

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

William Chapotat, Lionel Houssou, Mehdi Saqalli, Benoit Gaudou, Emilie Lerigoleur, Nicolas Maestripieri, Audren Bouadjio Boulic

▶ **To cite this version:**

William Chapotat, Lionel Houssou, Mehdi Saqalli, Benoit Gaudou, Emilie Lerigoleur, et al.. An Agent-Based Model of the Amazonian Forest Colonisation and Oil Exploitation: the Oriente Study Case. 8th International Congress on Environmental Modelling and Software, Jul 2016, Toulouse, France. hal-01446823

HAL Id: hal-01446823
https://hal.science/hal-01446823

Submitted on 26 Jan 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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

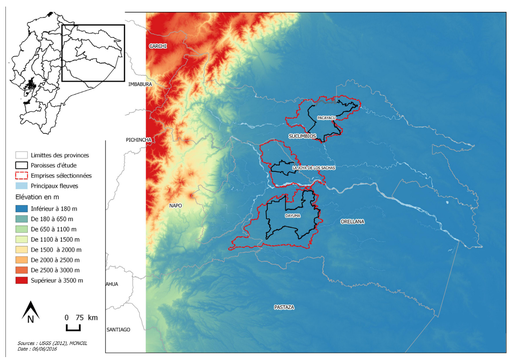
W. CHAPOTAT[(a)], L. HOUSSOU[(a)], M. SAQALLI[(a)], B. GAUDOU[(b)], E. LERIGOLEUR[(a)], N. MAESTRIPIERI[(a)], A. BOUADJIO - BOULIC[(b)].

(a) UMR 5602 GEODE, CNRS, University of Toulouse 2 Jean Jaurès, Toulouse 31058, France

(b) UMR 5505 IRIT, CNRS, University of Toulouse 1 Capitole, Toulouse 31000, France

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

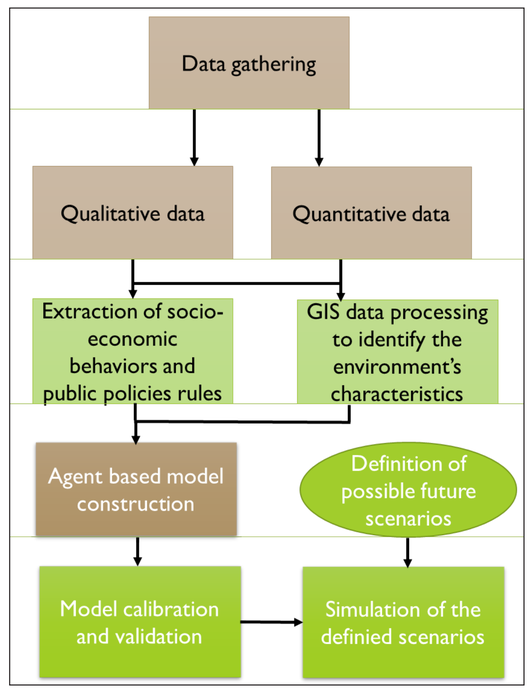
To simulate the possible futures of this territory by the means of a scenario based exploration tool

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 situtation 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

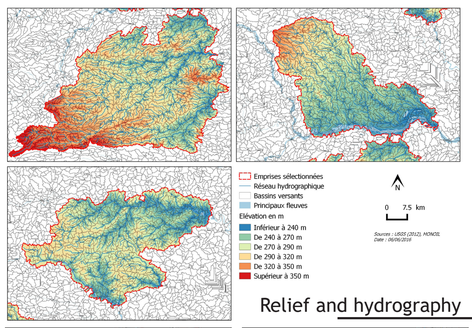
Steps of the project : / Modules created :

Data processing

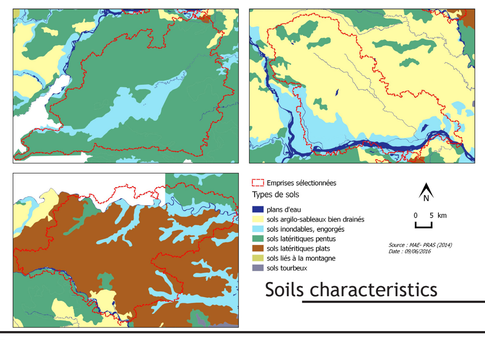
- Building a meaningful GIS dataset for feeding the model
- Creation of watersheds and rivers
- Demarcation of the study areas (Parish of Dayuma, Pacayacu, La joya de los sachas) using the DEM (Digital Elevation Model) including the upperstream watersheds
- Selection of rainfall data for each study site (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

Biophysical module

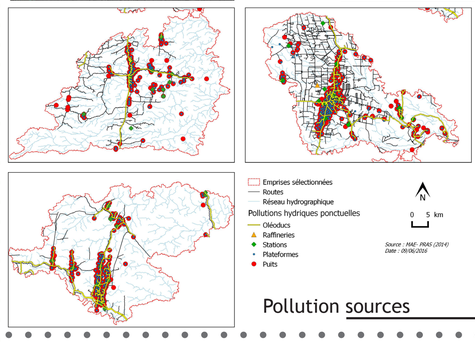
- Various pollution sources
- Environmental, hydrographic, climatic dynamics and soils characteristics
- Road network and health centers
- Model background



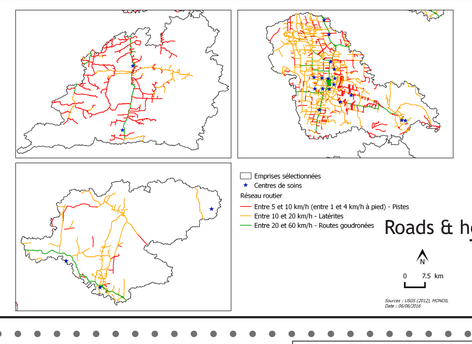
Relief and hydrography



Soils characteristics



Pollution sources



Roads & health centers

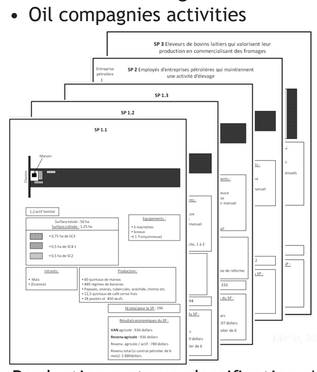
Agents module

INEC data base

- Total population by parishes
- Population density by parishes
- Intercensal growth rate by parishes
- Households by dweling 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 compagnies activities



Production systems classification, Morin, 2015

Regulation module

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

- *Elies & 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

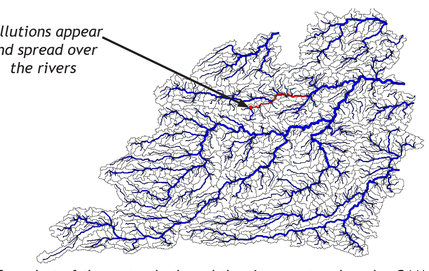
Conception of the model entities using UML language.

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

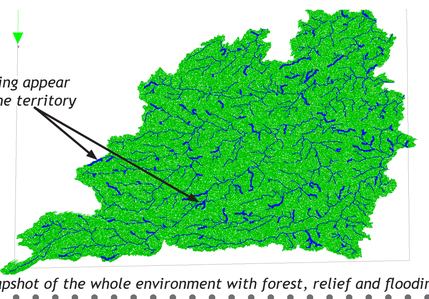
- Compute pollution sreading over the environment as function of the previous pollution calculation
- Implement flooding dynamics according to elevation and soils types
- Calculate the forest growth depending on fertility

Pollutions appear and spread over the rivers



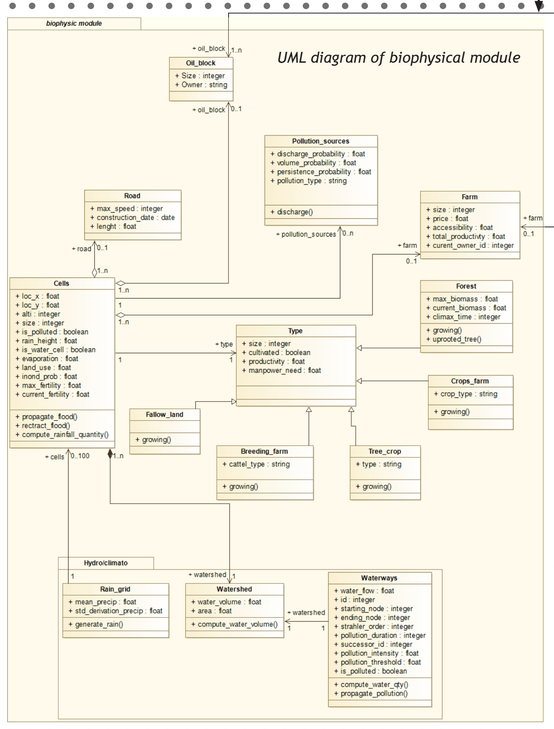
Snapshot of the watersheds and the rivers network under GAMA plateform

Flooding appear over the territory

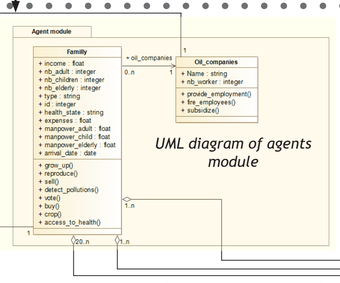


Snapshot of the whole environment with forest, relief and flooding

UML diagram of biophysical module



UML diagram of agents module



Agents represent households and oil compagnies.

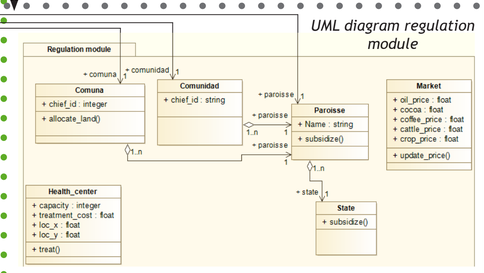
Households :

- vary according to size, age & gender of its members
- settle on lots progressively depending on soils fertility, accesibility & price
- choose their production system according to needs, manpower, land & expected gains
- are subjected to oil contamination, implying health affections

Oil compagnies :

- exploit their petroleum blocks and recruit saesonal workers among the local population

UML diagram regulation module



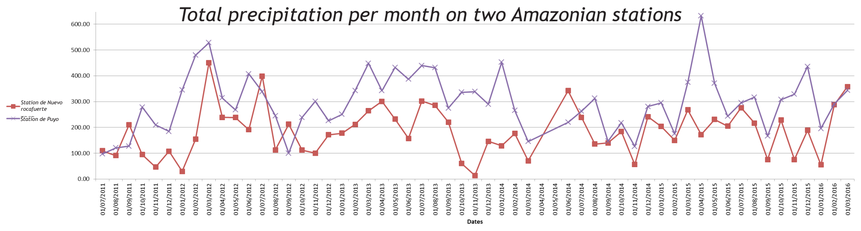
Regulation rules :

- 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 compagnies offer subsidies in order to counterbalance the effects of pollution and prospecting on farmers' plots but also create road to exploit oil ressources

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 (Maestripieri & Saqalli, 2015)
  - USGS (United State Geological Survey) precipitation data
  - Pollution data (MONOIL project, work in progress)

Total precipitation per month on two Amazonian stations



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».