Companion Modelling Approach for Collective Nitrogen Management in a French Municipality

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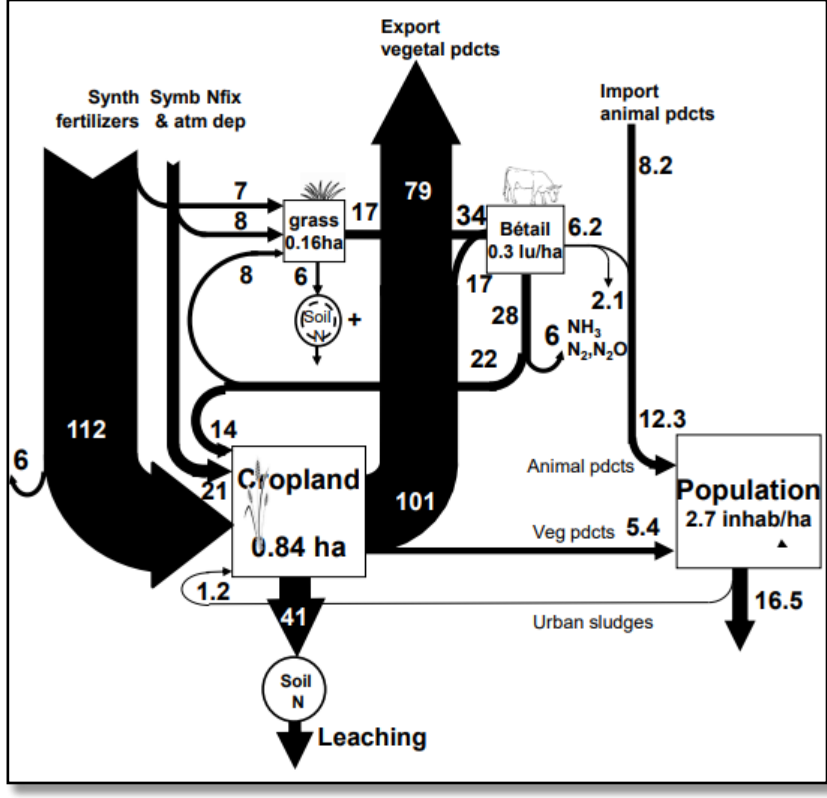
Context

- The specialization of agriculture has led to a disruption of nutrient cycles (Billen et al. 2017)

- Studies ask for interactions between farms at the territorial level (Nowak et al., 2015 ; Lucas et al. 2019)

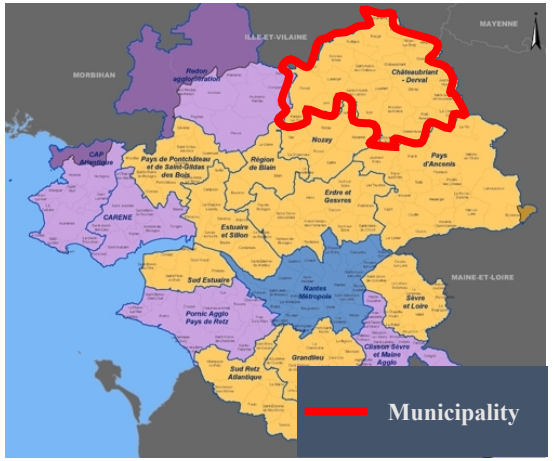
- But creating interaction at this level is not easy (Davies et al. 2004; Villamayor-Tomas et al. 2021)
  - Serious games are known to promotes collaborations and emergence of collective thinking (Den Haan & Van der Voort, 2018)



Source : Billen et al, 2017

Aim

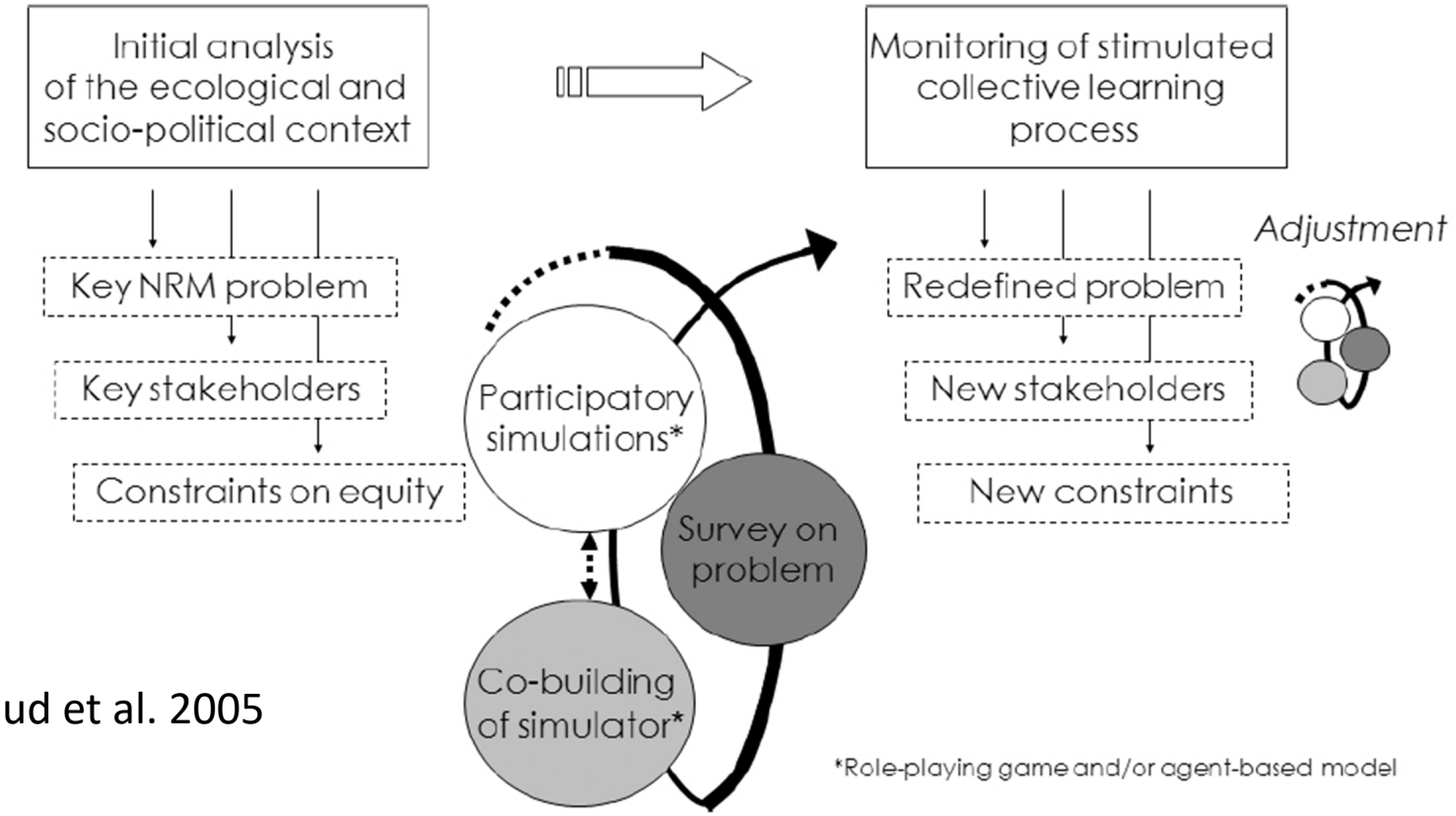
- Produce a share vision of the collective management of nitrogen, particularly from effluents in a municipality
- Build a tool to allow farmers to evaluate the interest of collective management
- Integrated to the GESTE project and tested in the Chateaubriant Derval municipality



Source : Loire-Atlantique.fr

Methodology

- ComMod methodology has been chosen (Etienne et al., 2010)



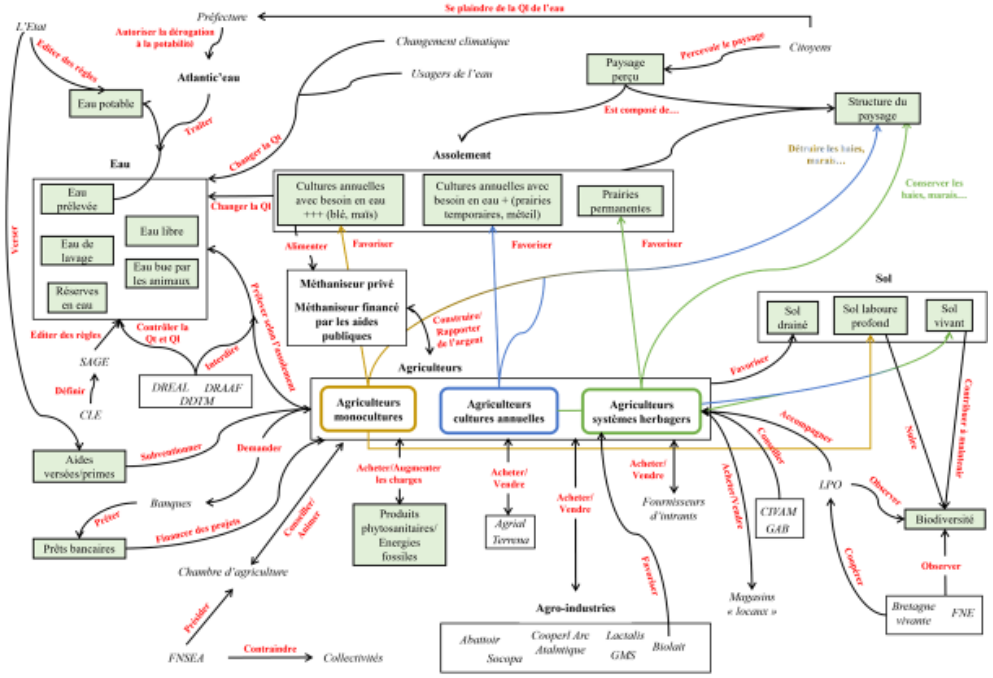
Barnaud et al. 2005

- The survey involved elected officials, advisory and support organizations, associations, cooperatives and agri-food industries and a variety of farmers.

Results : Shared vision

- From 12 individual interviews and a collective restitution we produced a representation of
  - actors,
  - resources,
  - dynamics and
  - interactions necessary to talk about nitrogen management in the territory

- This representation is the core data used to create a serious game



Individual representation of nitrogen management at municipality level

Results : shared vision

- On this topic, the stakeholders individually identify 38 types of people involved and 53 resources mobilized.
- Two dynamics stand out:
  - the presence of imported nitrogenous elements in the territory
  - the decrease in the number of livestock in favor of cultivated surfaces on increasingly large farms.
- These dynamics make the stakeholders of the territory put forward the solution of the biogas production
  - It can convert the animal and vegetal productions into digestate usable on the cultures,
  - even if several fears around the composition of these digestates exist.

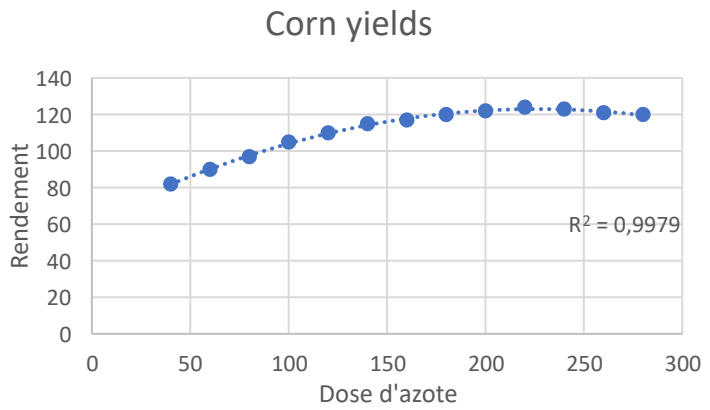
Results : game produced

- 2 areas around a town : one dominated by dairy farms, one by crop farms. 1 swine farm is present in each area.
- A biogas plant « in construction » will be available on the 2nd turn
- Type of fertilization available : mineral, slurry, manure, (digestate)
- Type of crops available : Corn, wheat, alfalfa, grassland, rapeseed

a French Municipality

Results: gameplay

- Action to realize : choose the crops and the fertilization level ; decide to bring inputs (crop, manure, slurry) to the biogas plant.
  - Cost of fertilization is according to the fertilization type and the distance
  - Productivity of crops are according to the fertilization (and soil N)
  - Productivity of biogas is according to the type of inputs
  - Livestock rentability is according to the quantity of feed used



Results : test of the game

- Biogas plant only used by own interest in first approach
- Some dairy farmers can’t participate to exchange as they don’t have enough manure
- Crop farmers tried to interact with the swine farmers
- Everyone had their results dropping with time
  - Cost of fuel and cost of mineral fertilizers
  - Few effects of rotations
  - Biogas plant parameters

- Players feels interested in the dynamics of cooperation

Discussion

- The use of manure to fertilize crops is conditioned by the presence of animals in the territory (livestock services, Dumont et al. 2019)
- Biogas plant can be used in the game as a converter from crop to energy (money) and… manure. (Britz and Delzeit, 2013)
- Off-farm actors are important for nitrogen management at the territorial level
  - but it also questions the role of farmers in collective management and the resilience of these tools in the event of a decrease in livestock production. (Agostini 2015)

Conclusions

- Nitrogen management in a municipality involve a large diversity of actors and resources
- Biogas is seen as a way to increase the nitrogen fluxes at the local scale
- The game is seen by agricultural counsellors as a tool to create interactions between crop and livestock farmers
- Still improvements to realize with the model behind the game
  - Time
  - Prices

Thanks for your attention