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Management of organic wastes at the landscape scale

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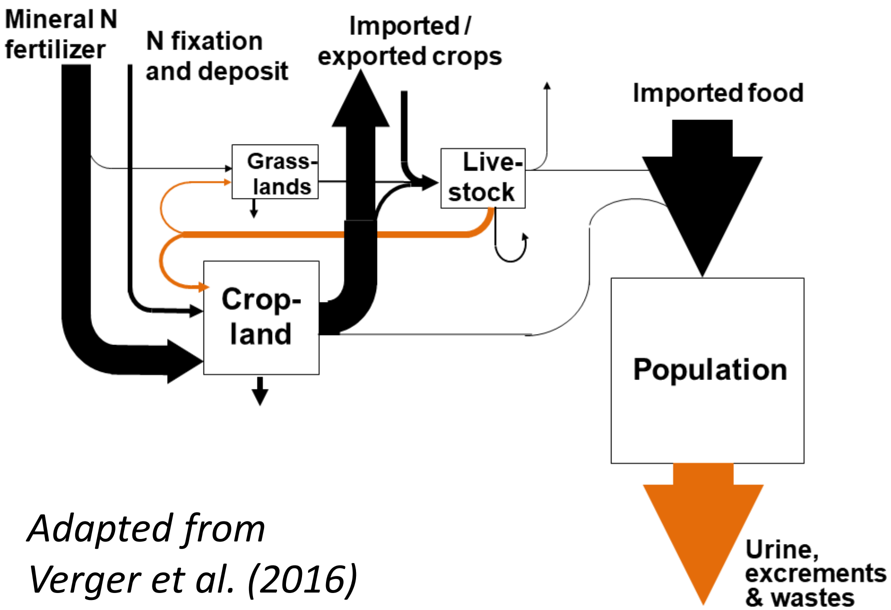
Recycling of organic wastes in agriculture

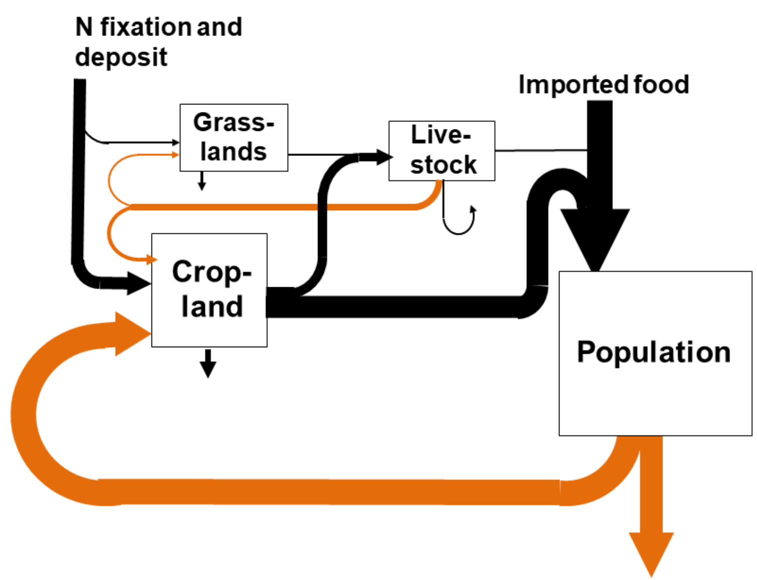
- Various benefits of organic wastes recycling in agriculture : nutrients supply, soil organic matter and associated physical properties, carbon storage…
- Some impacts to limit : NH_3volatilization, N_2O emissions, soil contamination (trace metal…)
- Potential for closing biogeochemical cycles

Actual N cycle of a small periurban area



Adapted from Verger et al. (2016)

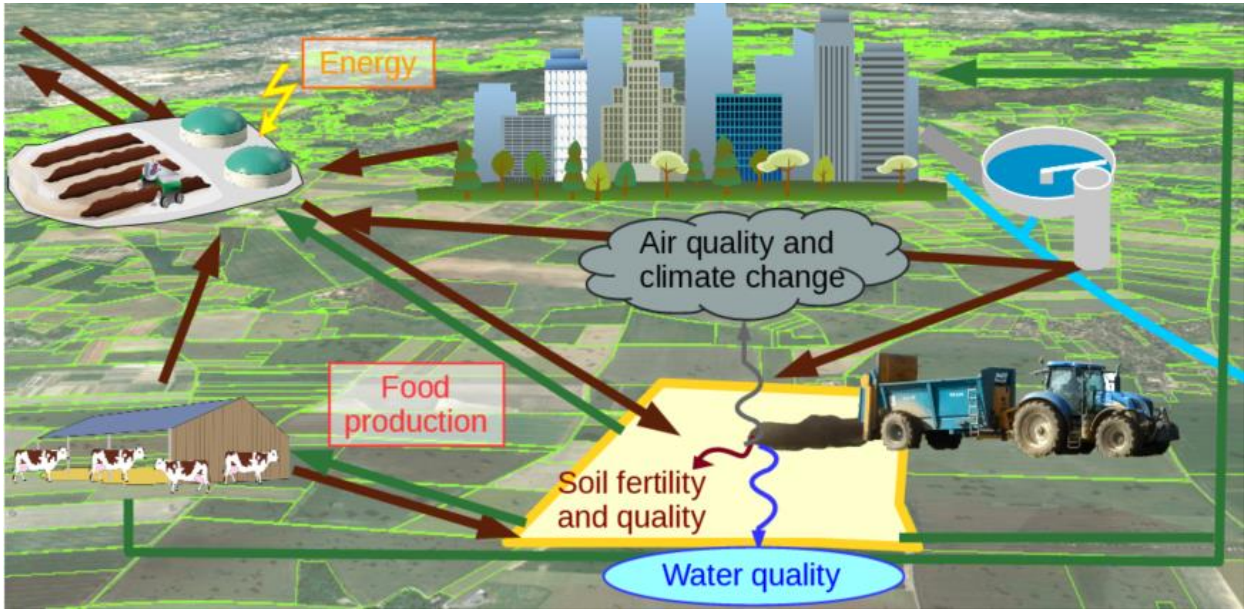
Scenario of N cycle looking for autonomy



Why organic wastes at the landscape scale ?

- Variability of organic wastes inside and among landscapes :
  - Variability of their availability and characteristics according to their source (livestock, cities…) and processes (composting, anaerobic digestion…)
  - Variability of their effects according to their characteristics, and to the landscape properties (soils, climate, cropping systems…)
- Fluxes of organic wastes inside and between territories
- Numerous "agents" implied in the management of organic wastes

- Related to other topics managed at the landscape scale: water and air quality, biomass, food and energy production…



Main related topics studied in the UMR ECOSYS

1) How the recycling of organic waste can contribute to close the biogeochemical cycles ?

2) How to optimize the management of organic wastes at the landscape scale?

   – To maximize their fertilizing value (substitution to mineral fertilizer), the carbon storage, the energy production…

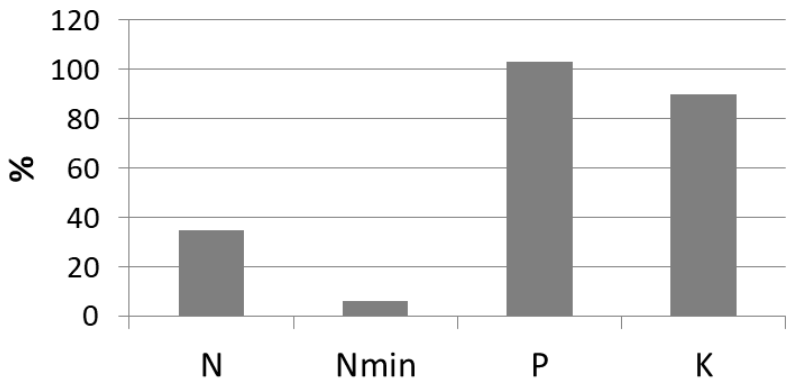
   – To minimize environmental impacts (soil contamination, air quality…)

   – While taking into account the characteristics of organic wastes and of the landscapes

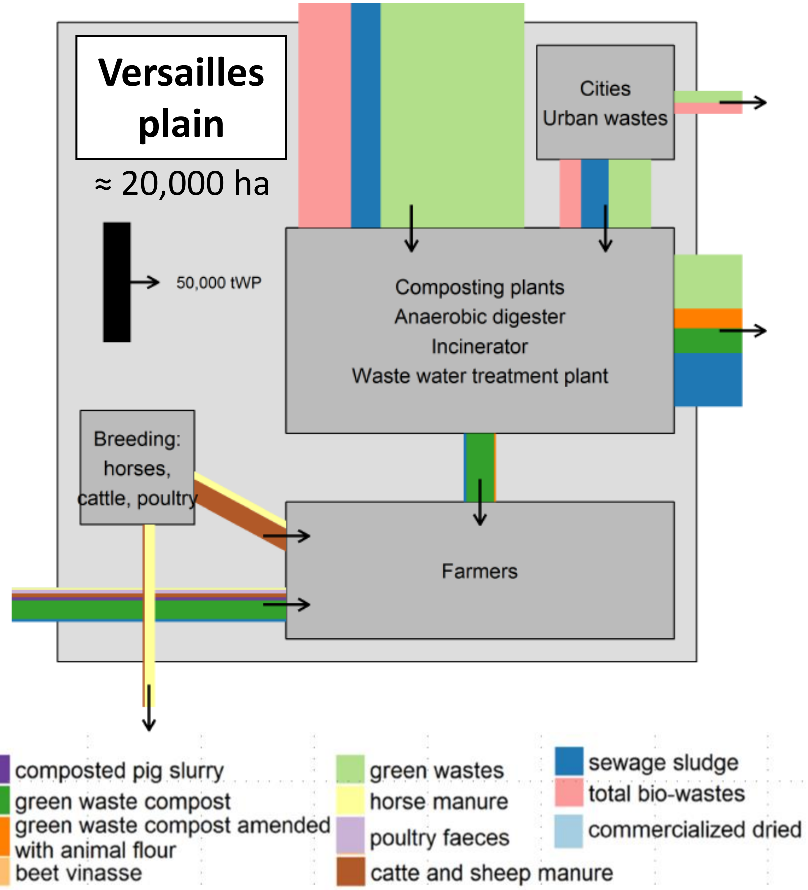
Organic wastes and closing of biogeochemical cycles

Adapted from Moinard (2018)

- Diagnosis of organic wastes fluxes in a peri-urban landscape: surveys and databases analyses
- Contribution to C, N, P, K fluxes :
  - organic wastes produced in Versailles plain represent 51 % of the humified carbon of the crop residues
  - Agriculture demand for P and K filled
  - Lack of N, especially short term mineralizable N
  - In an organic agriculture scenario, N demand also filled



Agriculture demand / potential supply by organic wastes



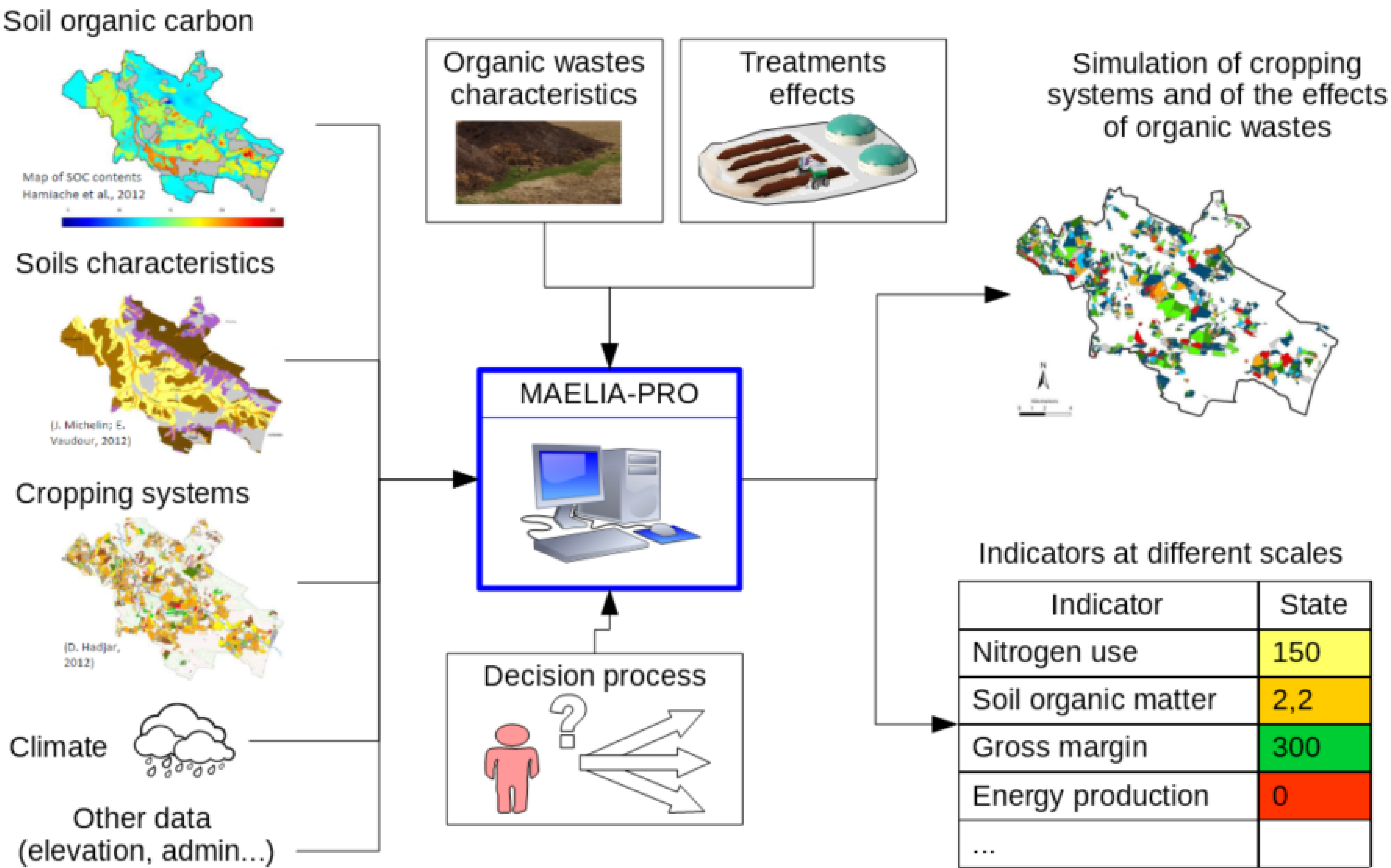
Fluxes of organic wastes in Versailles plain

Optimization of the organic wastes management

- This optimization required:
  - to represent the spatial variability of landscapes: soils, cropping systems, organic waste availability…
  - to simulate the effects of organic wastes on water, C, N, P cycles, on crop production, for example with soil-crop model: STICS (Brisson et al., 2008), CERES-EGC (Grabrielle et al., 2003)…
  - to take into account the other effects of organic wastes on soil contamination, soil physical properties…
  - to take into account logistic issues
  - to represent the behavior of farmers and organic wastes producer to enable the test of scenarios: taxes on mineral fertilizers, subsidies for carbon storage…

→ Development of an integrated modeling platform dedicated to simulate socio-agro-systems

General principles of the modeling approach



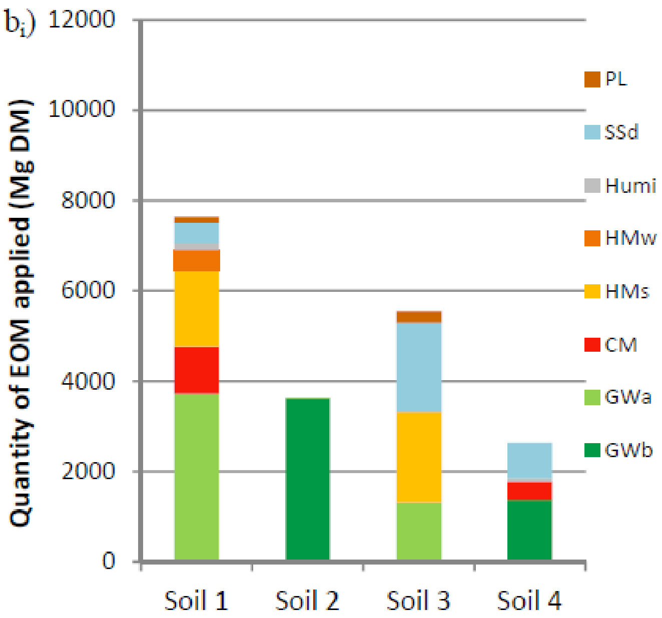
Indicator	State
Nitrogen use	150
Soil organic matter	2,2
Gross margin	300
Energy production	0
...	

http://maelia-platform.inra.fr/

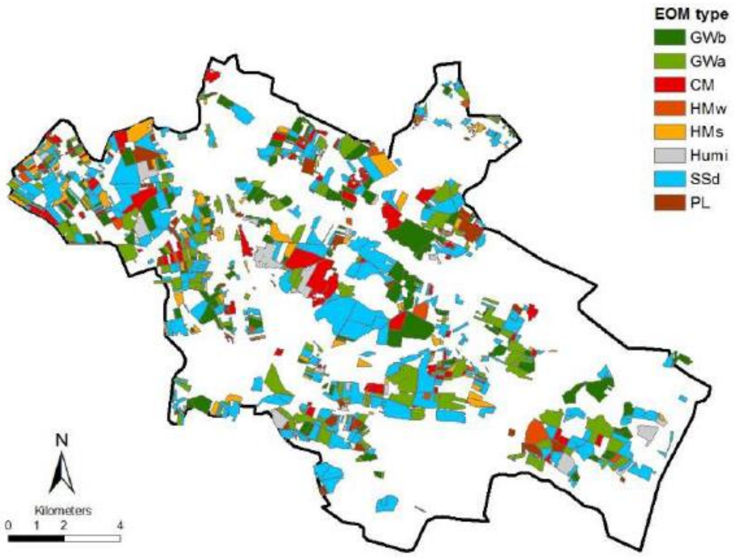
Example of optimization of organic wastes management

First attempt in a simplified framework (Noirot-Cosson, 2016)

- Optimization of the type and amount of organic wastes applied according to soil type and crop rotation to maximize carbon storage or mineral nitrogen saving
- Based on long term simulations with a soil-crop model considering potentially available organic wastes
- Up to 58 kg N / ha of saved mineral N fertilizer



Amount of applied organic waste per soil type to maximize carbon storage

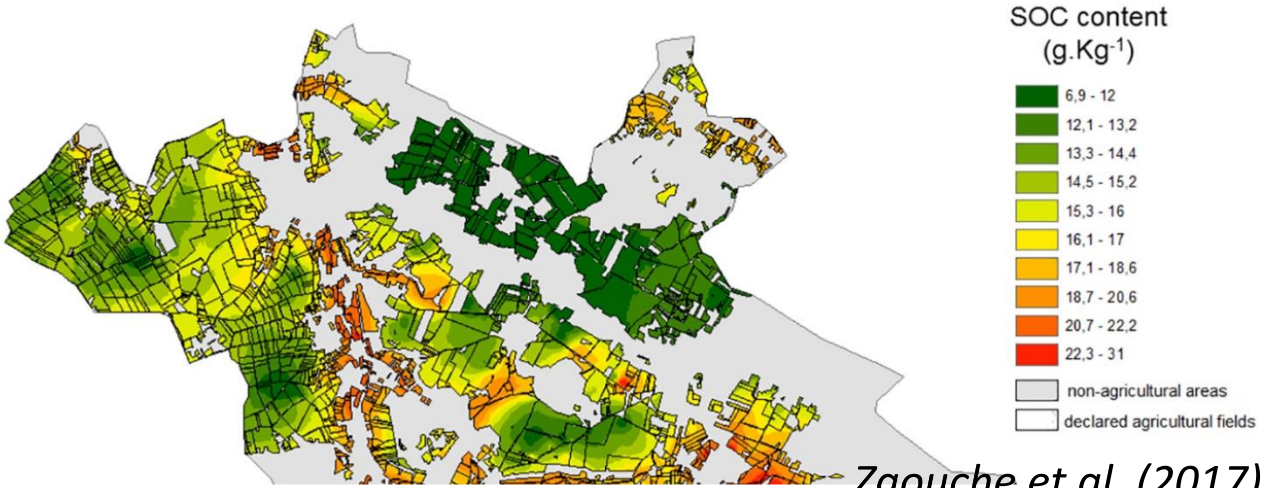


Spatial distribution of organic wastes to maximize mineral N fertilizer saving

Back to fields and data acquisition

- Landscape modeling require huge amount of data and a good understanding of underlying processes :
  - Importance of long term experimental trials around the studied landscapes
  - Short term field trials defined with farmers to adapt to new organic wastes (anaerobic digestate…)
  - Importance of farmers implication to identify their need and practices
  - Requirement in digital soil mapping (soil organic carbon and other properties)

Test of new organic wastes in a farmer field



Zaouche et al. (2017)

Conclusion

- Landscape approach of organic waste management is crucial :
  - To identify the relative importance of organic wastes in biogeochemical cycles
  - To account for spatial variability of organic wastes and for their variable effects according to landscape properties
  - To match with the spatial scale of management of related topics (water quality…)
  - To account for agents (farmers…) behavior and preferences
- Need to develop a multi-criteria modeling platform to test scenarios and support decision-making → need to identify relevant indicators
- A high amount of data is needed to calibrate and validate models

Thanks for your attention