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## **An Agent-Based Model of the Amazonian Forest Colonisation and Oil Exploitation: the Oriente Study Case**

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# An agent-based model of the Amazonian forest colonisation and oil exploitation : The Oriente study case

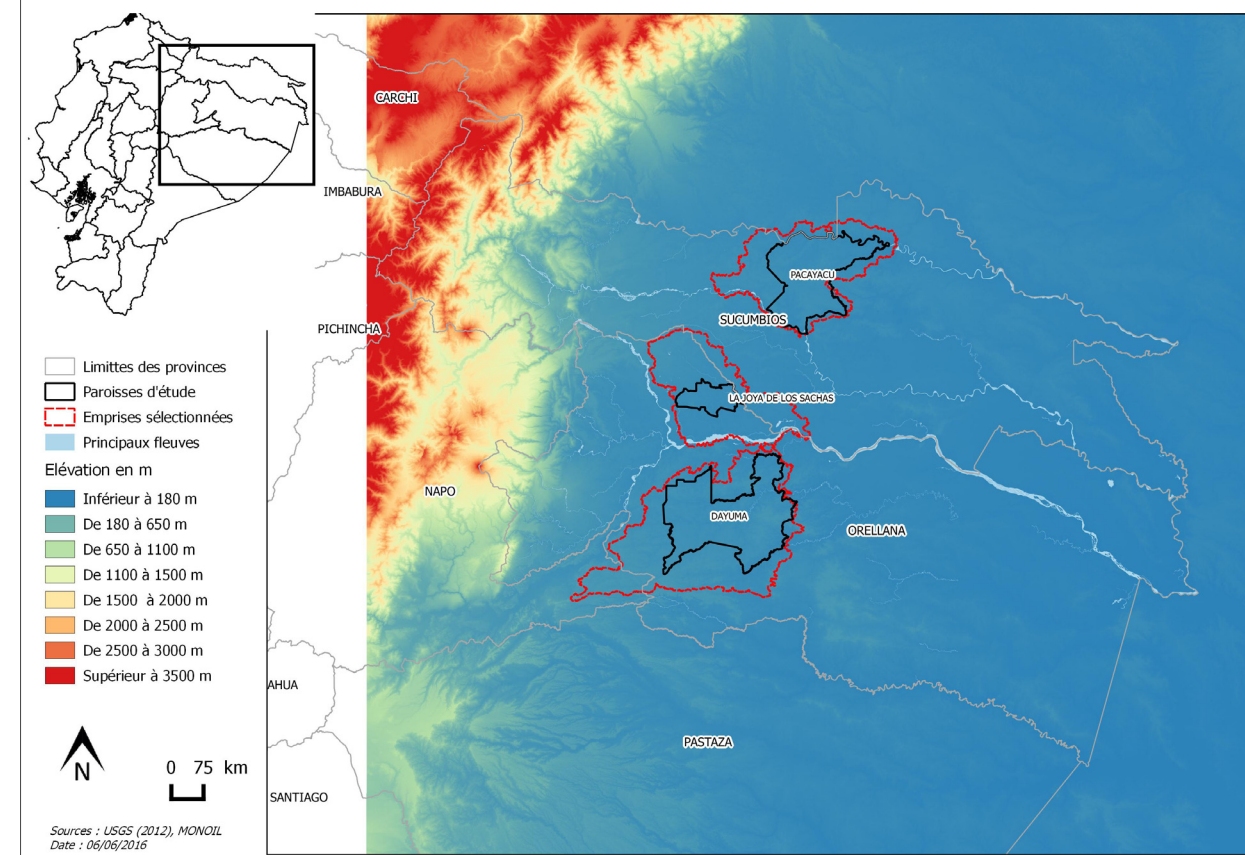


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## Context:



Sources : <http://www.monoil.ird.fr/photos>

## Aim :

To reproduce the environmental and socioeconomic impacts of colonization and oil exploitation on the Oriente (Ecuadorian Amazon)

Integrating :

- colonization & oil exploitation impacts
- microeconomics behaviors of the population
- public policies & goods' prices

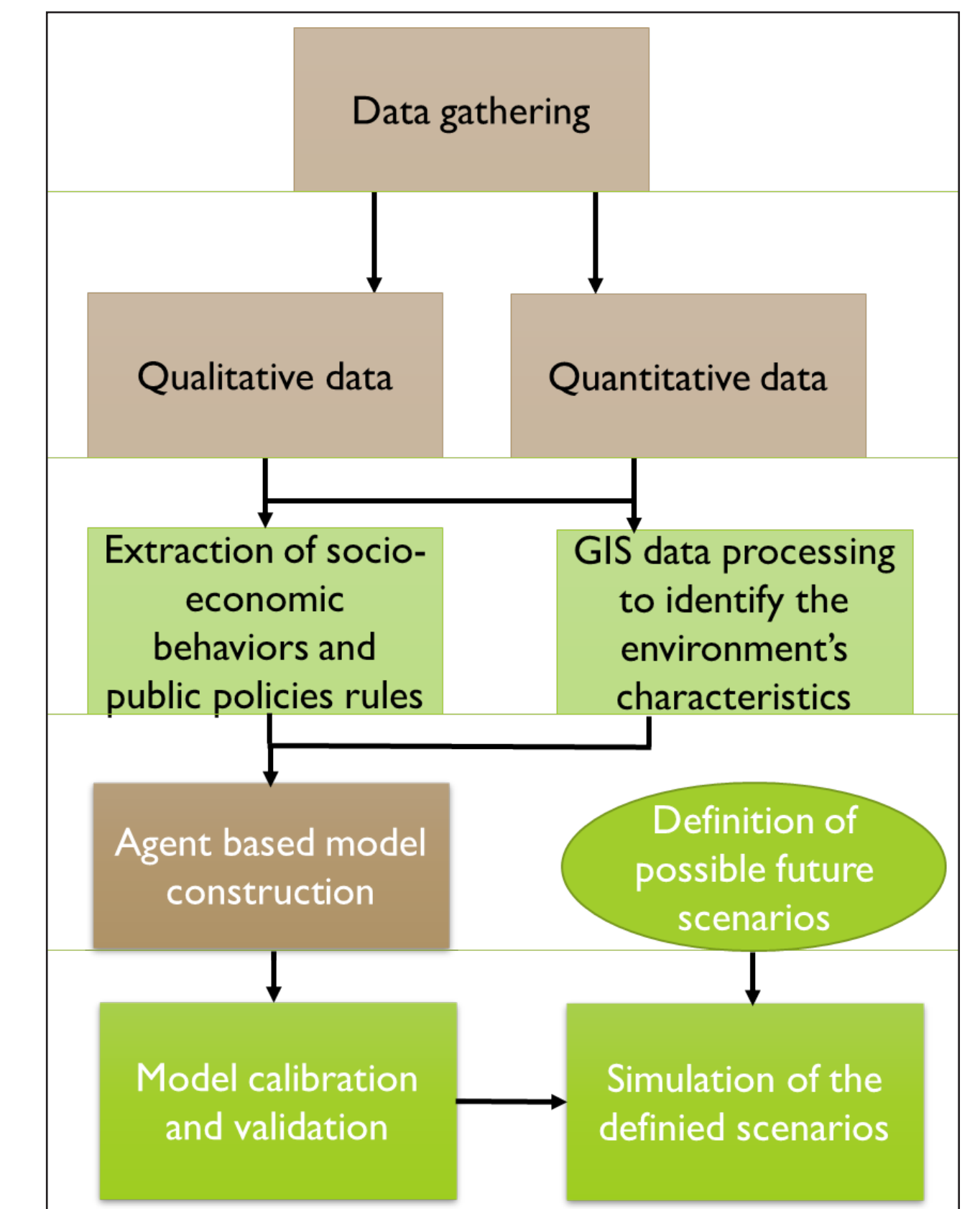
To simulate the possible futures of this territory by the means of a scenario based exploration tool

Two main steps :

- Retrospective simulation to replicate the past colonization of the environment and its effects on the environment
- Simulate the actual and possible future situation with the social structuration of agents and their difficulties to deal with oil contamination

To use the results obtained as decision-support tools

## Method :



## Construction of the MONOIL model

Modules created :

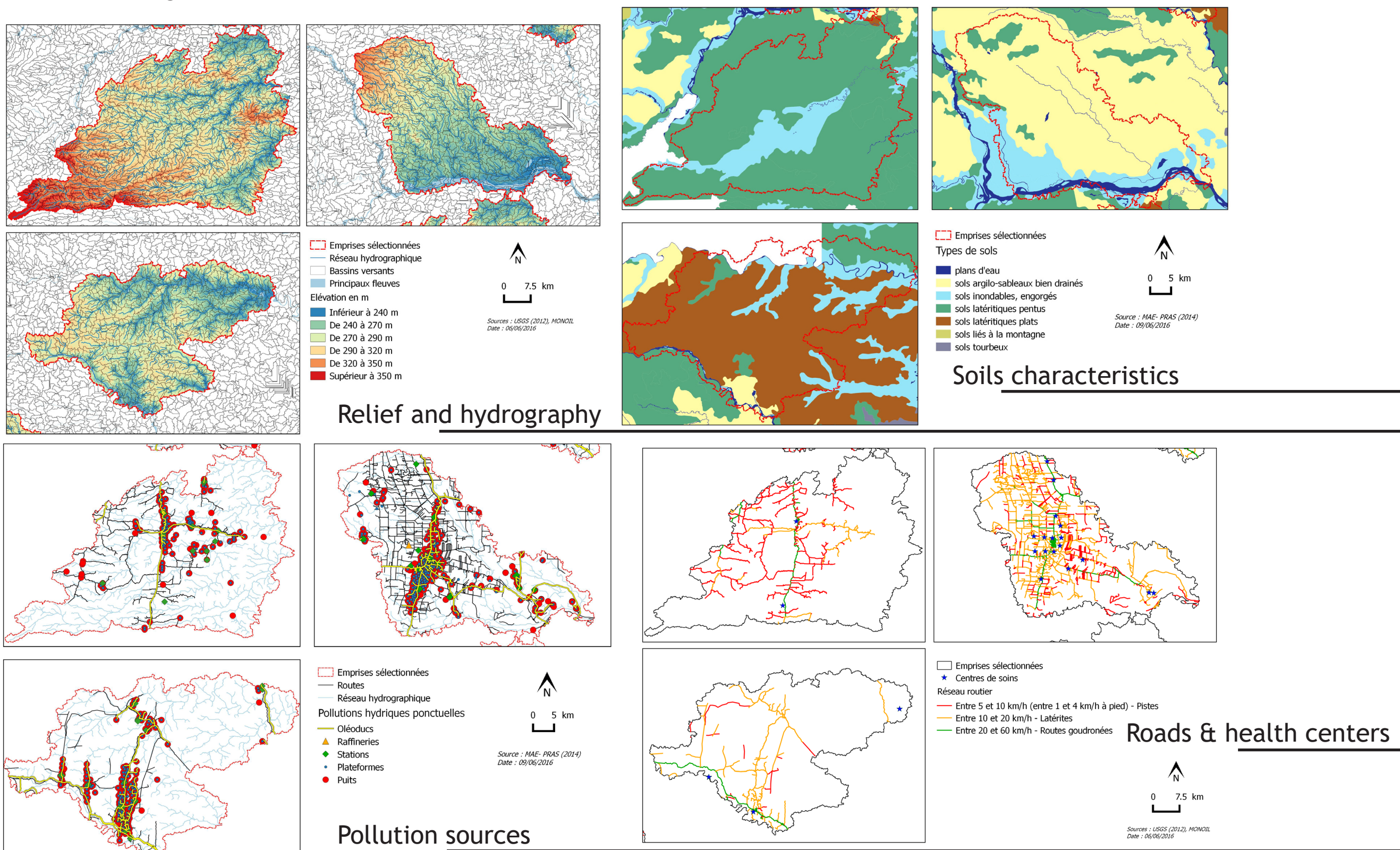
Steps of the project :

### Data processing

- Building a meaningful GIS dataset for feeding the model
- Creation of watersheds and rivers
- Demarcation of the study areas (Parish of Dayuma, Pacayacu, La joya de los sachas) using the DEM (Digital Elevation Model) including the upperstream watersheds
- Selection of rainfall data for each study site (Hijmans, et al. 2005)
- Classification of the pollutions sources according to their effect area and persistence on the environment
- Calculation of pollutions accidents' periodicity and volume variability
- Processing demographics data
- Definition of soils characteristics of our study areas using USDA (United State Department of Agriculture) data
- Computation of the fertility and flooding indices of our study areas' soils

Various pollution sources

- Environmental, hydrographic, climatic dynamics and soils characteristics
- Road network and health centers
- Model background



### Biophysical module

### Agents module

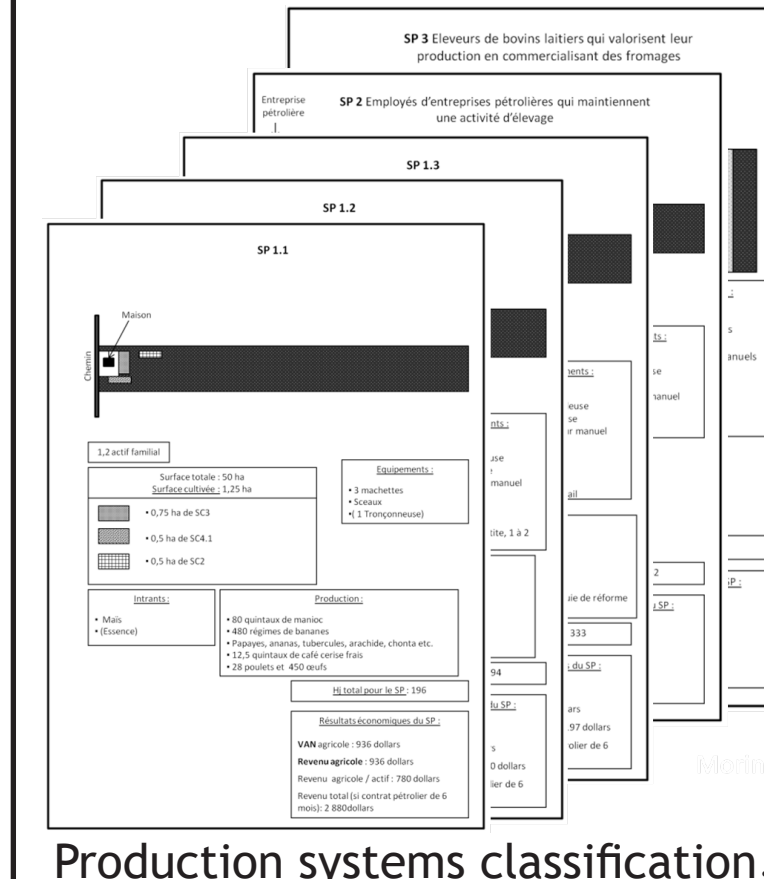
### Regulation module

INEC data base

- Total population by parishes
- Population density by parishes
- Intercensal growth rate by parishes
- Households by dwelling types and parishes
- Population by age range and parishes
- Population by ethnic groups and parishes
- Population by revenue
- Households size

Morin, L., 2015

- Farming production systems (Cocoa, coffee, corn, casava, banana)
- Livestock production systems (cows, porks, chickens)
- Productivity of each systems
- Manpower needed for each production
- Farmers social organisation
- Oil companies activities



Production systems classification, Morin, 2015

Definition of rules from MSc & Phd thesis and experts' opinion :

- Agricultural policies,
- Oil producer policies,
- Political and social structuration,
- Public and private subsidies system,
- Market prices,
- Healthcare system.

Readings

- *Eties & Mettetal, 1985*
- *Bilsborrow et al., 2006*
- *Engelman, 2011*
- *Juteau, 2012*
- *Paichard, 2012*
- *Dumont, 2013*
- *Wasserstrom & Southgate, 2013*
- *Morin, 2015*
- *Boyon, 2015*

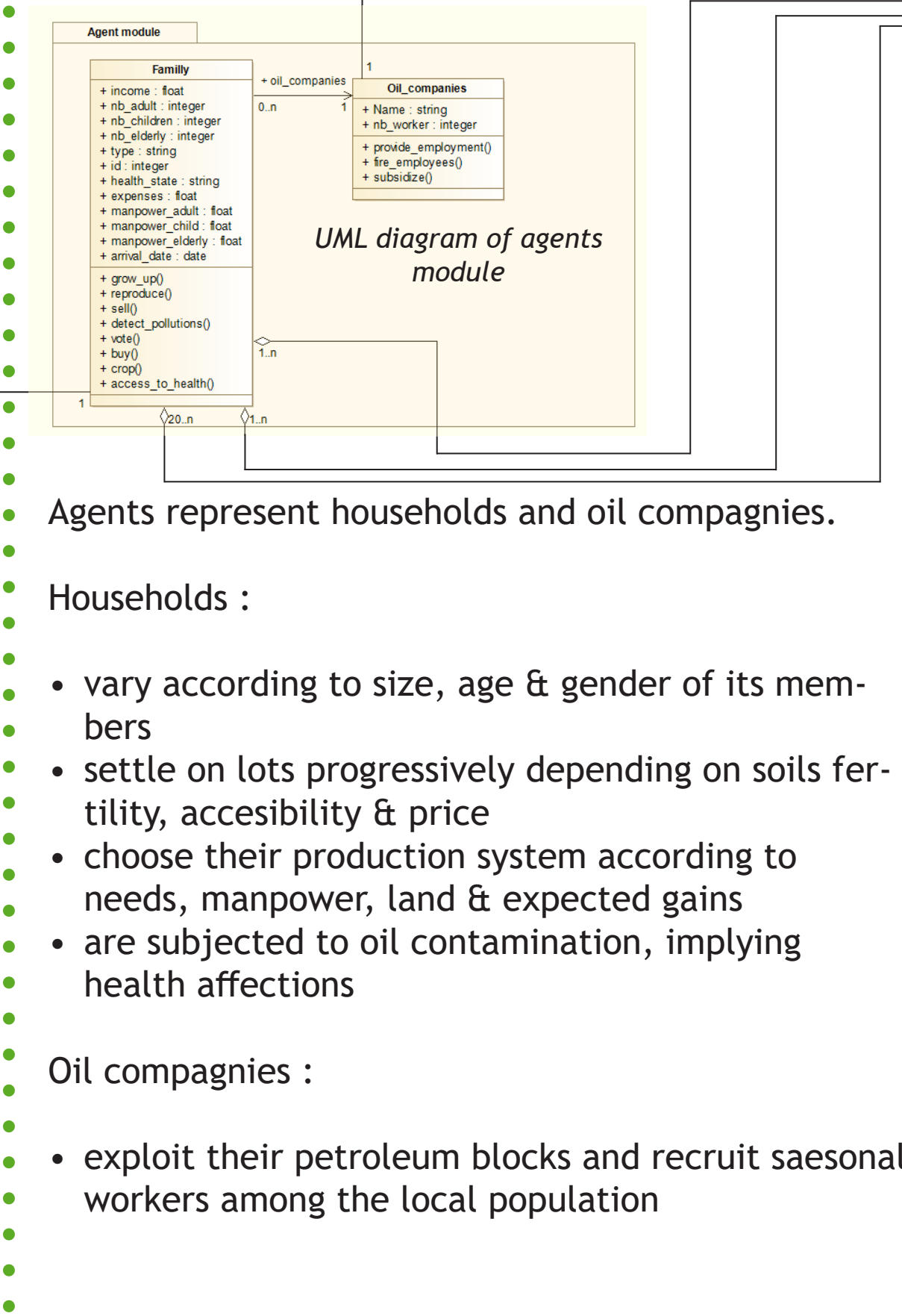
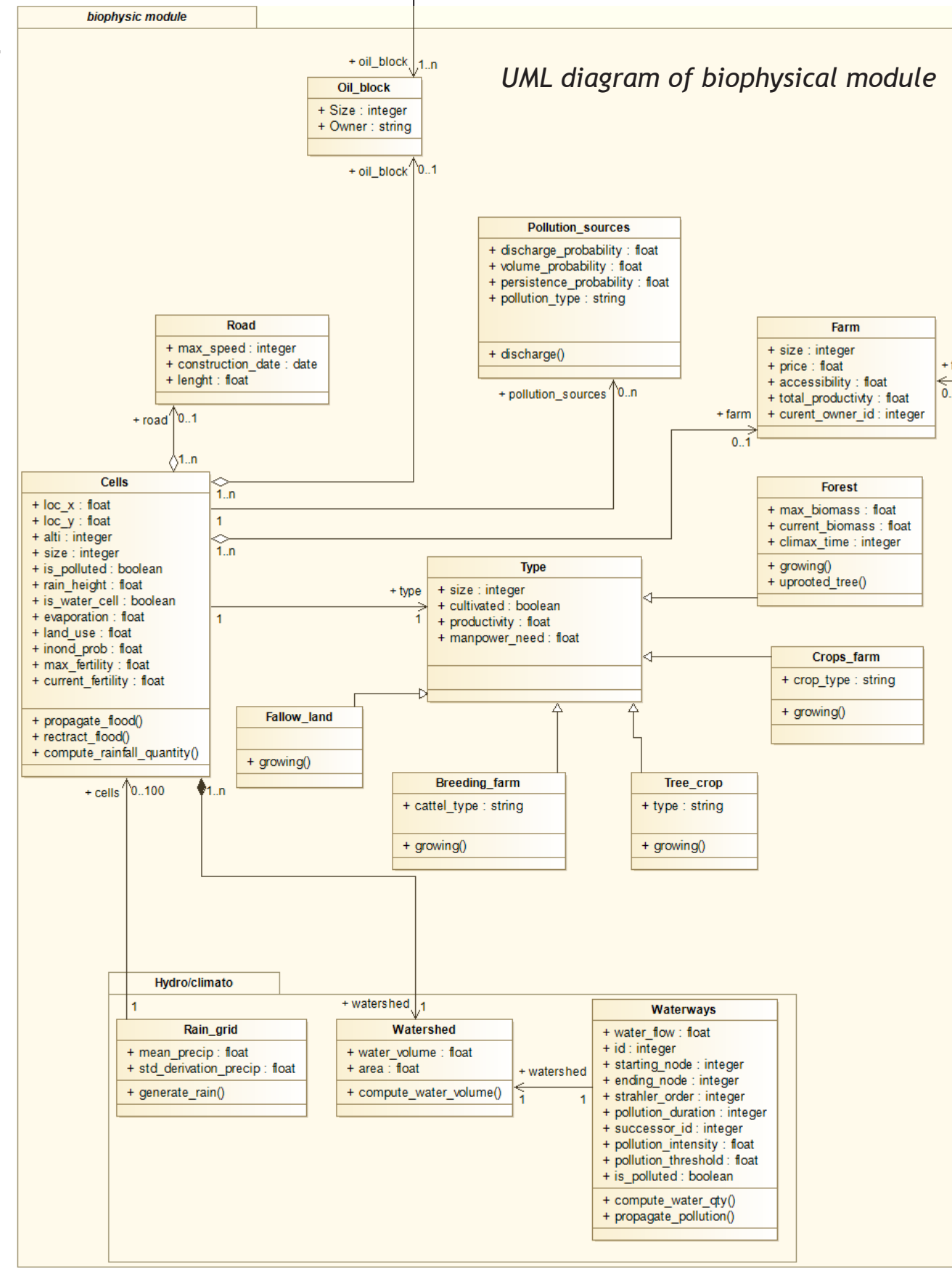
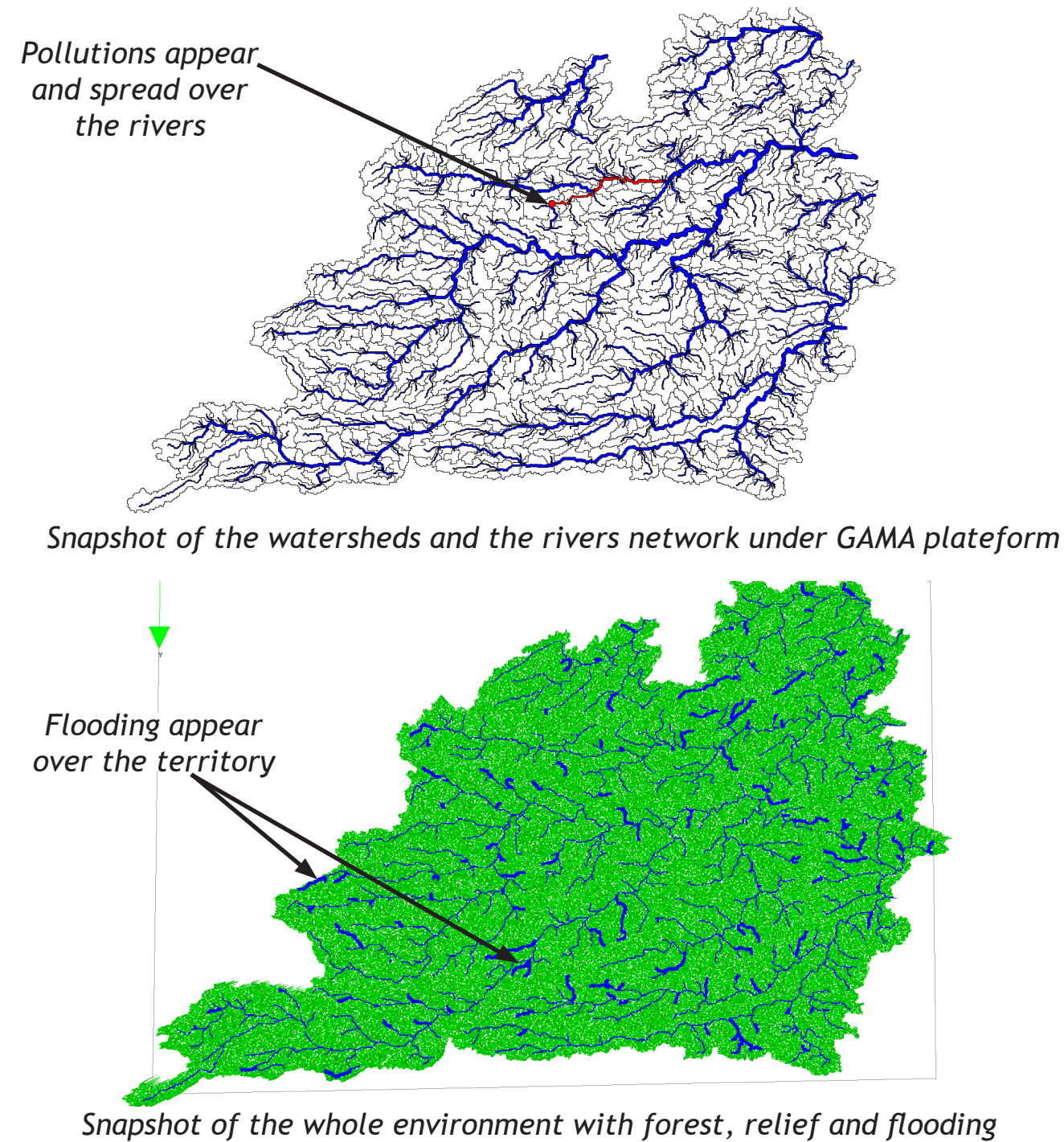
## Model building and implementation

Conception of the model entities using UML language.

Implementation of the model :

- Implementation of the elevation using the DEM
- Implementation of the rainfall, watersheds and rivers. Computation of the water flow
- Implementation of the flooding dynamics
- Implementation of pollutions and their spreading over rivers and soils
- Implementation of the agents dynamics
- Implementation of the model rules

- Compute pollution spreading over the environment as function of the previous pollution calculation
- Implement flooding dynamics according to elevation and soils types
- Calculate the forest growth depending on fertility

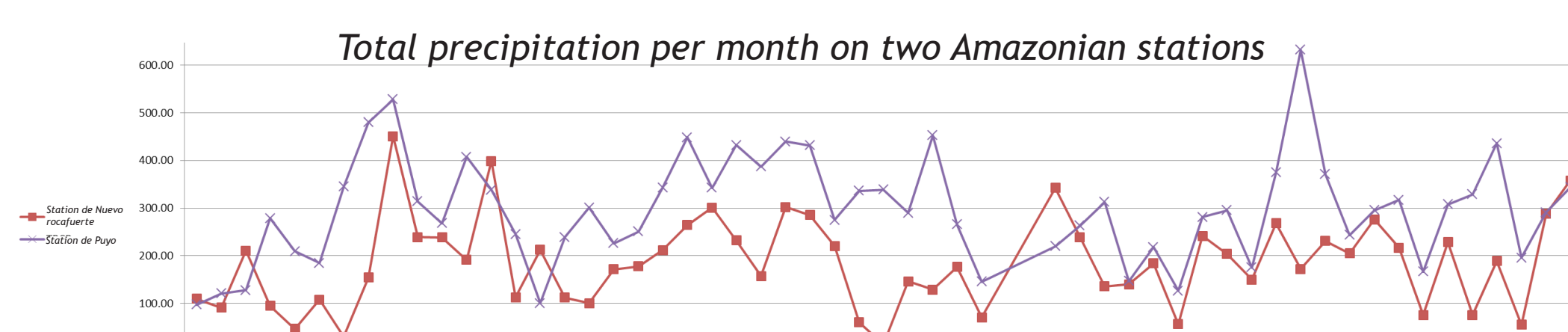


- Agents represent households and oil companies.
- Households :
- vary according to size, age & gender of its members
  - settle on lots progressively depending on soils fertility, accessibility & price
  - choose their production system according to needs, manpower, land & expected gains
  - are subjected to oil contamination, implying health affections
- Oil companies :
- exploit their petroleum blocks and recruit seasonal workers among the local population

- Regulation rules :
- Two land tenures
  - In Comuna ownership is collective. Each indigenous has temporary land lots
  - Settlers gather themselves in Comunidad where people keep their plots private
  - Market prices vary following historical variations
  - Farmers rationality balance between family needs securization & investing projects
  - Government allocate agricultural subsidies to population. It also provides the healthcare services
  - Oil companies offer subsidies in order to counterbalance the effects of pollution and prospecting on farmers' plots but also create road to exploit oil resources

## Model calibration

- Using external data to calibrate the environment and the agents behaviors :
- GIS land use data (GAD, Gobierno Autonomo Descentralizado & PRAS, Programa de Reparacion Ambiente y Social)
- Perception based map of pollution (Maestriperieri & Saqalli, 2015)
- USGS (United State Geological Survey) precipitation data
- Pollution data (MONOIL project, work in progress)



## Perspectives :

- A field mission is scheduled in October. During this mission we will discuss about our model with experts and MONOIL project actors :
  - Does the model look like they expect ?
  - Does the dynamics of the model fit with the reality ?
- It will also be an opportunity to define Oriente future development scenarios with the project stakeholders :
- survey local population and project stakeholders on the future of the territory
- create with them plausible future scenarios
- simulate these scenarios to help stakeholders in decision making process
- This work is still on progress until the end of October 2016.
- We also hope funding to lead a thesis on «migrations retrospective and prospective modelling over the colonisation of Amazonian forest : the ecuadorian case».