

MANAGEMENT OF LIVESTOCK EFFLUENTS IN REUNION ISLAND

**Use of a multi-agent system to analyse the economic
behaviour of players**



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Presentation

- Stockbreeding wastewaters are rich in nitrogen and phosphorus :
 - Useful to fertilise fields
 - Source of pollution in massive amounts
 - Regions referred as “structural exceeded zones” : Grand-Ilet



Presentation

- Rules established (92-99) determining quotas
- New water law provides charges to livestock producers
- Pork breeders face new systems of constraints :
 - Large quantities of excess slurry
 - No sufficient arable land to spread
 - Environmental policy enforcement => pollution fees
 - Rapidly evolving context
- Transportation of effluents to the sugar-cane farms

Approach

- MAS and “standard modelling” in ecological economics
- Use of MAS to simulate the incentives policy rules
- Previous studies
 - Available knowledge (since 1994)
 - => Simple model

Approach

- Rational and informed stakeholders :
 - Maximise its profits
 - Knows all the system : other agents, the space and the laws
- Analysis of cost functions
- Strategic choices
- Scientific interest :
 - Externality management
 - Tests of scenarios for environmental policies
 - Effects on the concerned actors

Structure of the MAS model

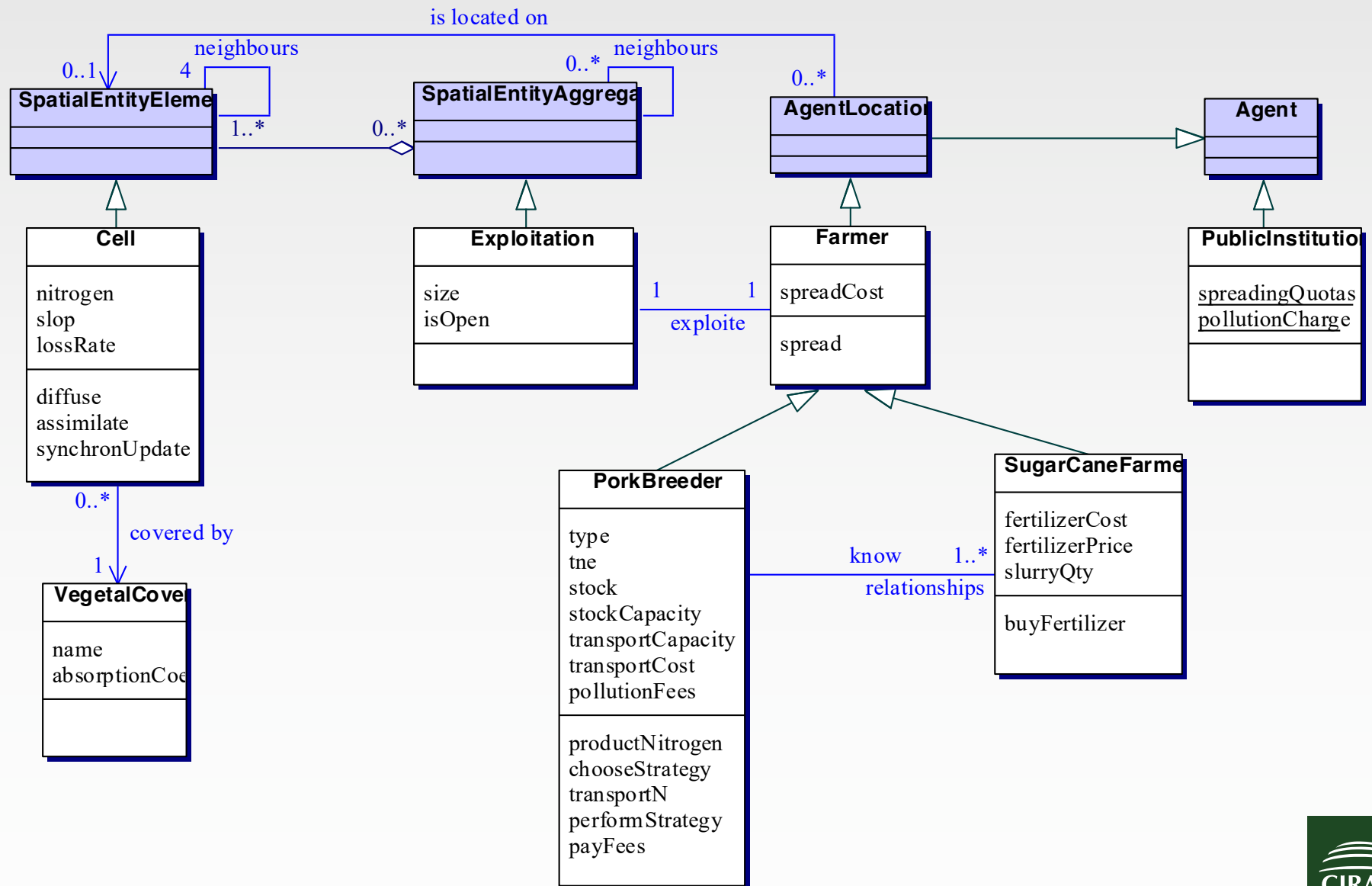
→ A space (100 km²)

- Distances and economic implications
- Diffusion, absorption and mineralisation of organic matter according to the vegetation cover

→ Some agents

- Pork breeders (56, 3 types)
- Sugar-cane producers (6)
- Public institution

Structure of the MAS model



Dynamic of the MAS

→ Monthly time-step

→ Spreading practices and transport of stockbreeding wastewater

- spreading of wastewater on the stockbreeder's farm surface,
- transport of the wastewater exceeding the spreading standard to the sugar-cane farms of the coastal areas

→ Environmental measures

- Standards (tons/hect/year)
- Taxes
- Subsidies

Dynamic of the agents

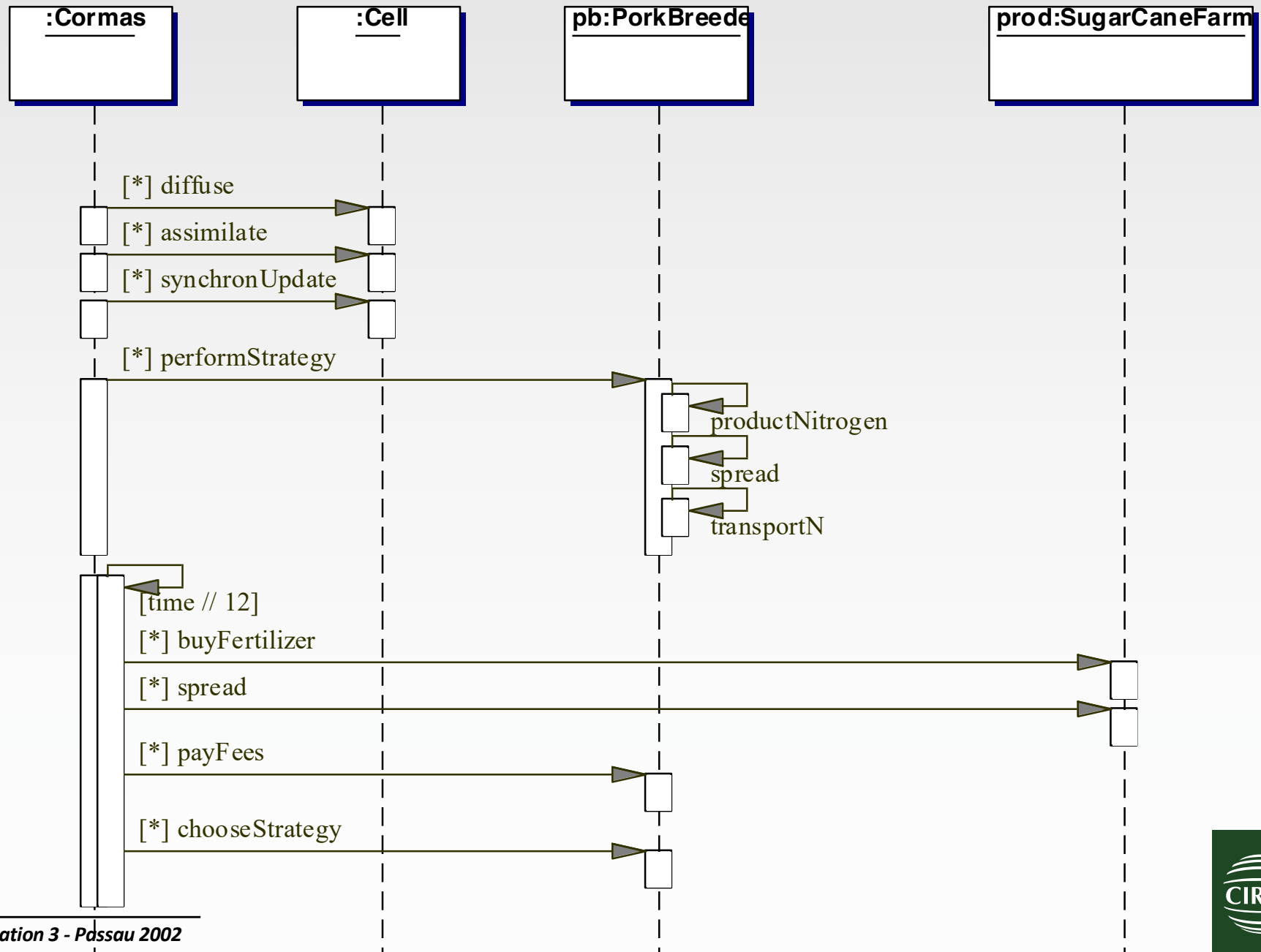
→ sugar-cane farmers of the coastal areas :

- Once a year, the farmers buy and spread mineral nitrogen on the sugarcane (annual demand)

→ Pork breeders :

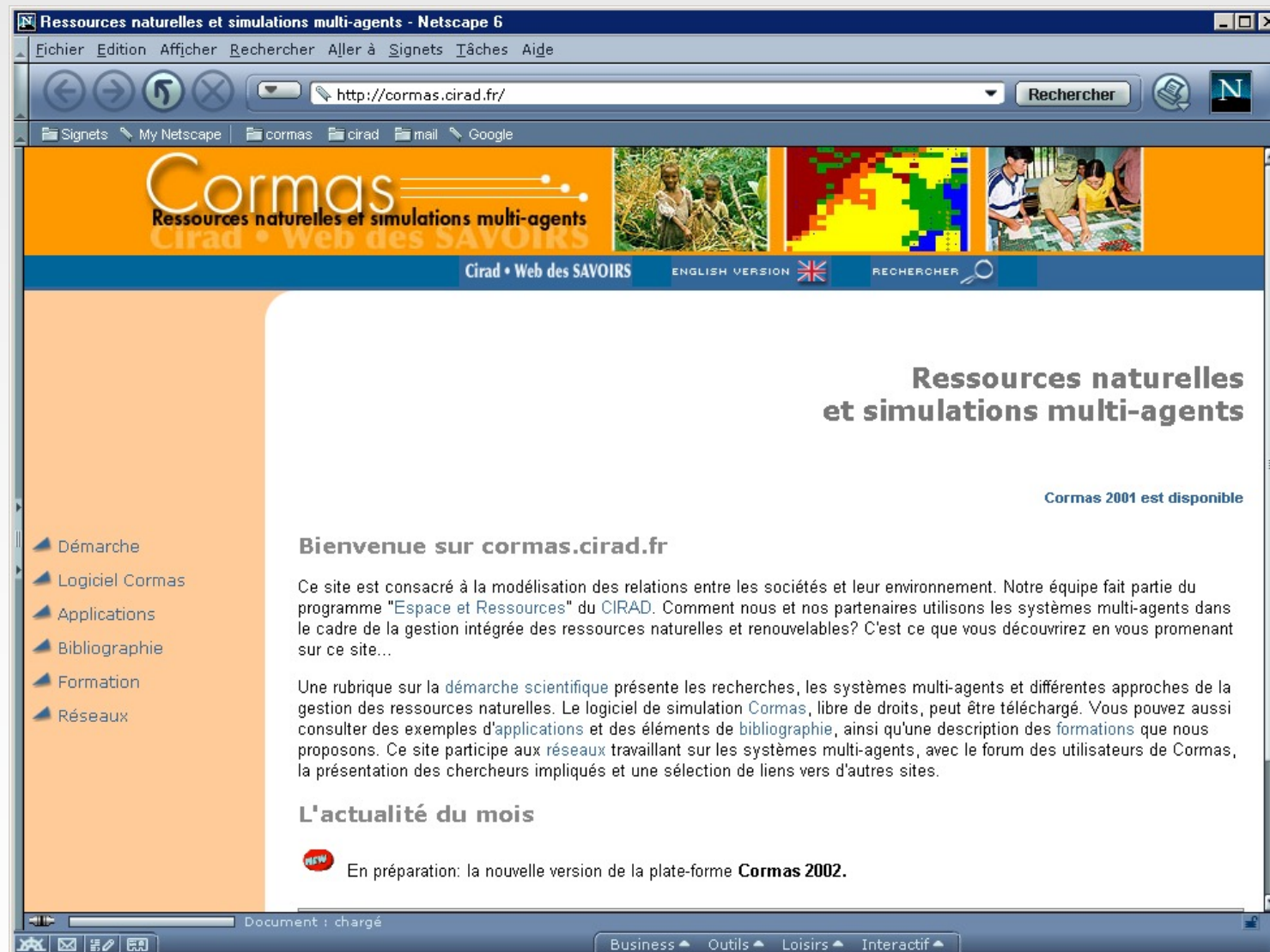
- Monthly wastewater production
- 4 strategies :
 - strat 0: spreading of wastewater on their farm surface,
 - strat 1: spreading of wastewater until the standards + on the neighbours + the rest on its own lands
 - strat 2: transport the wastewater exceeding the spreading standard to the open nearest sugarcane farms
 - strat 3: choose between strat 1 or 2, by comparing the cost he paid to the cost he would pay with the other strategy.

Sequential diagram of the step method



CORMAS : <http://cormas.cirad.fr>

Common-pool Resources and Multi-Agent Systems



The screenshot shows a Netscape 6 browser window displaying the website <http://cormas.cirad.fr>. The browser's address bar contains the URL, and the page title is "Ressources naturelles et simulations multi-agents - Netscape 6". The website header features the "Cormas" logo with the tagline "Ressources naturelles et simulations multi-agents" and "Cirad • Web des SAVOIRS". Below the header, there are navigation links for "ENGLISH VERSION" and "RECHERCHER". The main content area is titled "Ressources naturelles et simulations multi-agents" and includes a sub-heading "Cormas 2001 est disponible". A sidebar on the left lists navigation options: "Démarche", "Logiciel Cormas", "Applications", "Bibliographie", "Formation", and "Réseaux". The main text area contains a welcome message and a paragraph about the site's focus on modeling relationships between societies and their environment. It also mentions the availability of the Cormas simulation software and provides information about the current month's update, "L'actualité du mois", which is the preparation for the new version of the platform, "Cormas 2002".

Ressources naturelles et simulations multi-agents

Cormas 2001 est disponible

Bienvenue sur cormas.cirad.fr

Ce site est consacré à la modélisation des relations entre les sociétés et leur environnement. Notre équipe fait partie du programme "Espace et Ressources" du CIRAD. Comment nous et nos partenaires utilisons les systèmes multi-agents dans le cadre de la gestion intégrée des ressources naturelles et renouvelables? C'est ce que vous découvrirez en vous promenant sur ce site...

Une rubrique sur la démarche scientifique présente les recherches, les systèmes multi-agents et différentes approches de la gestion des ressources naturelles. Le logiciel de simulation *Cormas*, libre de droits, peut être téléchargé. Vous pouvez aussi consulter des exemples d'applications et des éléments de bibliographie, ainsi qu'une description des formations que nous proposons. Ce site participe aux réseaux travaillant sur les systèmes multi-agents, avec le forum des utilisateurs de Cormas, la présentation des chercheurs impliqués et une sélection de liens vers d'autres sites.

L'actualité du mois

En préparation: la nouvelle version de la plate-forme **Cormas 2002**.

CORMAS : <http://cormas.cirad.fr>

The screenshot displays the CORMAS software interface, which is used for agent-based simulation. The main window, titled "Cormas [Djemiong]", contains several sections:

- Model:** A section for defining the simulation entities, divided into three categories: Spatial (Dj_Cell, Dj_HuntingLocality), Social (Dj_Duiker, Dj_Hunter, Dj_HuntingGroup), and Passive. Below this are controls for "Control the evolution" (Prepare and Schedule) and "Define the observation" (Space).
- Visualisation:** A section with three icons representing different visualization modes: a grid, a network diagram, and a bar chart.
- Simulation:** A section with controls for simulation execution, including "Initialize...", "Step", "Run", and "Final time" (set to 0).

Two additional windows are open:

- Communications' Observer:** A window showing a network diagram with nodes and edges, representing the communication structure between agents.
- Charts - Global Level:** A window displaying a line graph of simulation results. The graph shows the number of predators (nbPredators, red line) and the number of preys (nbPreys, green line) over time steps. The y-axis ranges from 0 to 200, and the x-axis represents time steps. The nbPreys line starts at approximately 120, dips to around 75, and then rises to about 200. The nbPredators line starts at approximately 35 and decreases to near 0.

Results

→ 6 producers, 56 pork breeders, Strategy 3

→ 4 scenarios :

– Scenario 1 :

- Standard = 170 Kg.N / ha
- Pollution tax = 0
- Sugarcane farms areas between 20 to 40 ha

– Scenario 2 :

- Standard = 170 Kg.N / ha
- Progressive pollution tax (every 2 years, + 2 FF for each additional Kg.N)
- Sugarcane farms areas between 20 to 40 ha

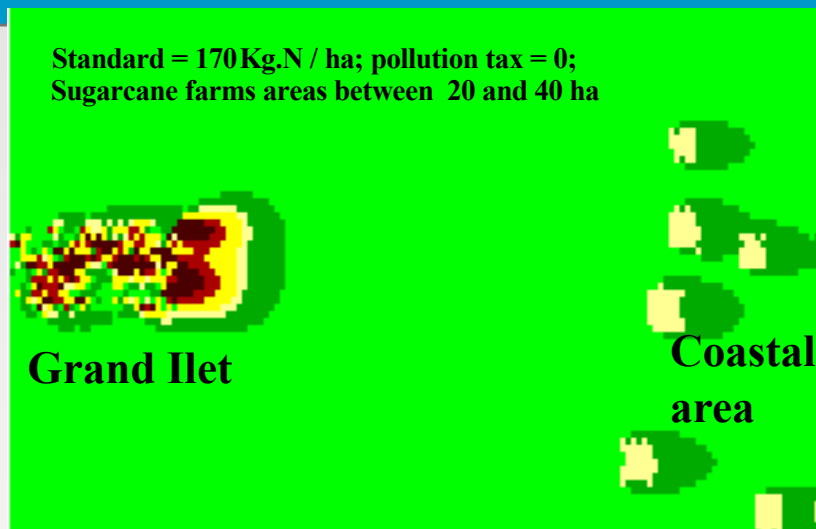
– Scenario 3 :

- As scenario 2, except
- Sugarcane farms areas between 40 to 80 ha

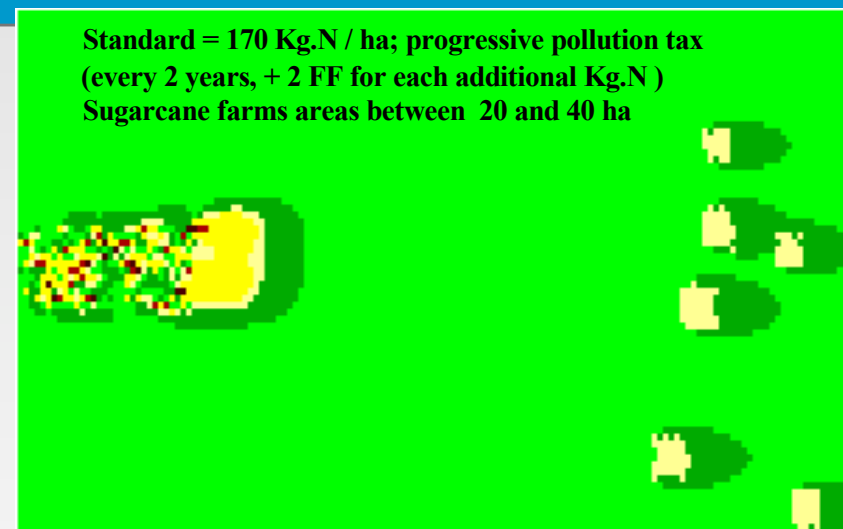
– Scenario 4 :

- As scenario 2, except
- Standard = 300 Kg.N / ha

Nitrogen Concentration in the soil after 10 years (120 time-steps) according to 4 combinations of environmental policies



1



2



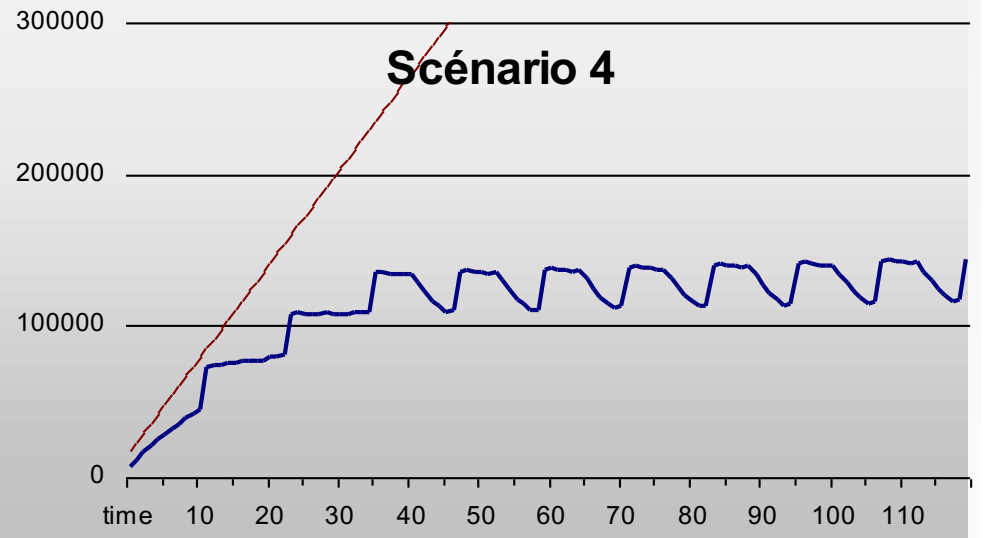
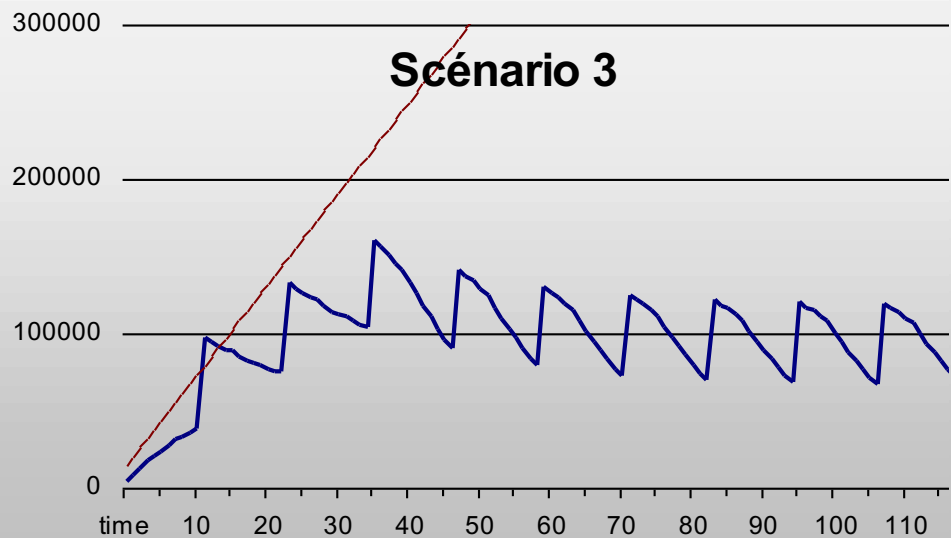
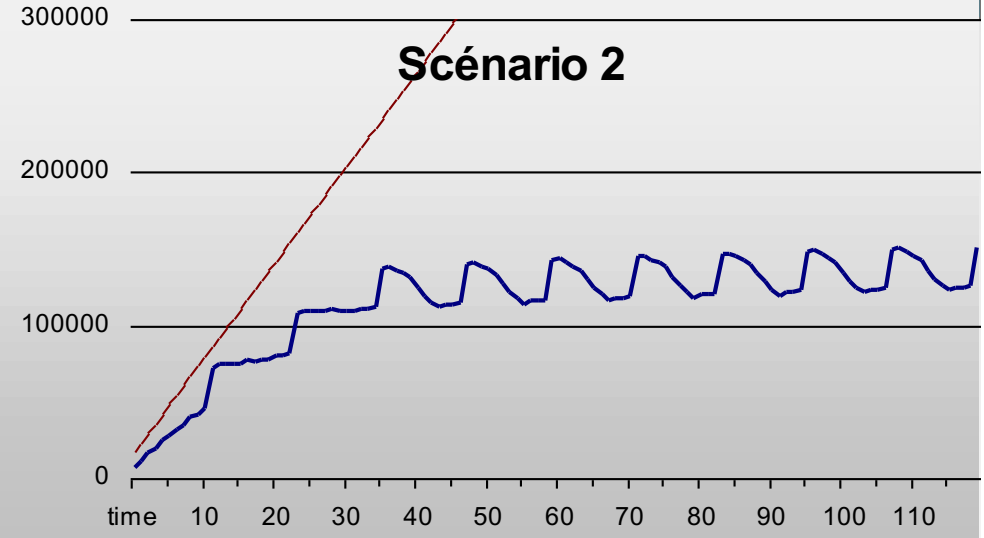
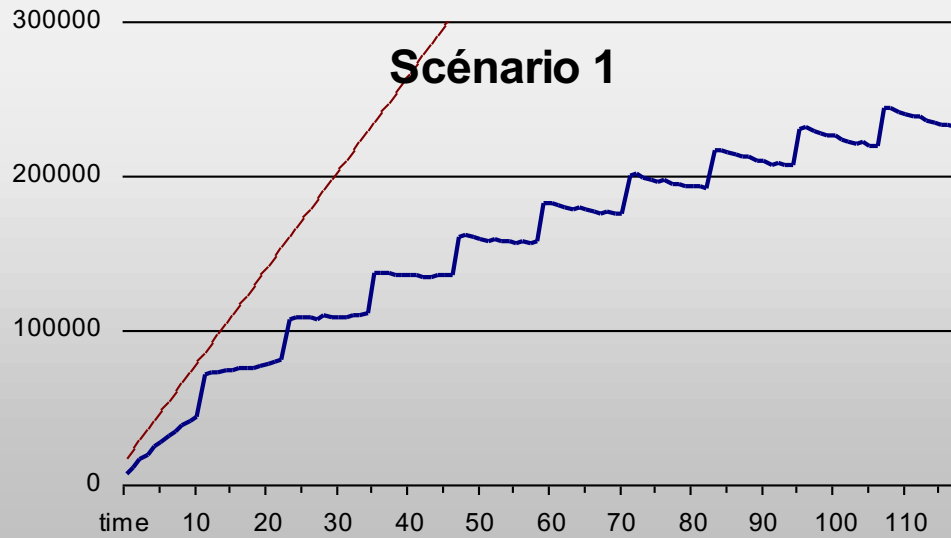
3



4

Standard = 170 Kg.N / ha
 Pollution tax = 0
 Sugarcane farms areas between 20 to 40 ha

Standard = 170 Kg.N / ha
 Progressive pollution tax (every 2 years, + 2 FF / Kg.N)
 Sugarcane farms areas between 20 to 40 ha



As scenario 2, except
 Sugarcane farms areas between 40 to 80 ha

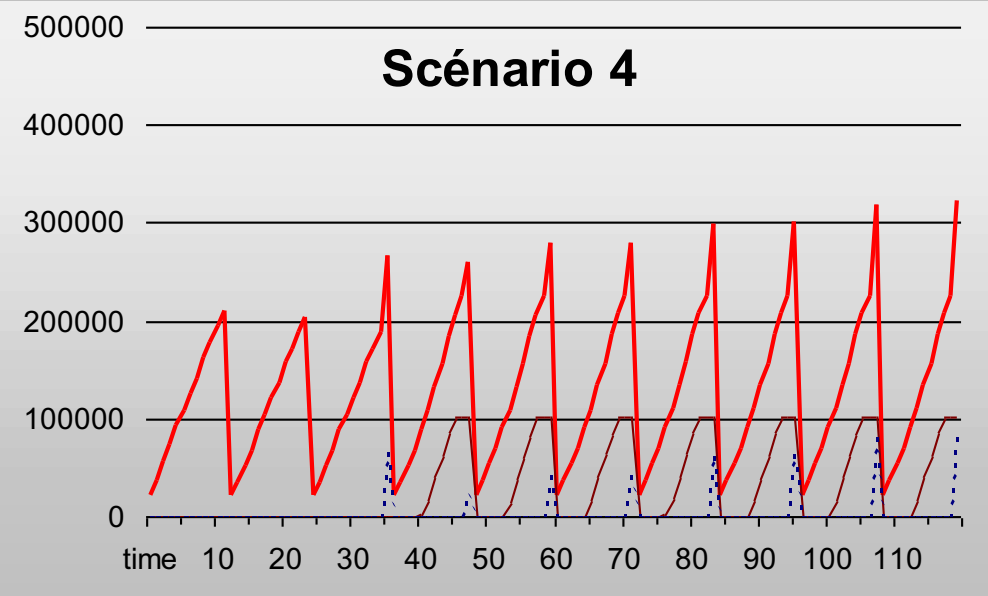
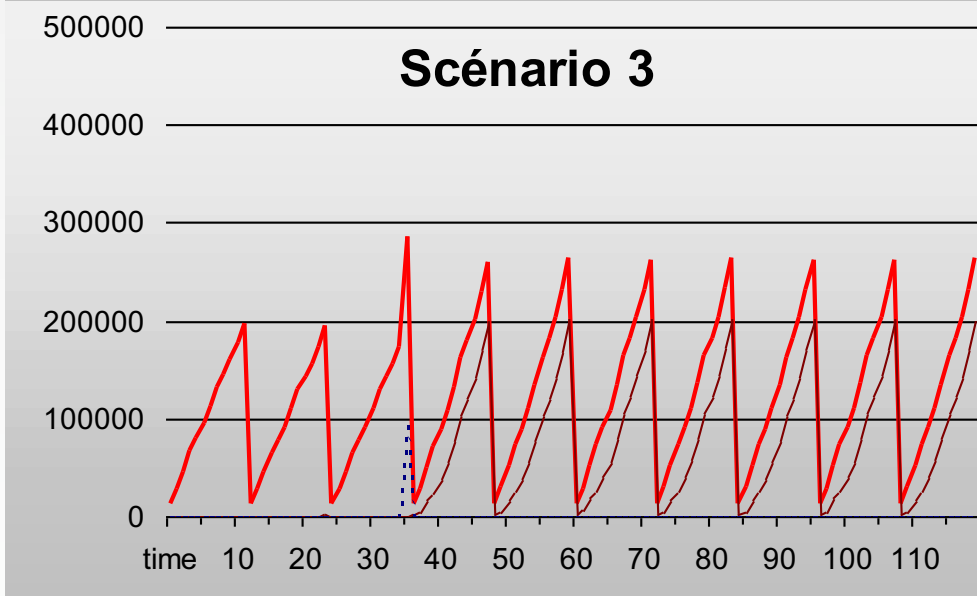
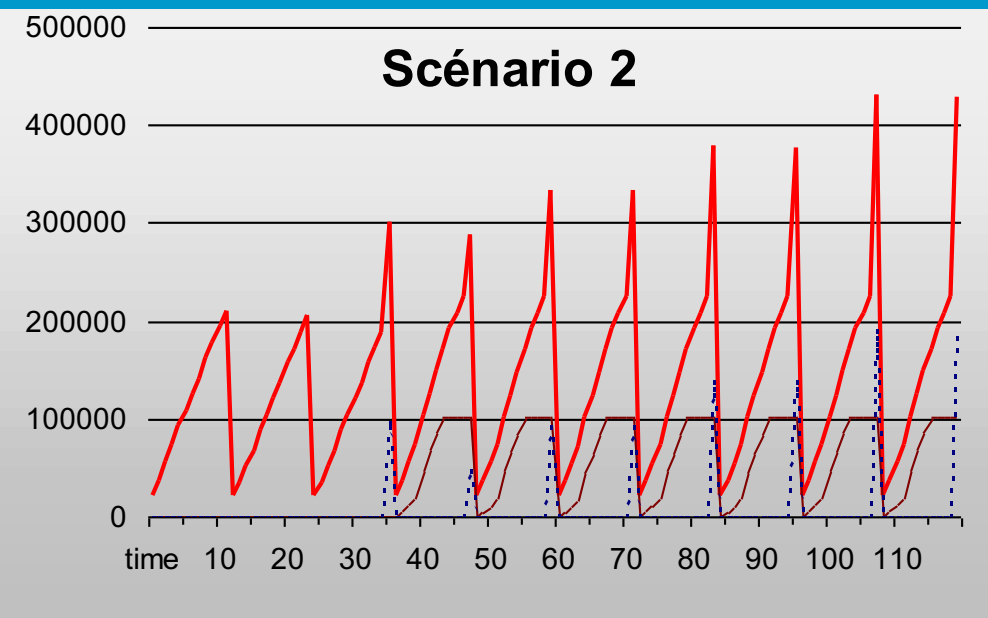
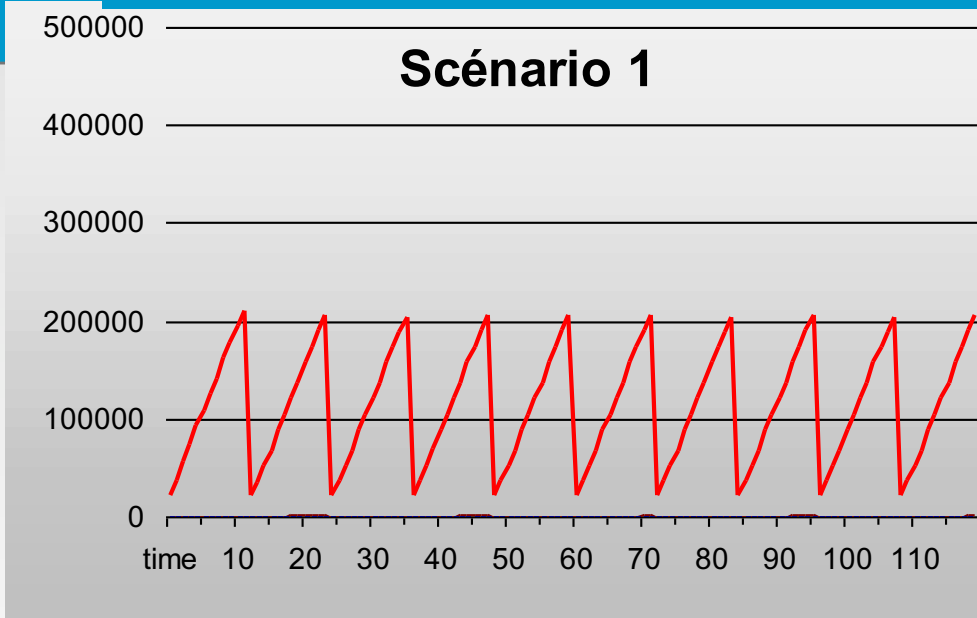
— N EGI CumulProd — N_Environment

As scenario 2,
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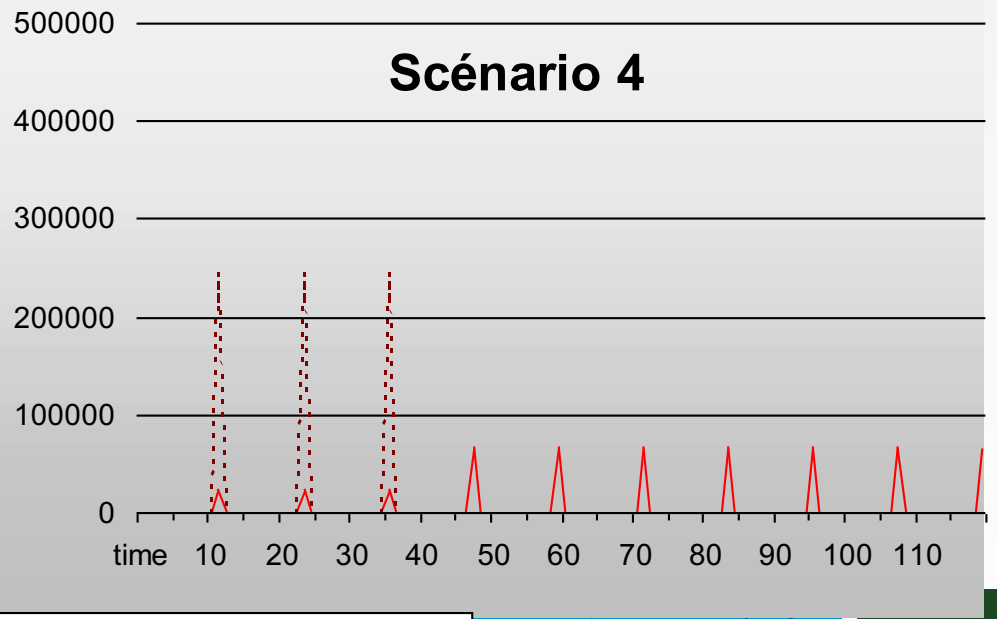
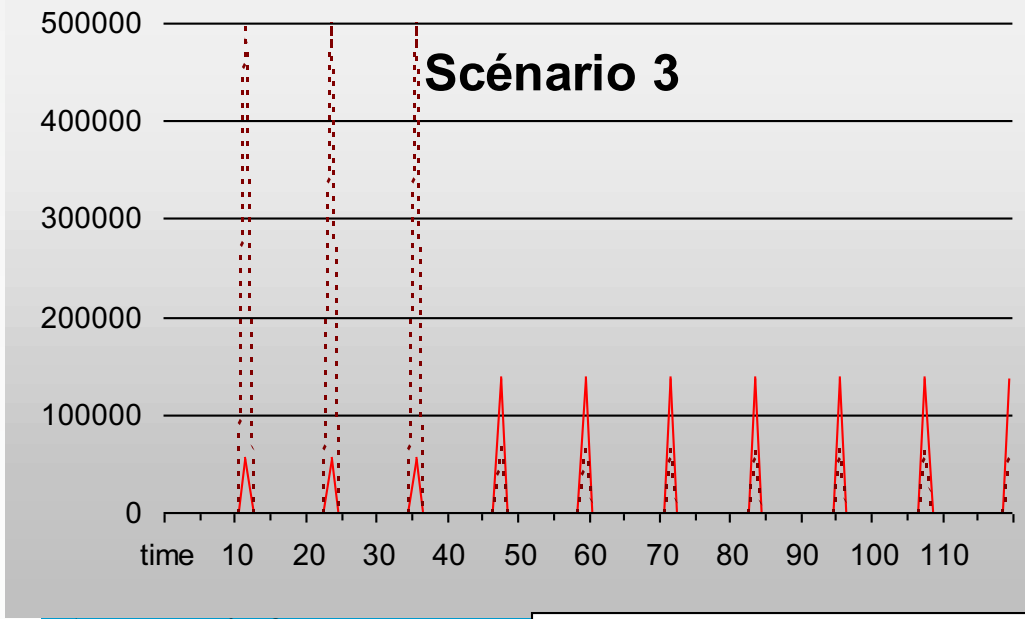
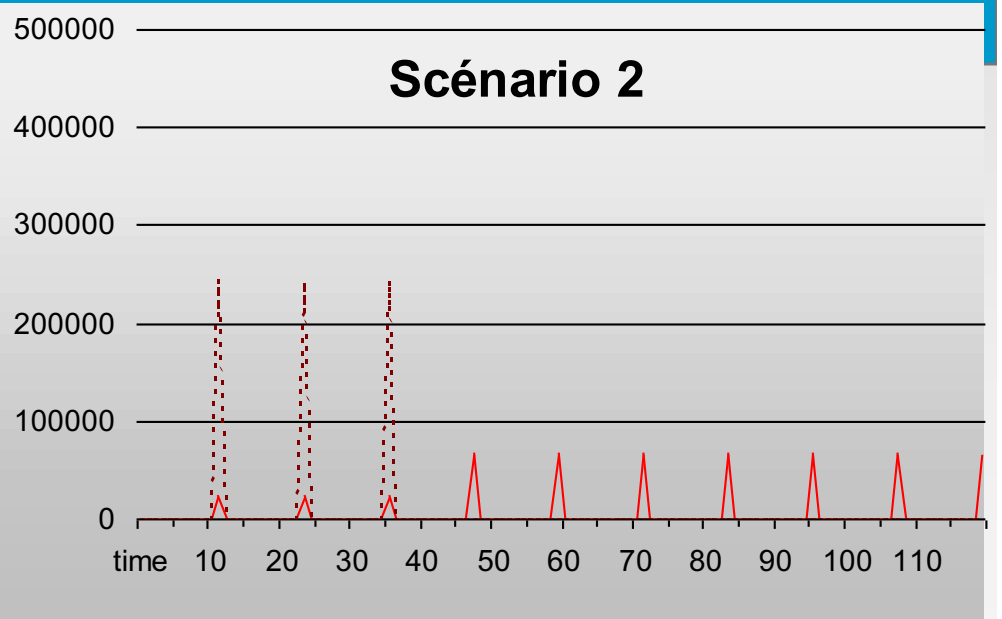
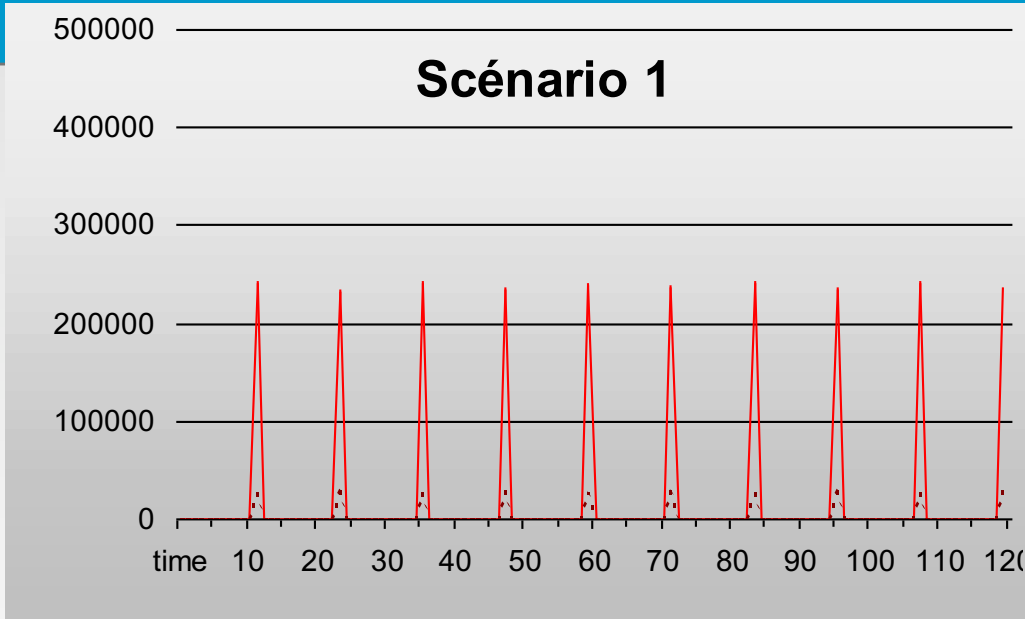
— Total Cost — Transportation Cost — Pollution Fees

As scenario 2,
 Standard = 300 Kg.N / ha



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As scenario 2, except
 Sugarcane farms areas between 40 to 80 ha

— Spreading Cost Fertiliser Cost

As scenario 2,
 Standard = 300 Kg.N / ha



Conclusion

→ Advantage of the MAS

- allows to study in the same time economical and ecological consequences of policies

→ The wastewater tax seems to allow a control of the pollution (=> rational agents)

→ An exceeded increase of the tax is useless:

- it doesn't modify the pollution in the environment and
- it increases the social cost

→ The environmental measures are efficient if there is enough spreadable place on the coast area

Further modelling steps

- Introduction of heterogeneous behaviours
 - Agents not entirely rational
 - Agents partly informed
 - Other behaviours
- Introduction of collective management alternatives
- Coordination processes between agents
- How nitrogen evolve in the soil
- Improvement of the costs calculation