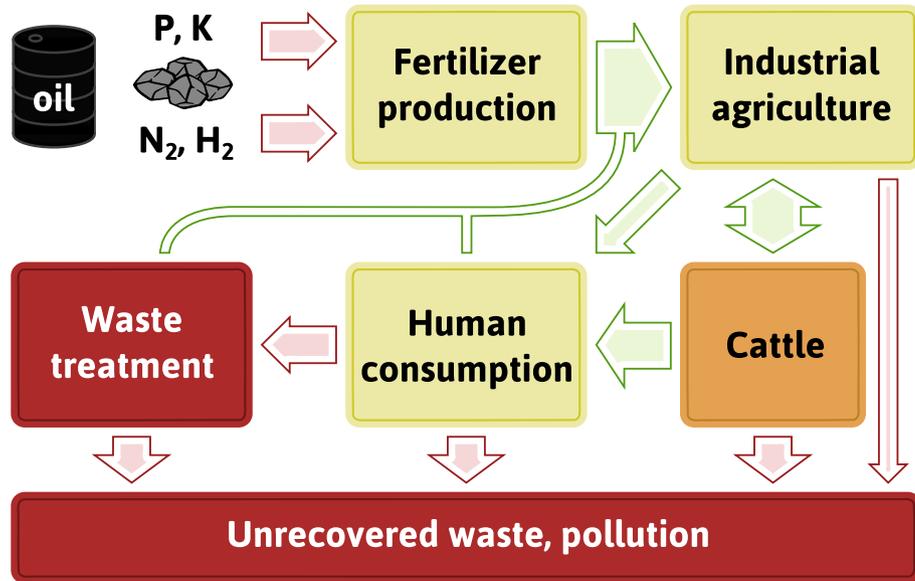
Flushed (potable water)

to the sewers

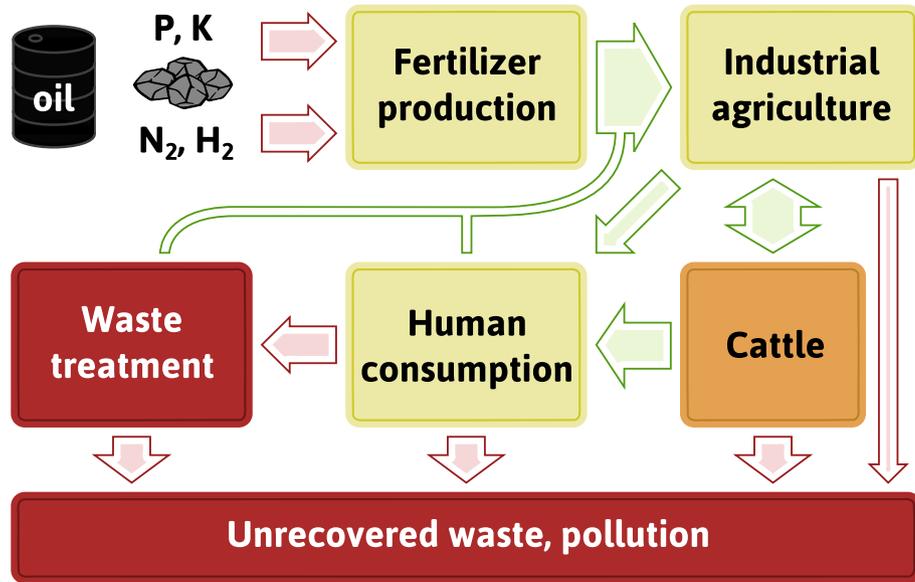
then lakes and seas

- 5% recovery for N, 50% for P (but polluted)
- Bacterial and viral pollution of the water
- Eutrophication

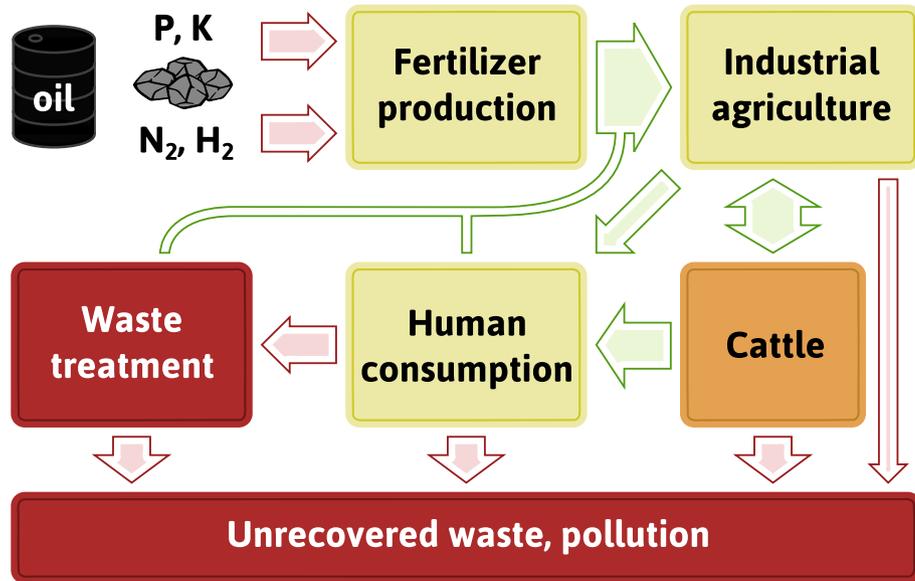
Towards sustainable agri-food systems



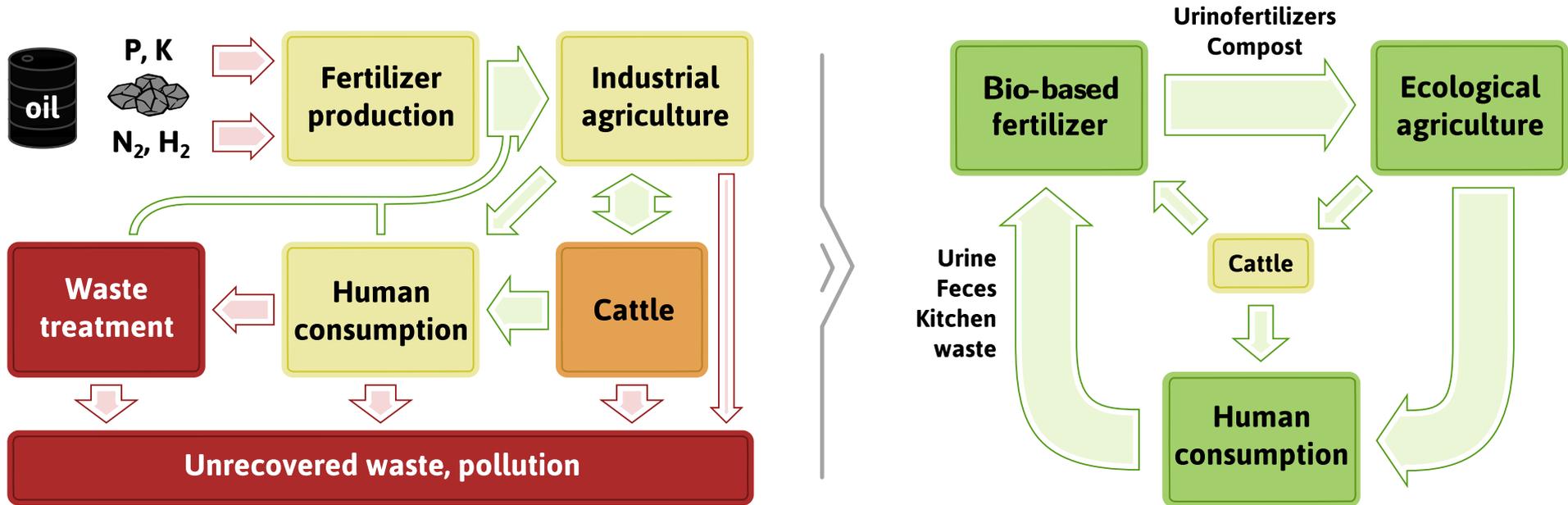
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The stakes of humanure

- 30 MtN, 3 MtP, 5 MtK/y deposits worldwide (out of 100/17/33 Mt)

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- 30 MtN, 3 MtP, 5 MtK/y deposits worldwide (out of 100/17/33 Mt)
- For Europe [Billen2021]:

50% meat consumption + urine recovery

⇒ full organic agriculture without synthetic fertilizers

One Earth



CellPress



Perspective

Reshaping the European agro-food system and closing its nitrogen cycle: The potential of combining dietary change, agroecology, and circularity

Gilles Billen,^{1,*} Eduardo Aguilera,² Rasmus Einarsson,^{2,3} Josette Garnier,¹ Simone Gingrich,⁴ Bruna Grizzetti,⁵ Luis Lassaletta,² Julia Le Noë,⁴ and Alberto Sanz-Cobena²

How to recover human excreta?

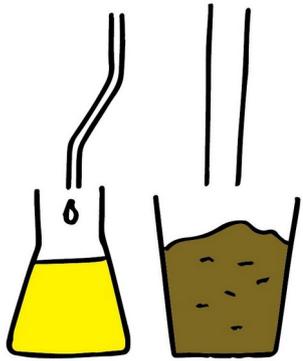


Waterless toilets



Urine source separation

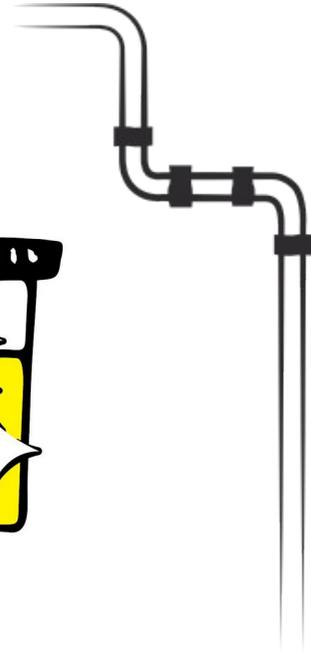
Credits: Louise Raguet



Large
amounts
of liquid



Self-
sanitizing



Pipes



Male

/

Female



waterless urinals

Urine-based fertilizers

Stored urine (acidified/alkalinized)

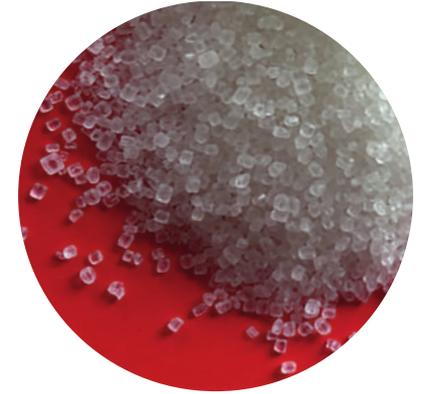


Concentrated urine

Granulates



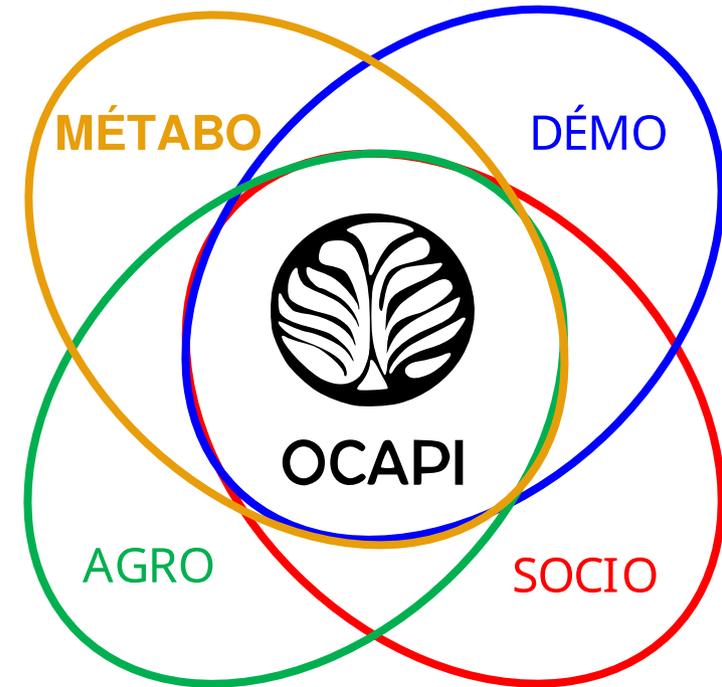
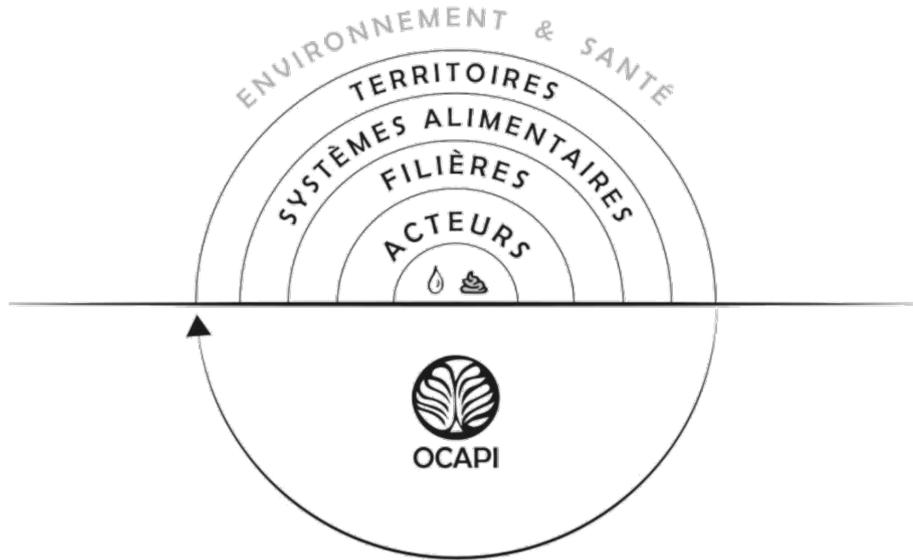
Ammonium sulfate



Struvite

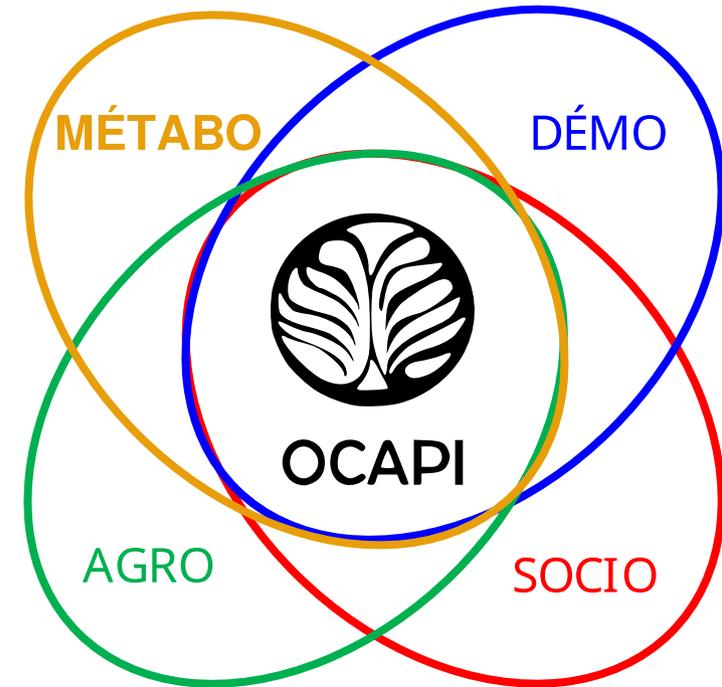
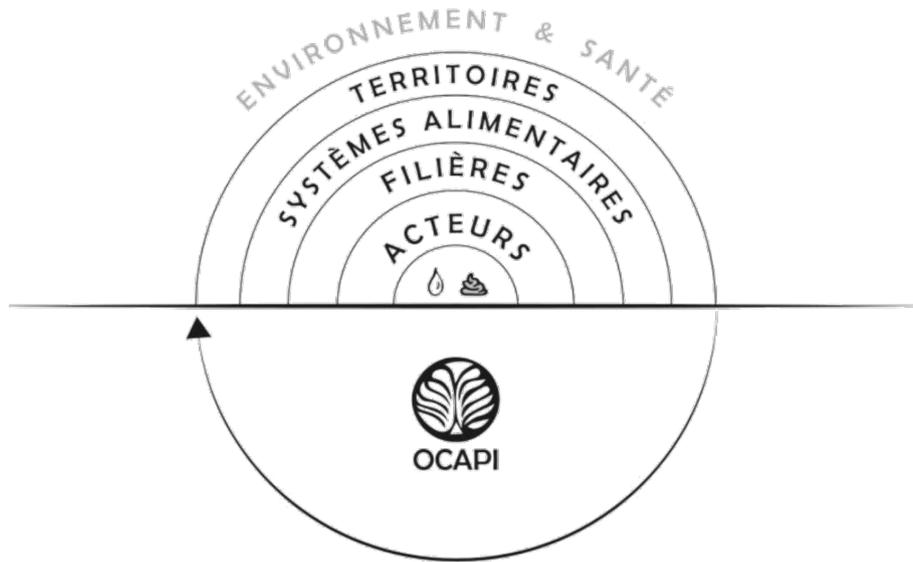


The OCAPI program



Systemic and transdisciplinary approach

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Systemic and transdisciplinary approach



The CAFE project

- Circular Agri-Food Ecosystems (funded by an MSCA)
- Territorial scenarii towards nutrient circularity and food sufficiency
 - accounting for urine, feces, and biowaste
 - explicit focus on agricultural use

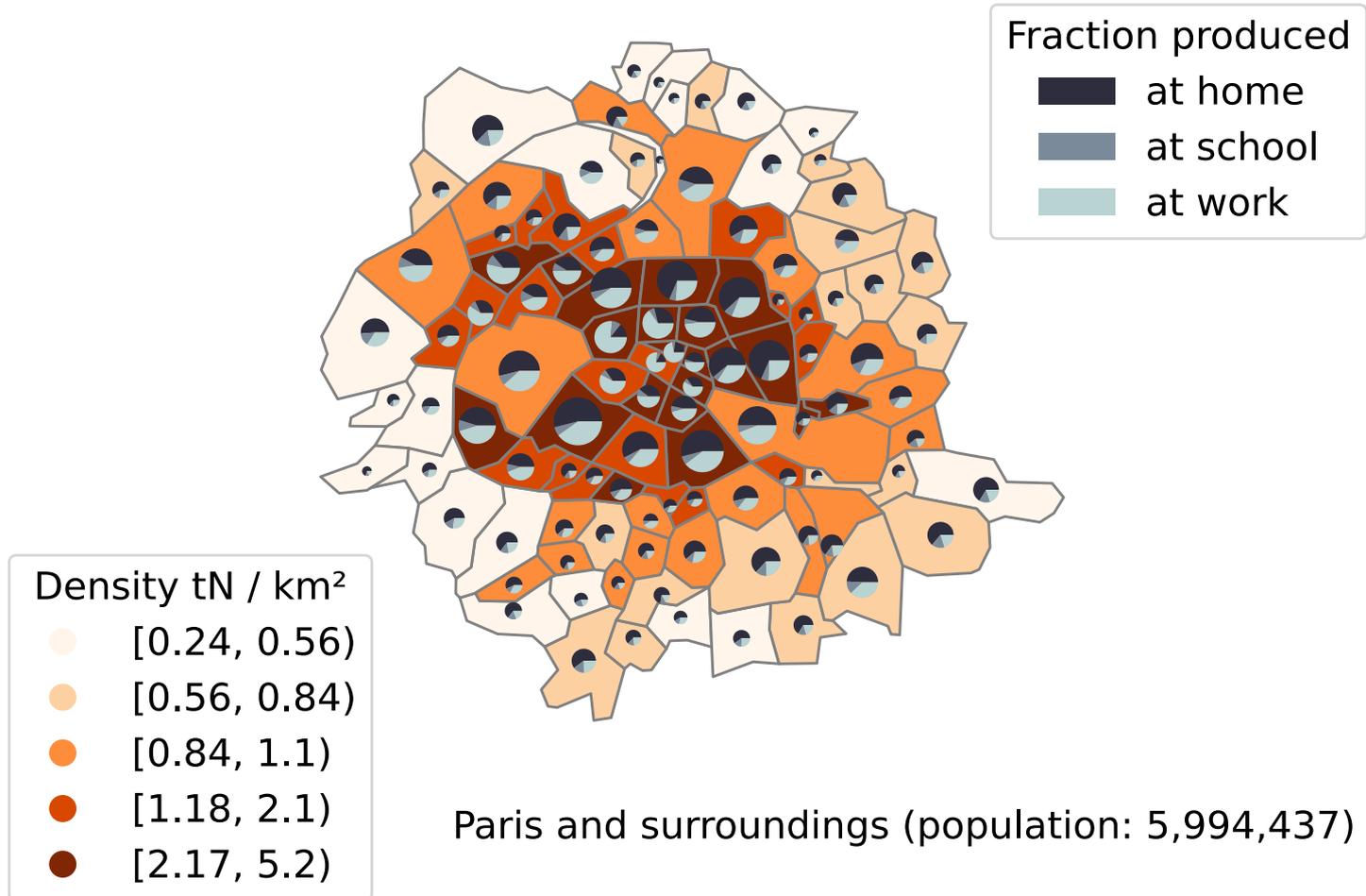
The CAFE project

- Circular Agri-Food Ecosystems (funded by an MSCA)
- Territorial scenarii towards nutrient circularity and food sufficiency
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 - explicit focus on agricultural use
- Objectives:
 - maximize nutrient circularity
 - ensure the quality of the resources returned to the soil
 - minimize environmental impacts and maximize resilience

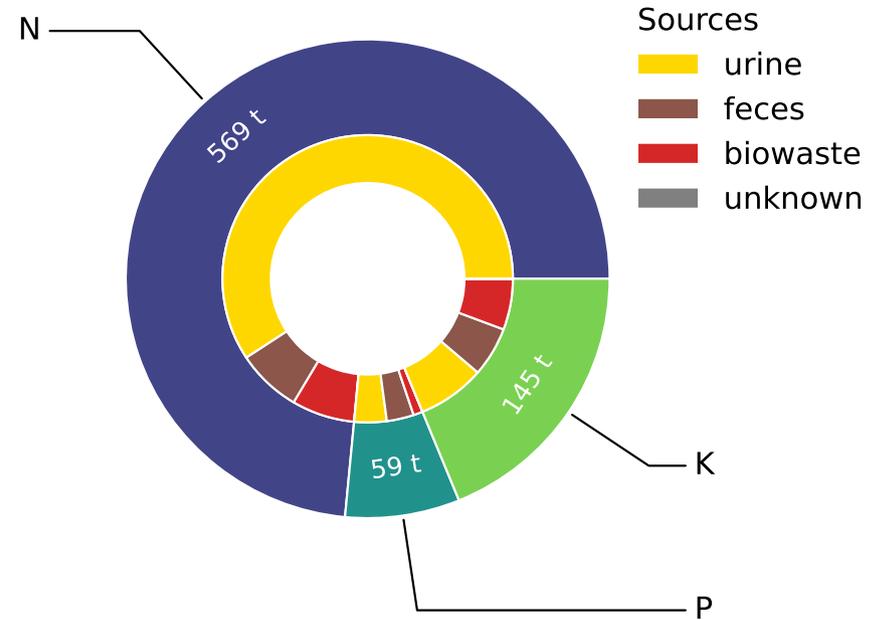
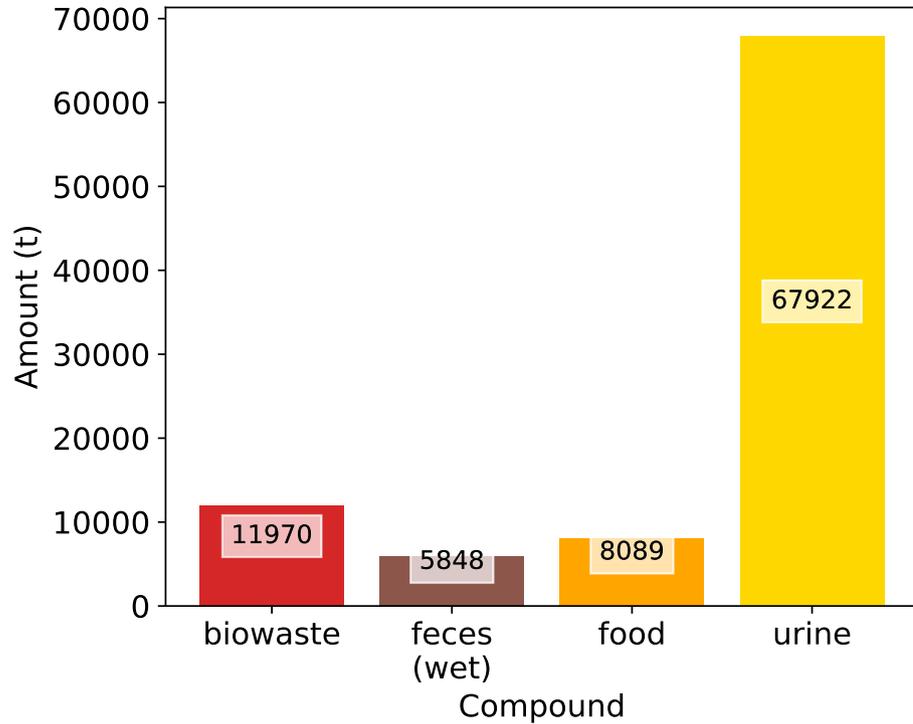
Quantifying urban deposits

- Physiological database for excreta production
- Analysis of the nutrient content of organic matter
- Locating the excretions and waste generation
 - excreting population \neq resident population
 - demographics \rightarrow excretion at work vs at home

Visualizing urban deposits

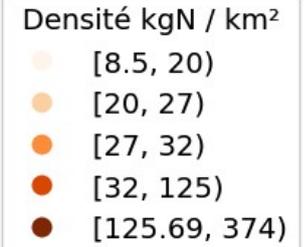
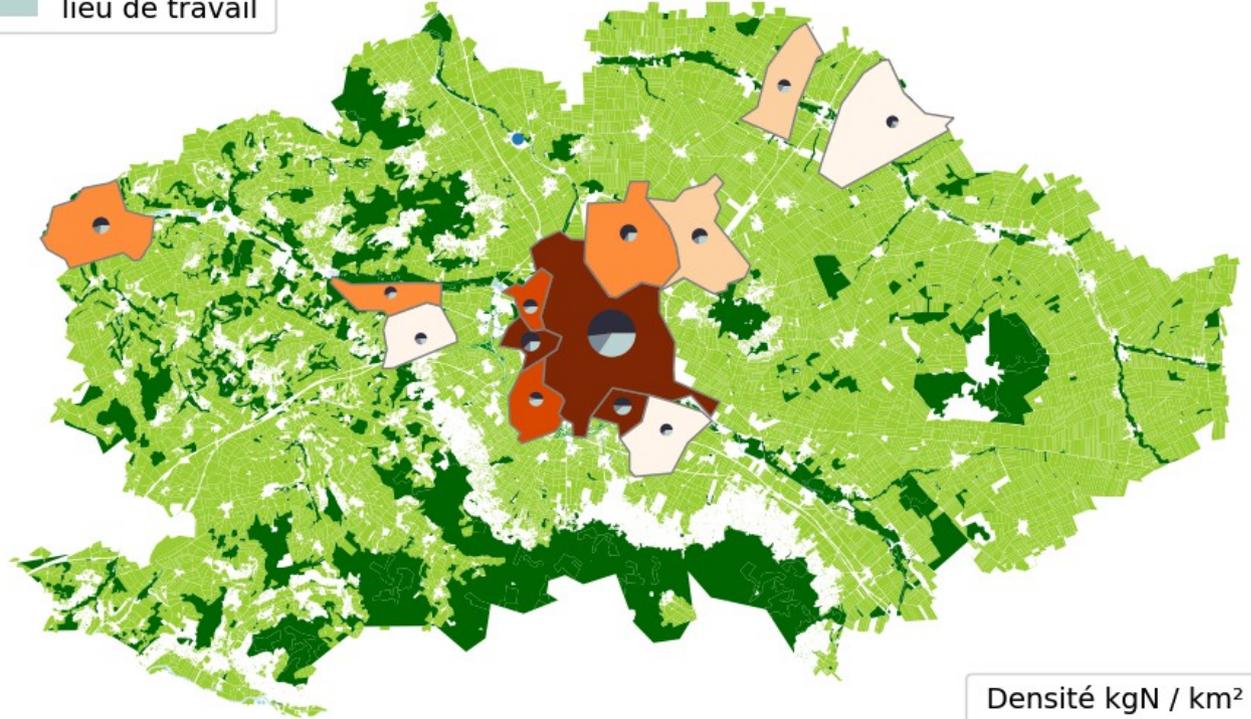
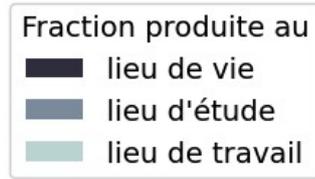


Visualizing urban deposits



Reims

- Production:
1.4 ktN/y
- Usage:
[3-15] ktN/y
for 150 kha



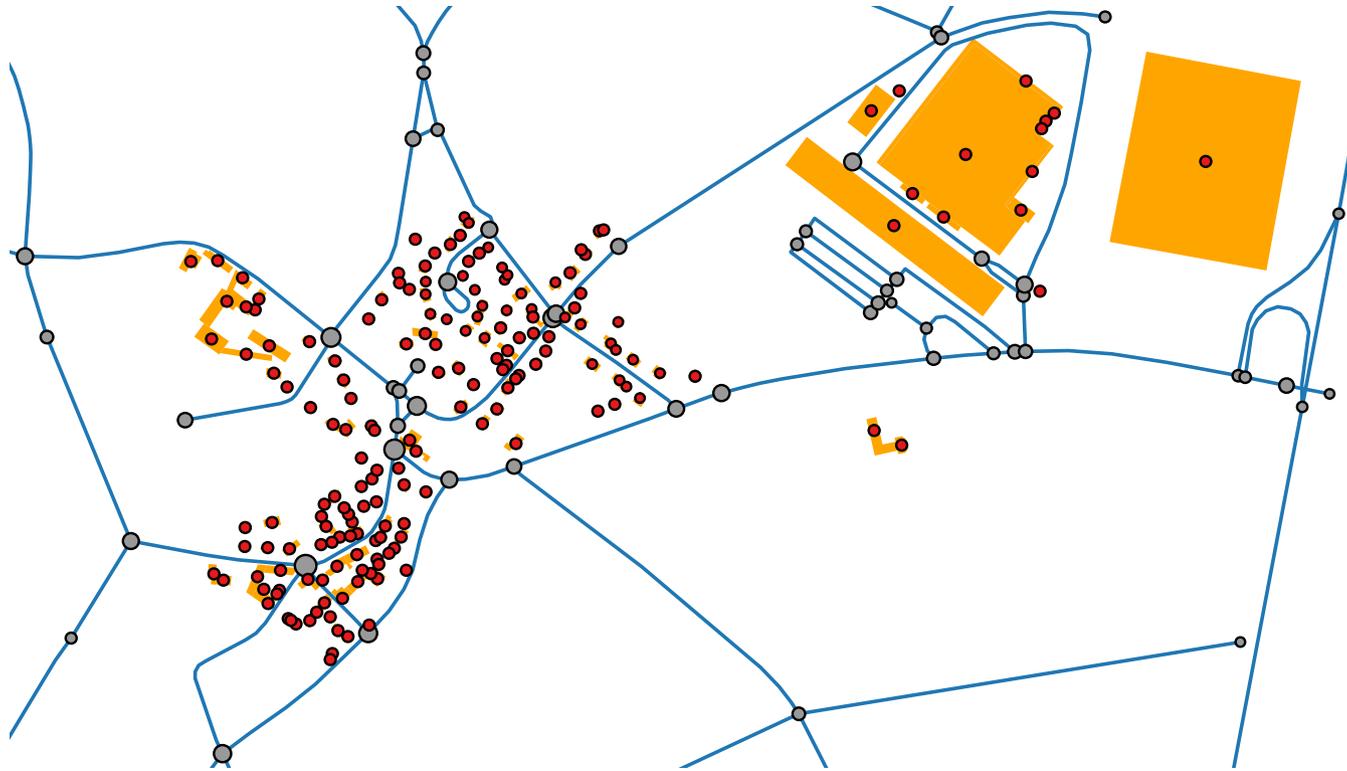
Reims et environs (population : 302 043)

Perspectives

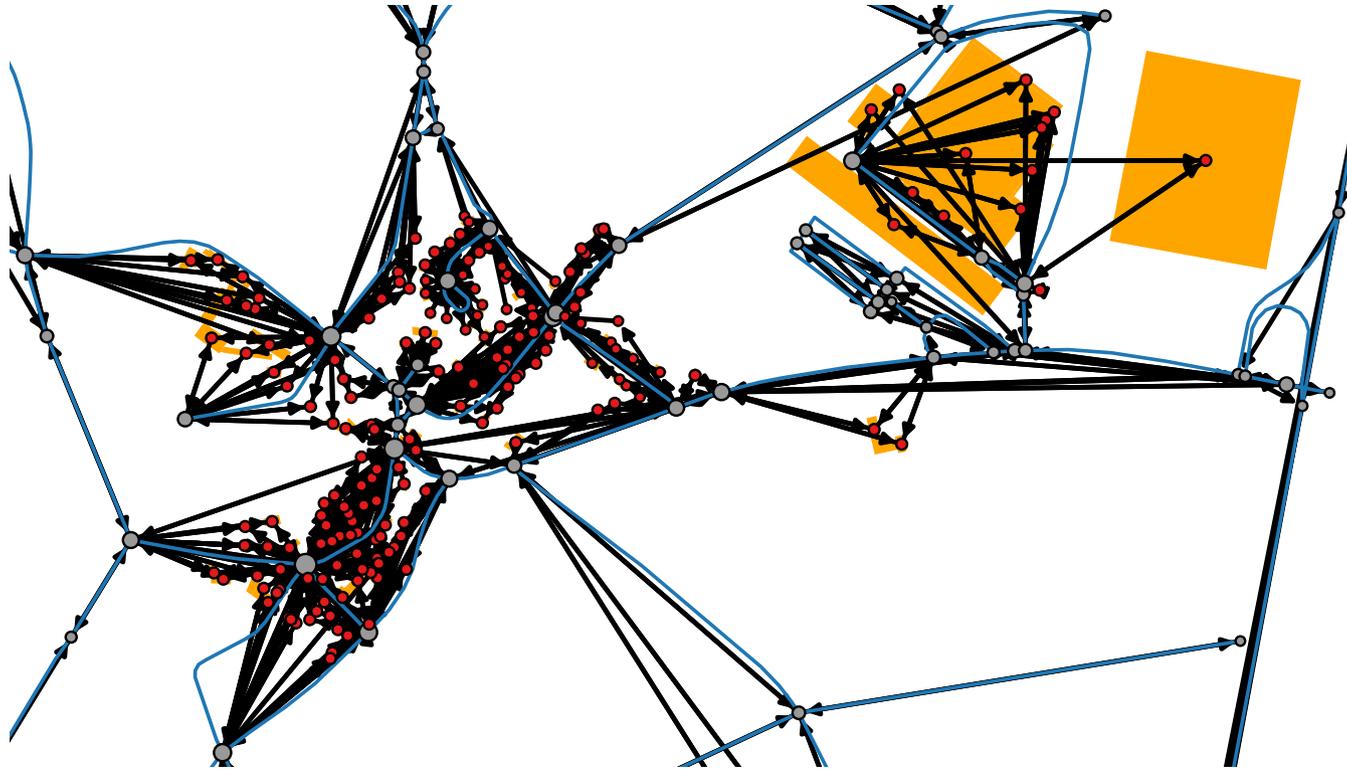
Towards building-level analysis



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And logistics-aware analysis

- Choice of collection method (frequency/travel mode)

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- Choice of transformation method
 - composting, anaerobic digestion
 - storage, urine concentration...

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- Nutrient needs and timing \Rightarrow storage size

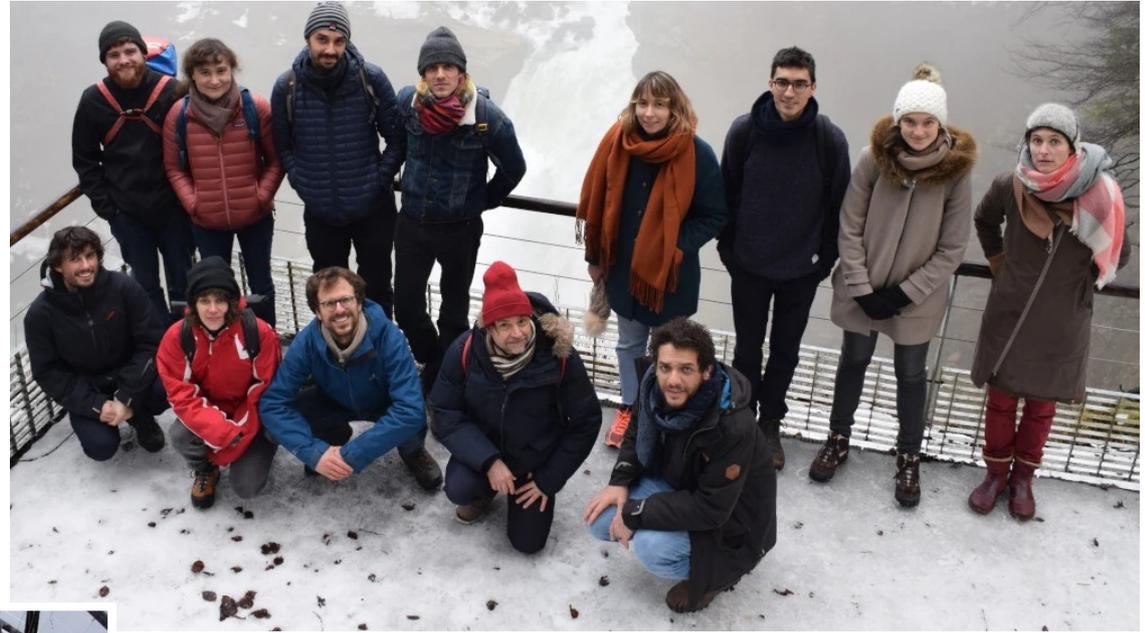
And logistics-aware analysis

- Choice of collection method (frequency/travel mode)
- Choice of transformation method
 - composting, anaerobic digestion
 - storage, urine concentration...
- Nutrient needs and timing \Rightarrow storage size
- Altogether gives logistics impacts in LCA

Wrapping up

Remerciements

- Toute l'équipe OCAPI



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- Ligia Barna (TBI)

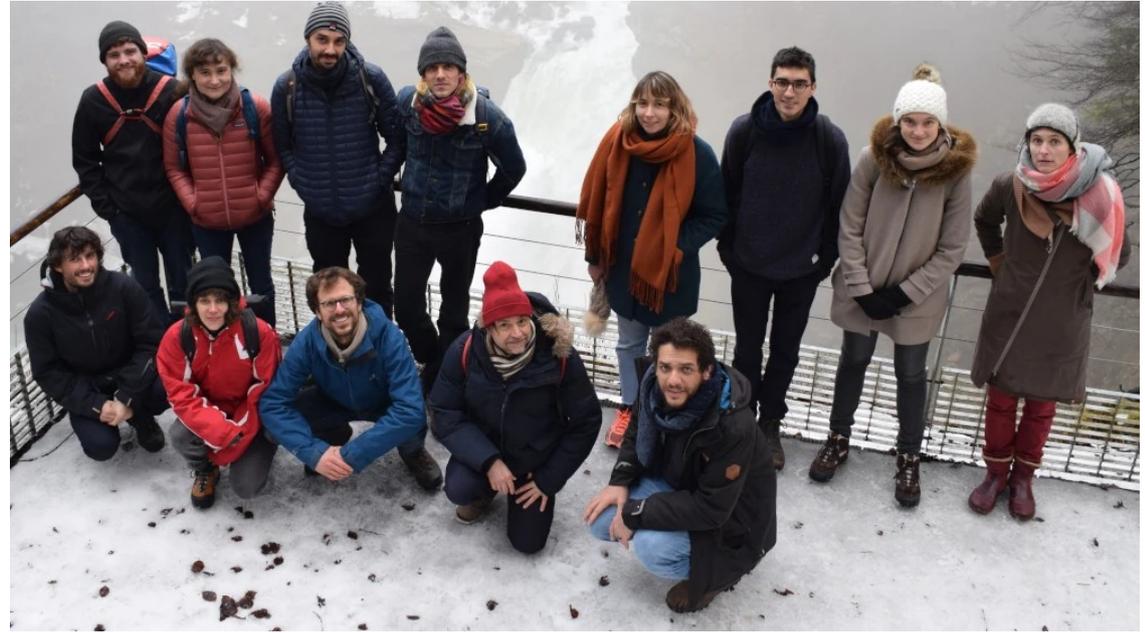


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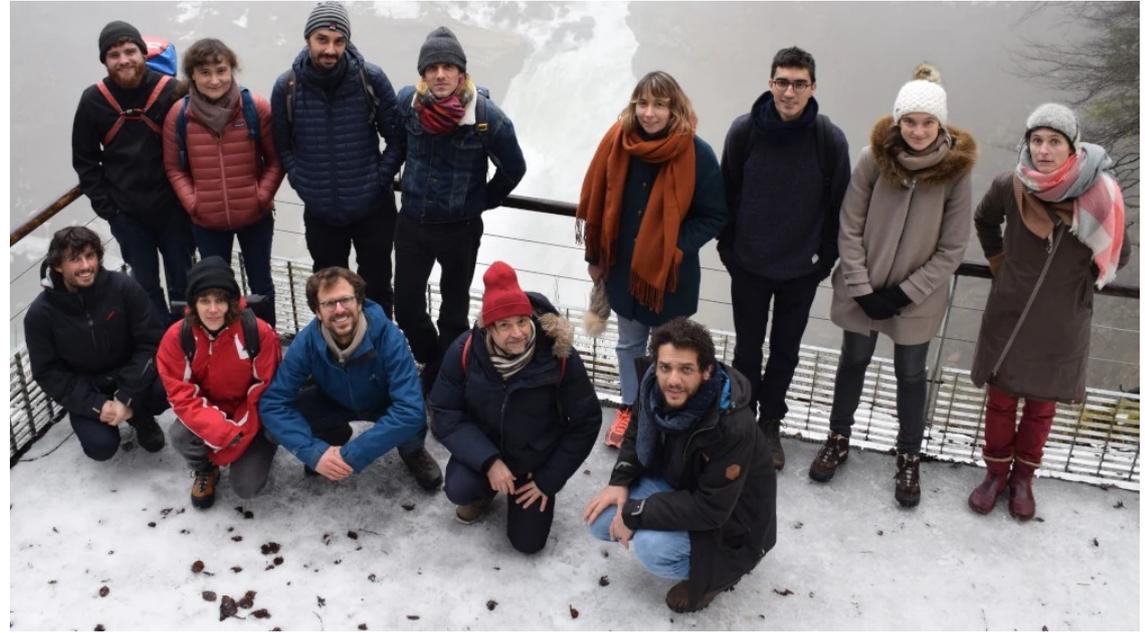
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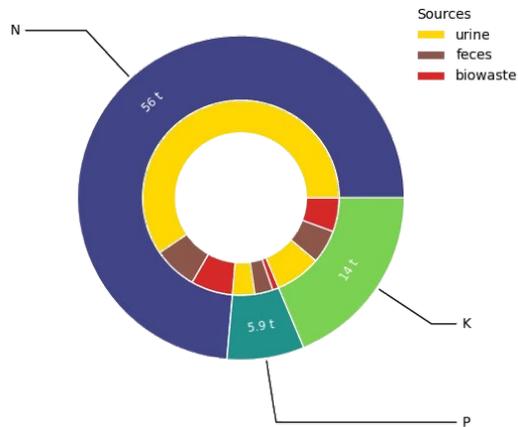


- Mathilde Besson, Mathieu Spérandio, Étienne Paul (TBI, Toulouse)
- Nicolas Linéart (Solagro, Toulouse)

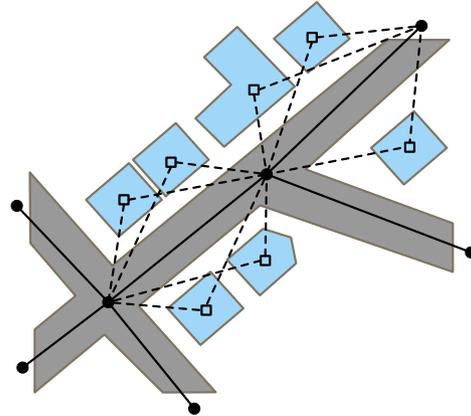


Conclusion

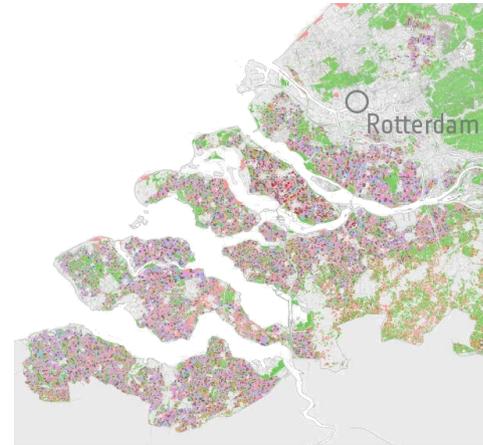
Deposits



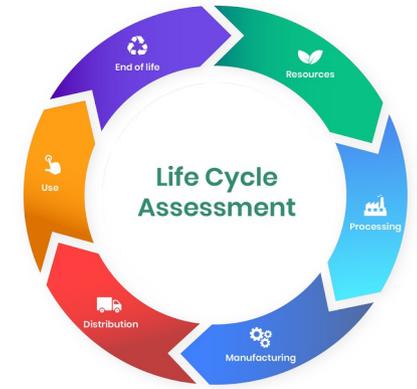
Logistic



Agricultural needs



LCA



- OCAPI on the Fediverse: toot.aquilenet.fr/@Ocapiprogramme
- CAFE website: tfardet.srht.site/research/cafe_project.html
- CAFE codes: sr.ht/~tfardet/CAFE

References

- Besson *et al.* “Environmental Assessment of Urine, Black and Grey Water Separation for Resource Recovery in a New District Compared to Centralized Wastewater Resources Recovery Plant”. [Journal of Cleaner Production \(2021\)](#).
- Billen *et al.* “Reshaping the European Agro-Food System and Closing Its Nitrogen Cycle: The Potential of Combining Dietary Change, Agroecology, and Circularity”. [One Earth \(2021\)](#).
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