Examples of Multiagent Based Simulations

2. The DS Model

Simulation of Land use evolutions for public decision making

Example of Multiagent-based Simulation: DS

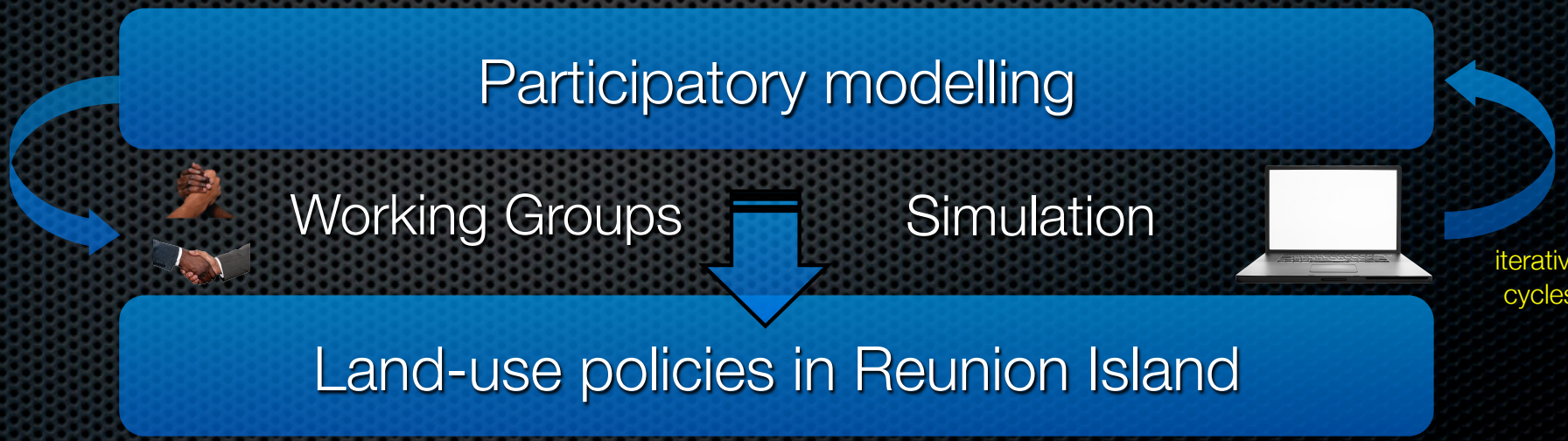
DS application context

Example of Multiagent-based Simulation: DS

Context and Objective of DS

- Help Reunion Island Public decision maker to build the "*SAR – Schéma d'aménagement du territoire*" Strategy
- Landscapes are now expected to fulfil multiple functions and this causes conflicts among stakeholders.

Simulation process: Fruit of the collaboration of many researchers, decision-maker, local institutions…



Example of Multiagent-based Simulation: DS

Coupling dynamics

Three major classes of land-use:

Agricultural spaces

Natural spaces

Land-Use dyn.

Urban spaces

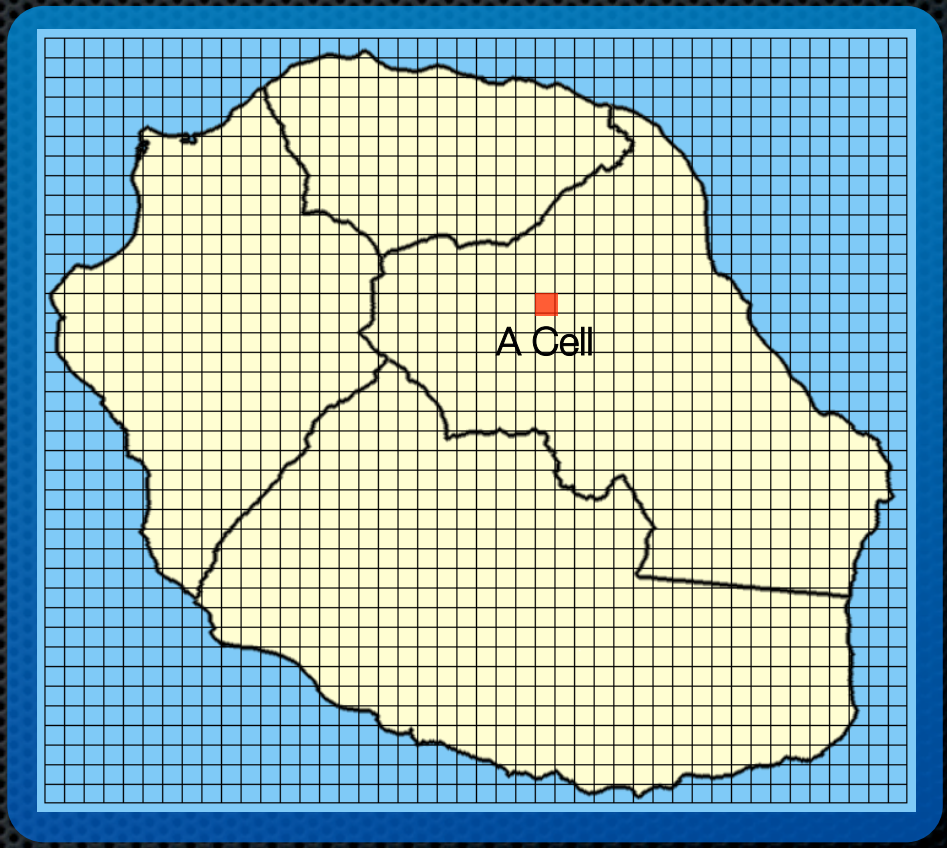
Population Dyn.

Land-Use / Population Dynamic

Example of Multiagent-based Simulation: DS

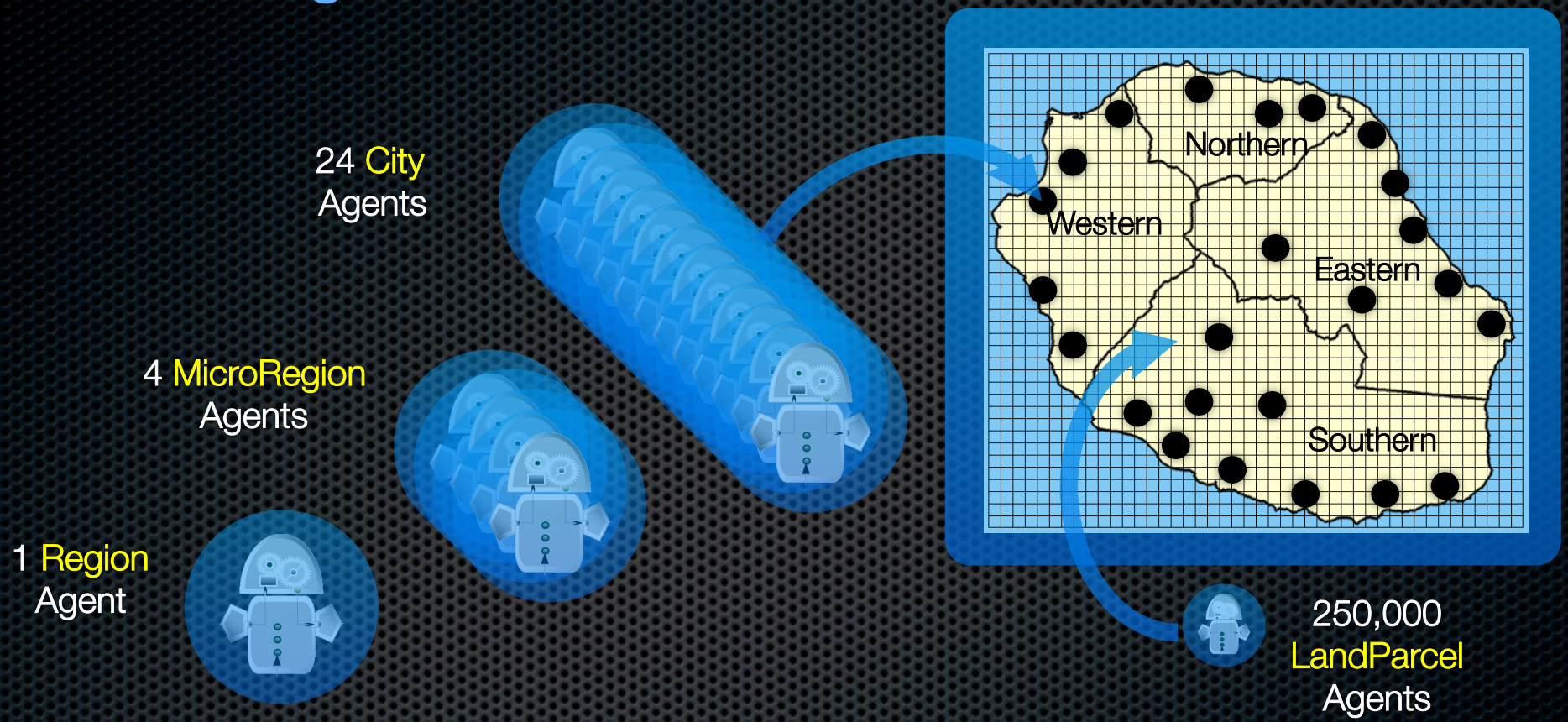
Spatial entities

- The Territory is represented with Cells
- A Cell is an elementary spatial square units of land.
- The model allows to use different cells size in a same simulation
- Cells are environment resources for DS agents



For this application we make simulation with 1 ha (and also 4ha) cells
252,980 (or 63,245) cells to cover the whole island

Social agents

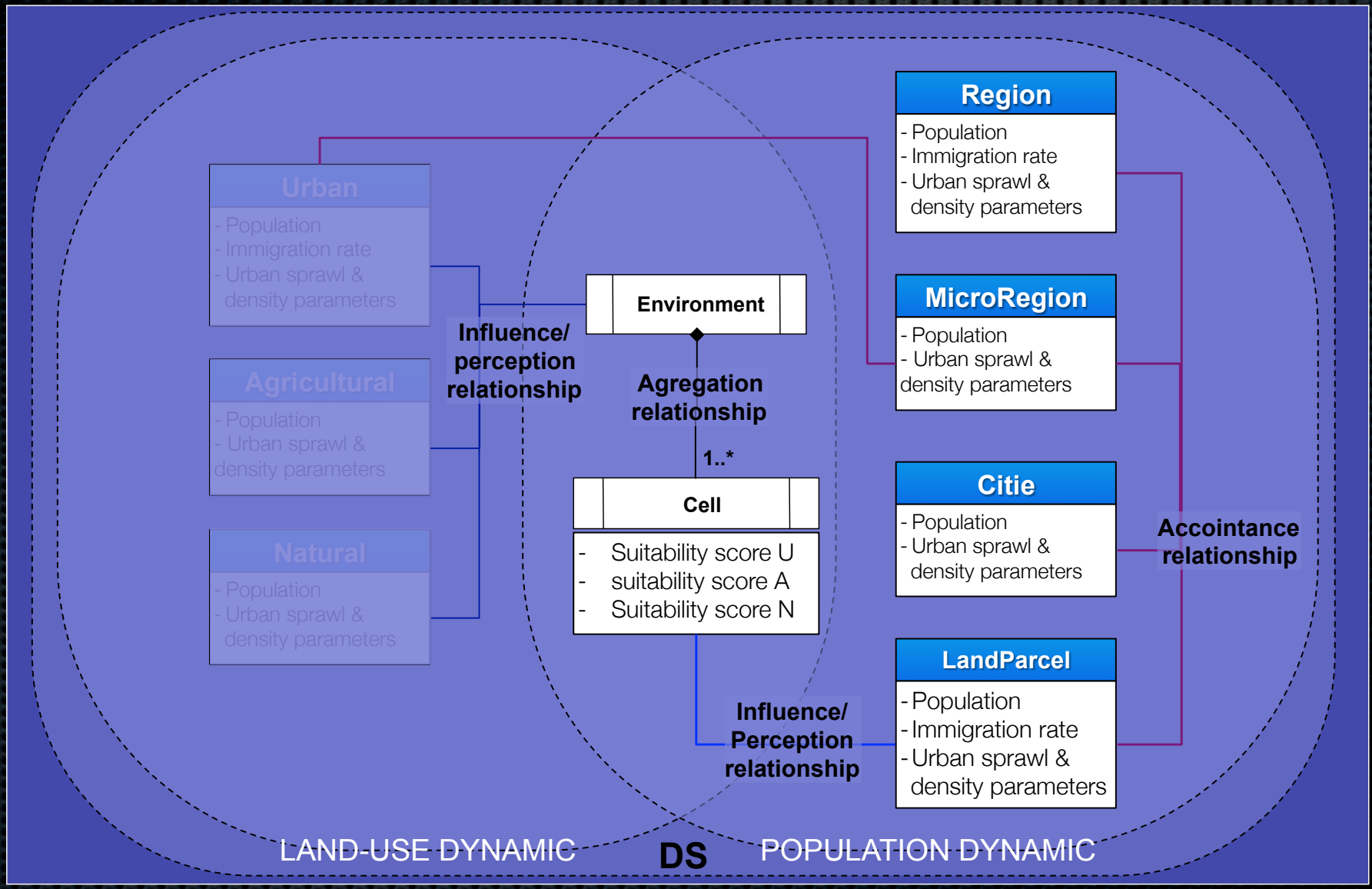


The land parcels agents are as many as the cells of the environment

- Land Parcels = agents with an internal behaviour
- Cell = simple objects of the environment that can be manipulated by the Land Parcel agents of the DS Multiagent system.

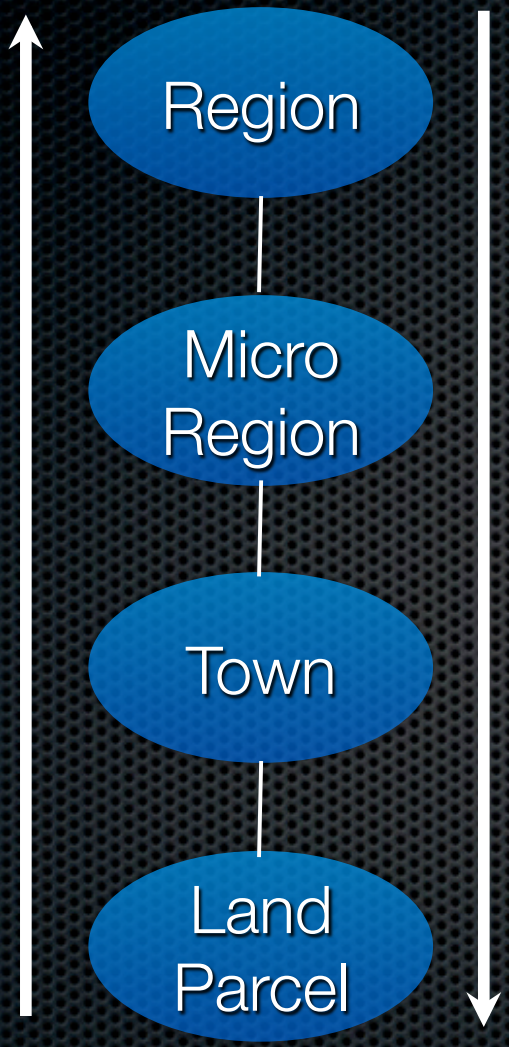
Example of Multiagent-based Simulation: DS

DS Agent Model



Example of Multiagent-Based Simulations: DS

Population Dynamics



- Each Year :
  - Top /Down and Bottom/ Up Interactions
- Allocation of agent new population
  - Calculation of the number of departures, births and deaths of the year;
  - Updating the age pyramid
  - Updating the total population
- Taking into account
  - land attractiveness
  - immigration rates
  - population density

Example of MultiAgent-Based Simulations: DS

Spatial entities based on Colored Maps

Research Institution

IRD Institut de recherche pour le développement

Université de la Réunion S'ouvrir aux mondes

Ifremer

Météo France

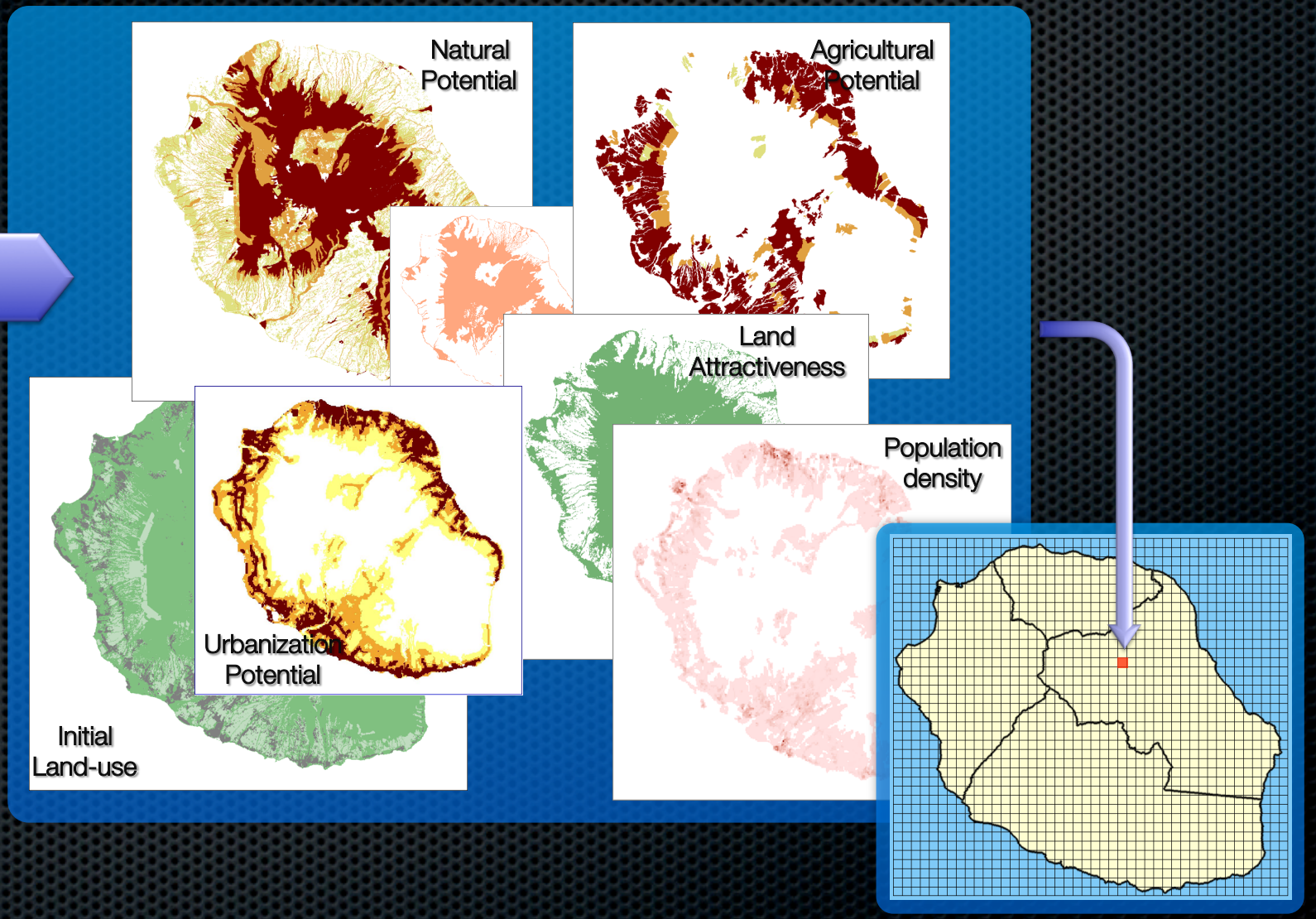
cirad

Region Reunion

Liberté • Égalité • Fraternité République Française

INSEE

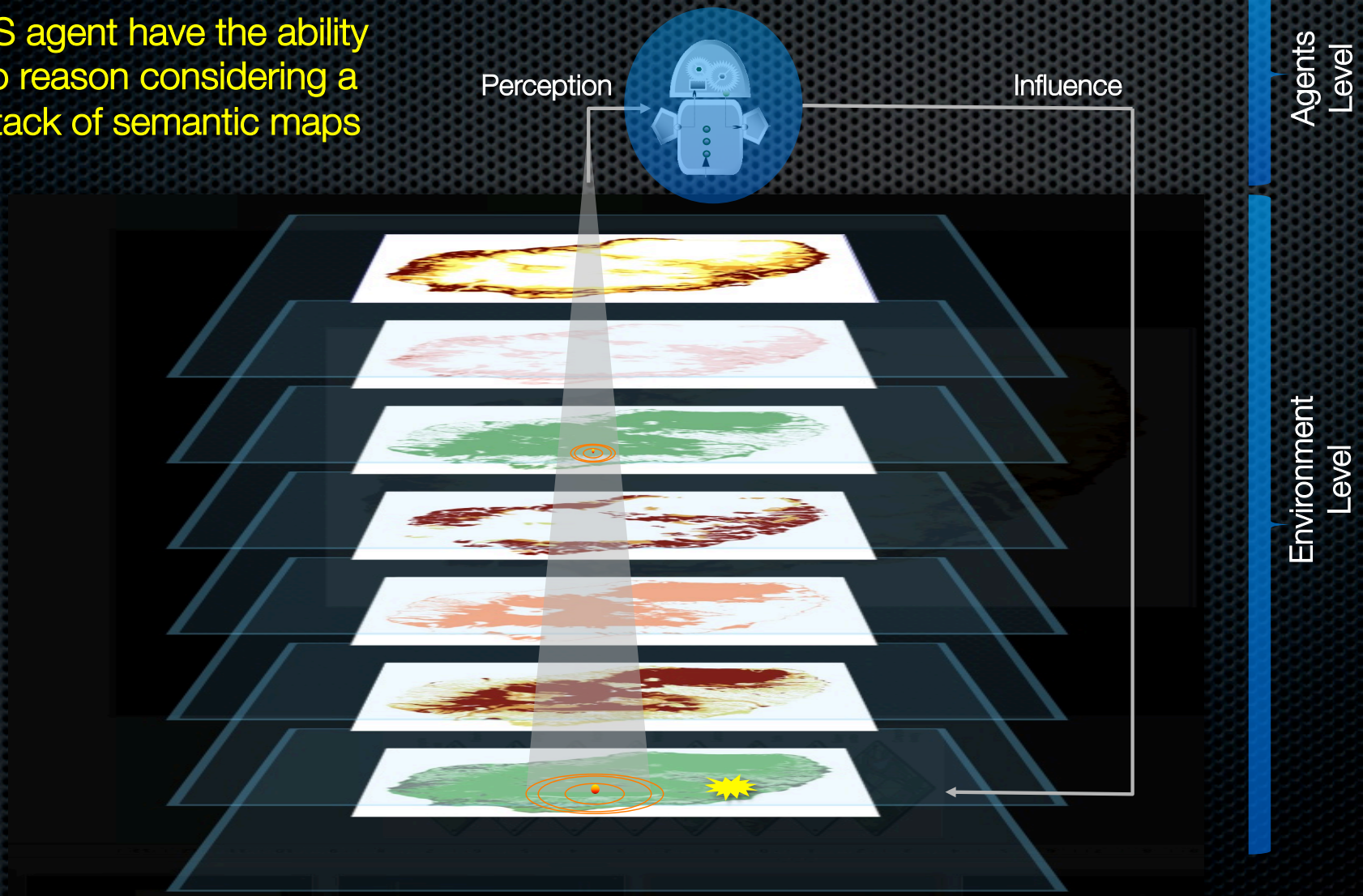
Social Institution



Examples of Multi-Agent Based Simulations: DS

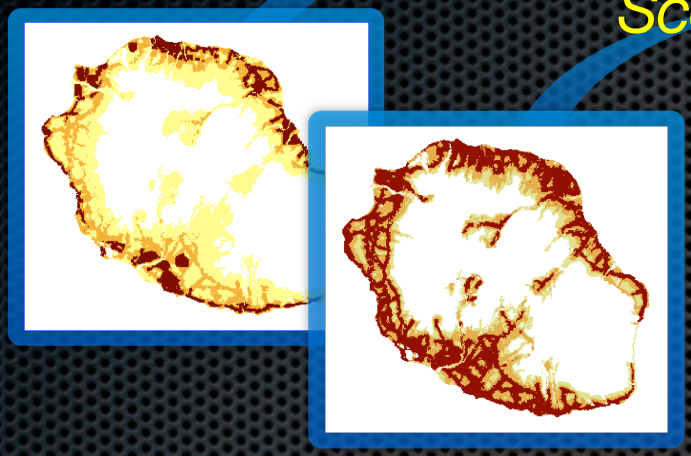
How to define the environment?

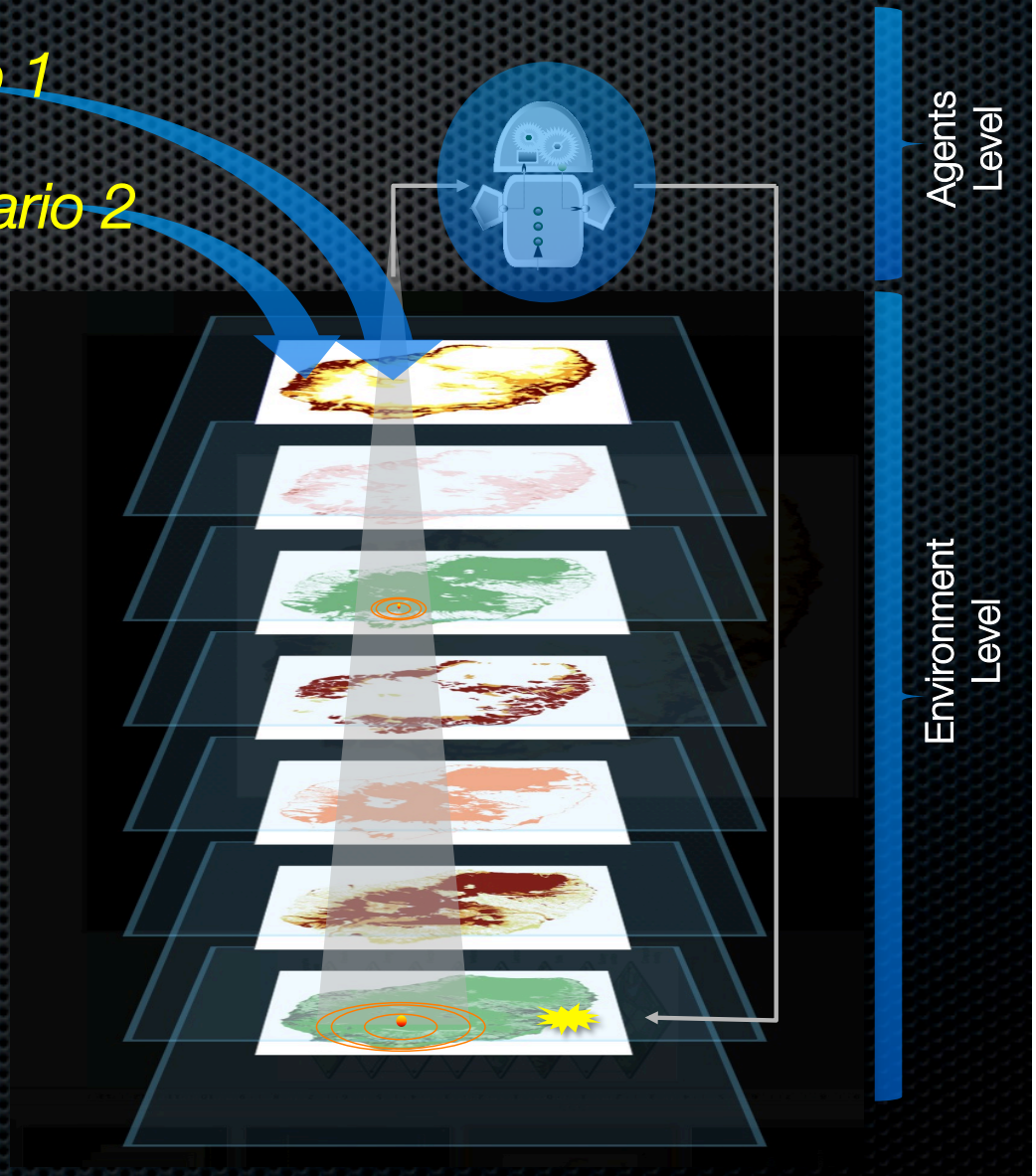
DS agent have the ability to reason considering a stack of semantic maps



Examples of Multi-Agent Based Simulations: DS

Scenarios can be defined with maps





XELOC: eXtensible Editing Language Of Configuration

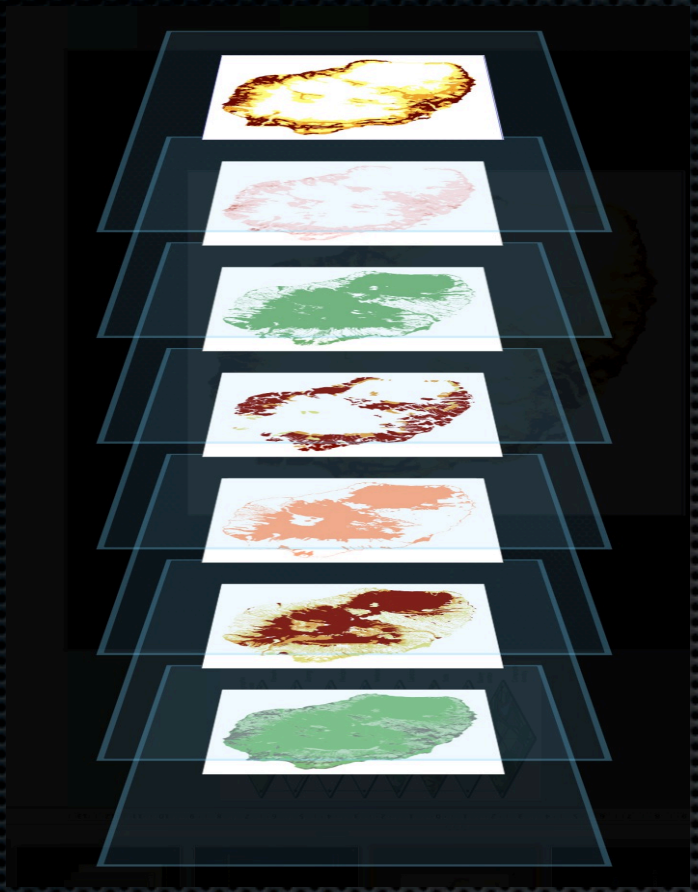
XML Langage that facilitate environment configuration

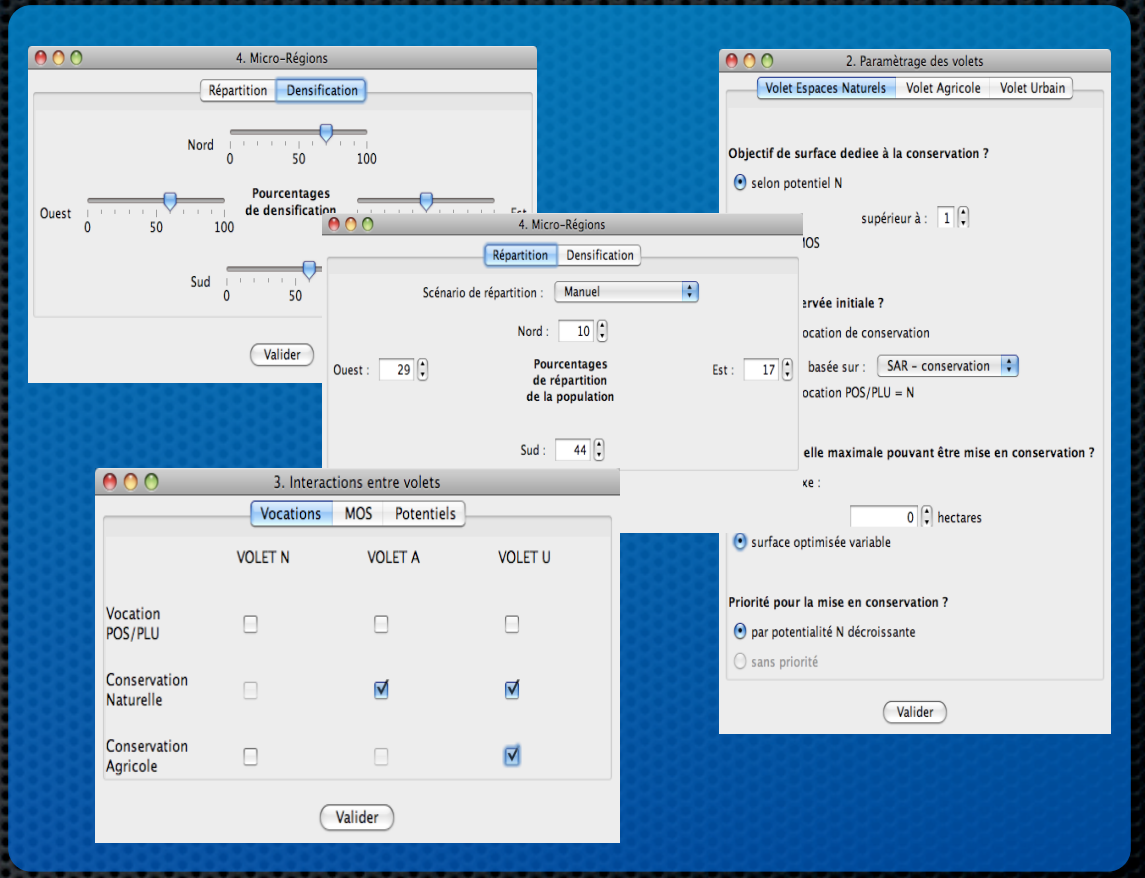
```
<!-- Ajout de l'environnement spatial -->
<addEnvironment  name="ForestWorld"
                 setGlobal="worldName" />
<!--  Configuration de cet environnement -->
<configEnvironment environment="@worldName">
    <multiValue>
        <champ name="request"
               value="size" />
        <champ name="row"
               value="@nbRow" />
        <champ name="column"
               value="@nbColumn" />
    </multiValue>
</configEnvironment>
```

13 alternative scenarios identified in the project

Examples of Multi-Agent Based Simulations: DS

Scenarios configuration

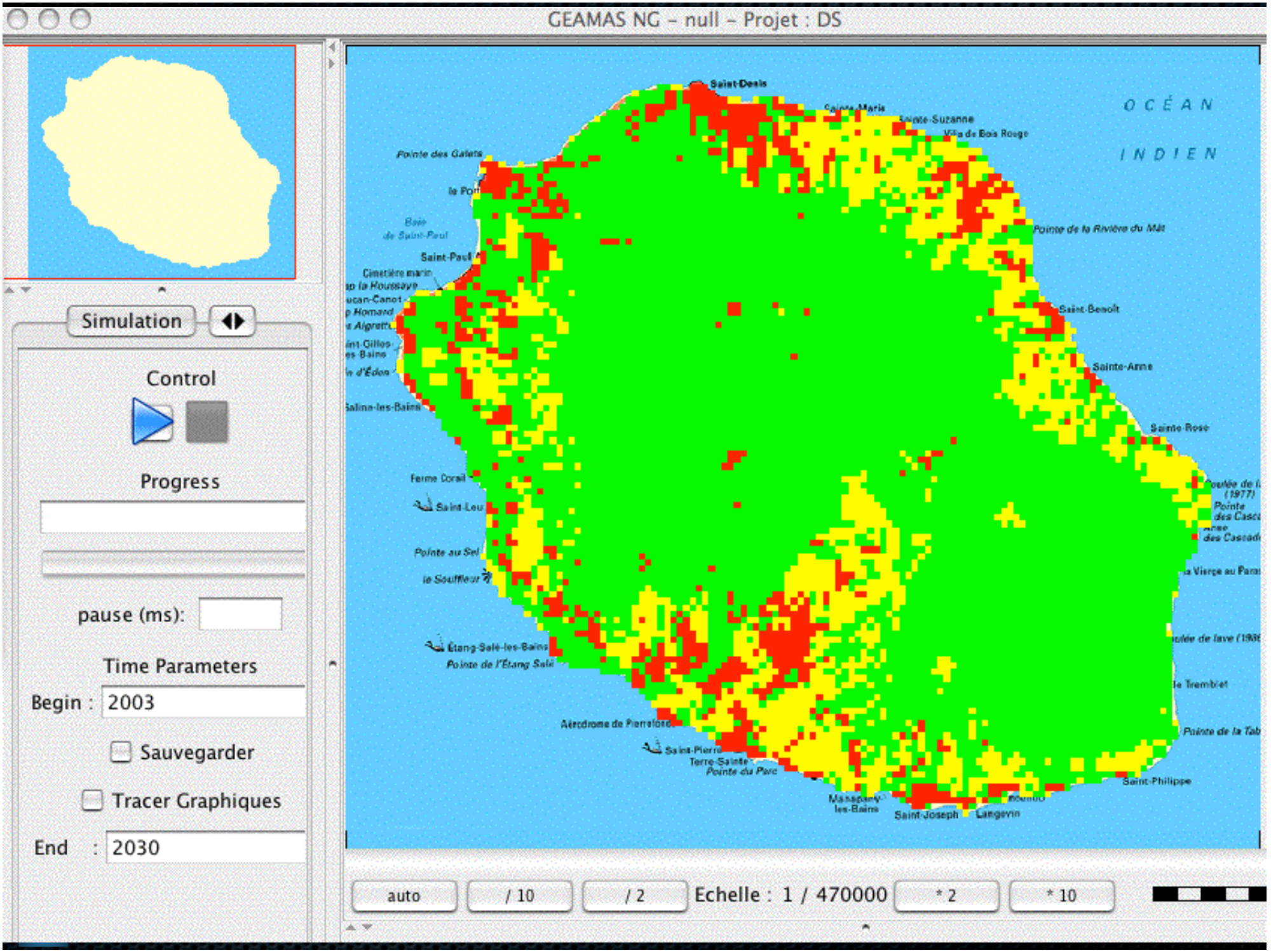




Maps

User interface

GEAMAS-NG Multiagent systems simulation platform


GEAMAS NG - null - Projet : DS
Simulation
Control
Progress
pause (ms):
Time Parameters
Begin : 2003
Sauvegarder
Tracer Graphiques
End : 2030
OCÉAN
INDIEN
Saint-Denis
Sainte-Suzanne
Pointe des Galets
Pointe de la Rivière du Mât
Saint-Paul
Saint-Benoît
Sainte-Anne
Sainte-Rose
Saint-Leu
Pointe au Sel
Étang-Salé-les-Bains
Pointe de l'Étang Salé
Aérodrome de Pierrefonds
Saint-Pierre
Terre-Sainte
Pointe du Parc
Saint-Philippe
Saint-Joseph
Langevin
auto
/ 10
/ 2
Echelle : 1 / 470000
* 2
* 10

DS Agent Model: Results

The DS Model

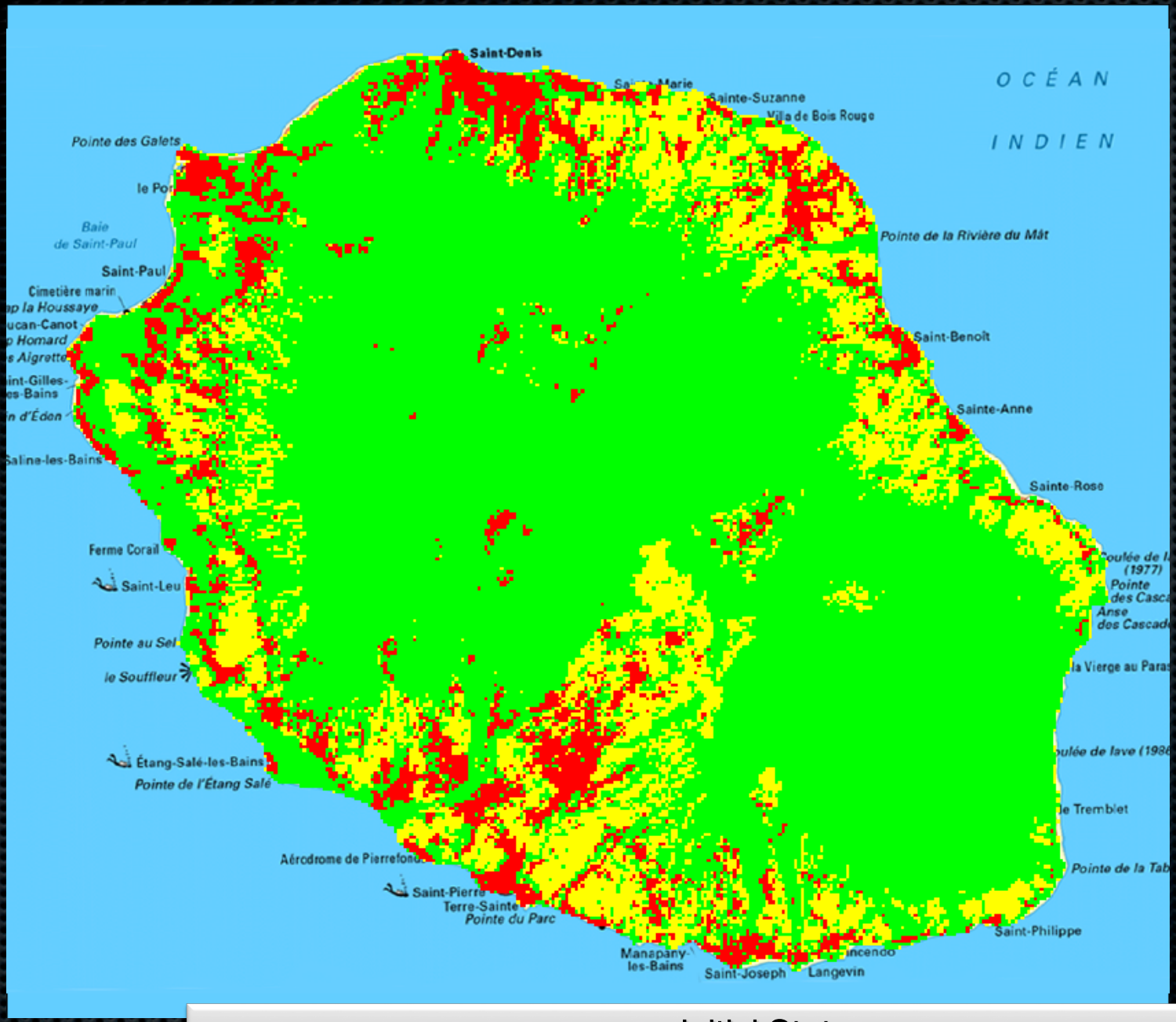
- **A few results (yes, results!)**

Example of Multiagent-Based Simulations: DS

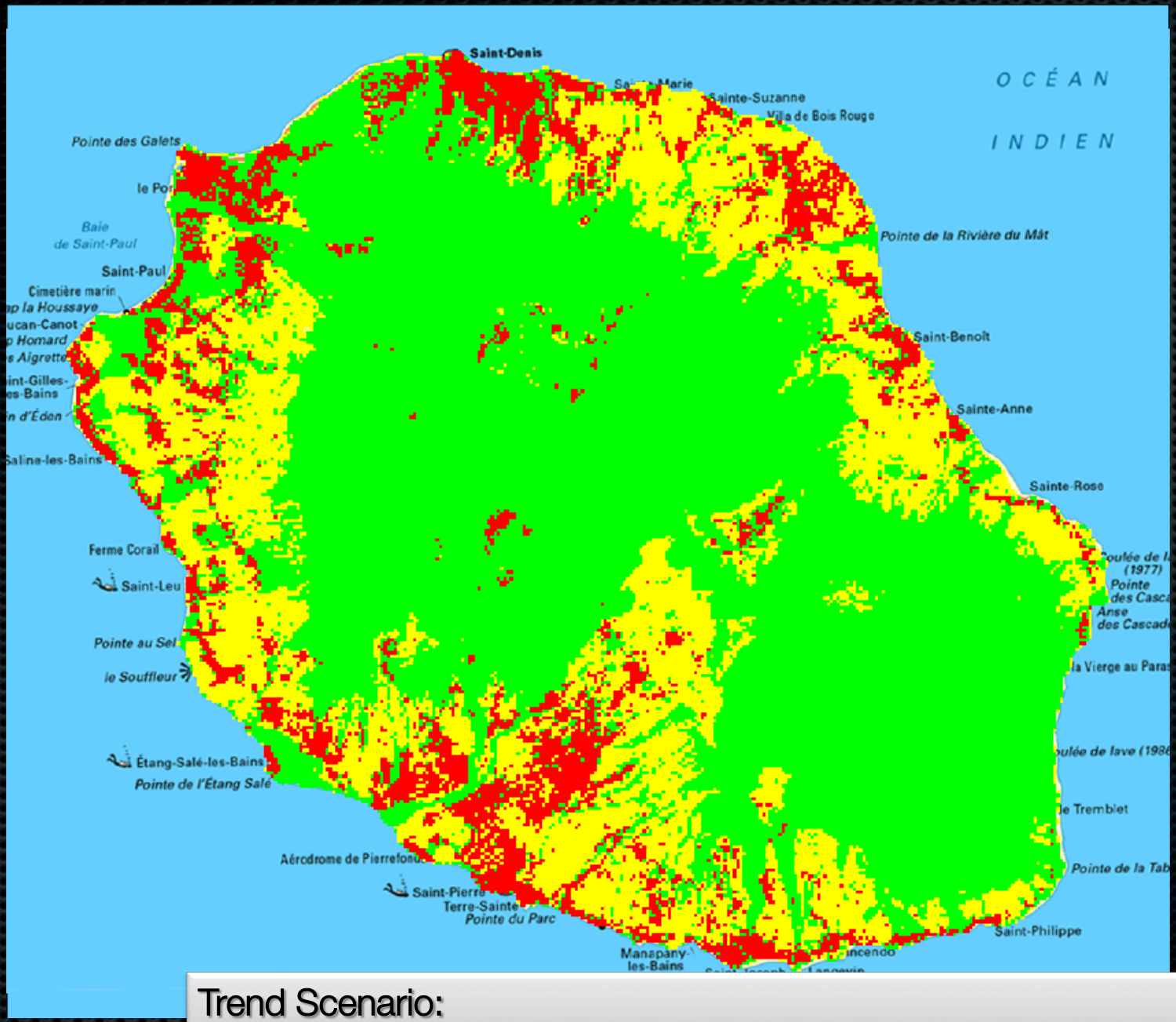
Results: land-use dynamic

what would happen if there was no change in the current territorial dynamics.

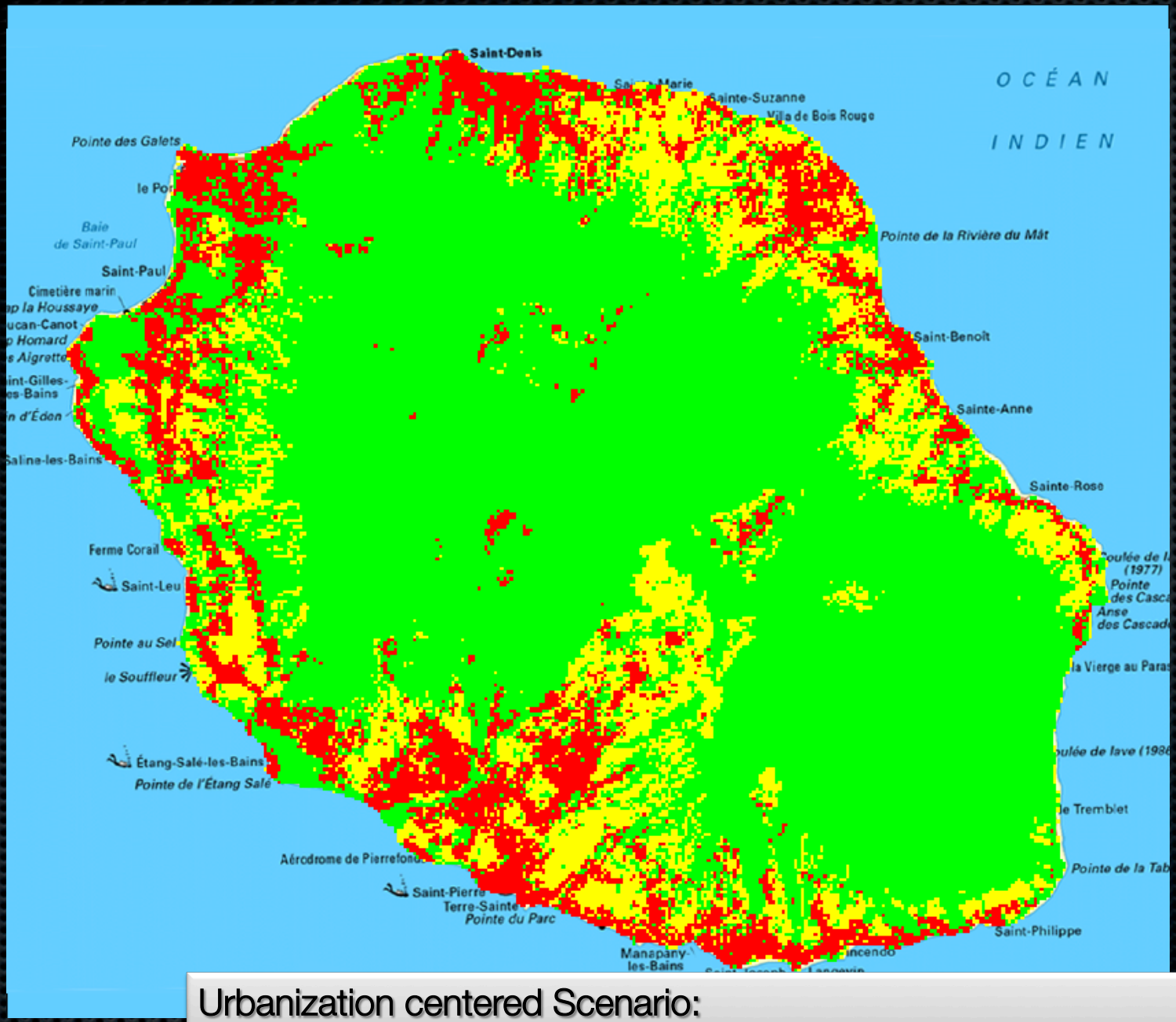
	2003 initial state	2030 Trend Let-it be-island	2030 town centered	2030 economy centered	2030 biodiv. centered
Natural Spaces	183 152 ha	172 780 ha (-10 372 ha) **- 5,7 %**	173 460 ha (-9 692 ha) **- 5,3 %**	158 024 ha (-25 128 ha) **- 13,7 %**	176 628 ha (-6 524 ha) **- 3,6 %**
Agricult. Spaces	42 316 ha	41 248 ha (-1 068 ha) **- 2,5 %**	45 860 ha (+ 3 544 ha) **+ 8,4 %**	63 736 ha (+21420 ha) **+ 50,6 %**	45 948 ha (+3 632 ha) **+ 8,6 %**
Urban Spaces	24 756 ha	36 196 ha (+11440 ha) **+ 46,2 %**	30 904 ha (+6 148 ha) **+ 24,8 %**	28 464 ha (+3 708 ha) **+ 15 %**	27 648 ha (+2 892 ha) **+ 11,7 %**



Initial State



Trend Scenario:
This produces a scattered location of settlements



Urbanization centered Scenario:

Polarised urban densification and urban sprawl only on agricultural lands

Examples of Multi-Agent Based Simulations: DS

Another talk on DS… about software architecture

- Spatialized simulations lead to the emergence of structures/phenomena
- Can we detect these phenomena ?
- What value would it give ?
- Can we go farther and manipulate these phenomena ?

DS provide an architecture for the reification of emergent phenomena…

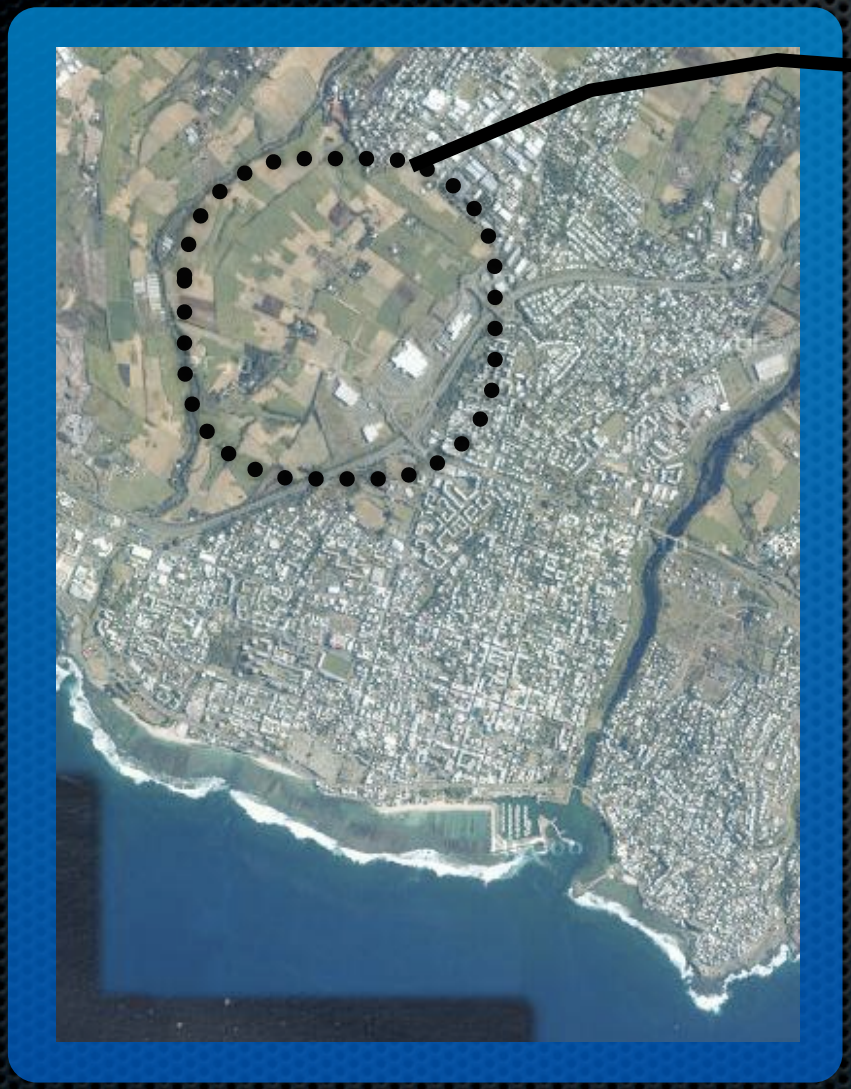
Use to ⇒ **Refine** the initial **model**

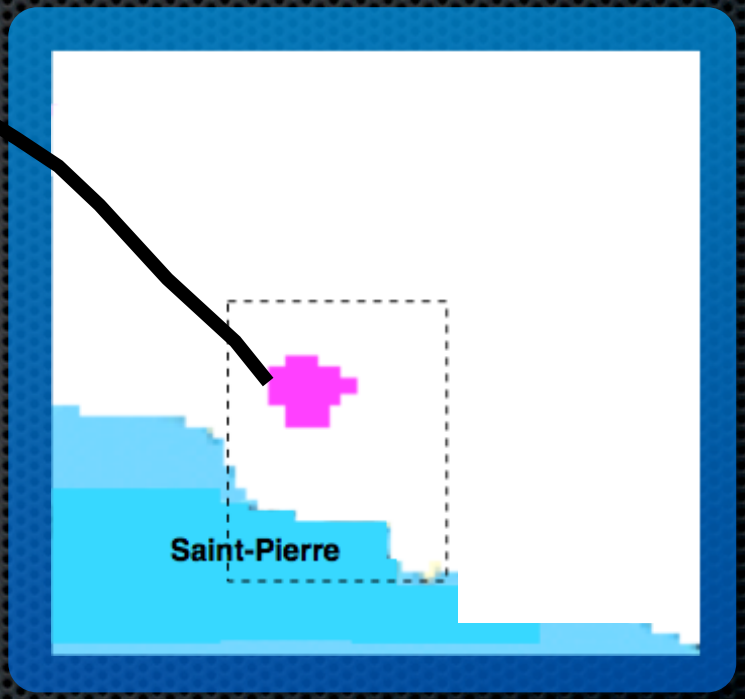
⇒ **Reify** emergent **new urban areas**

Another talk ? (maybe…)

[1] Reification of emergent urban areas in a land-use, simulation model in Reunion Island, In ECAI-2012 workshop on "Intelligent Agents in Urban Simulations and Smart Cities", pp. 28-32.
[2] Emergence as Metaknowledge: Refining Simulation Models through Emergence Reification ESM, 2008.

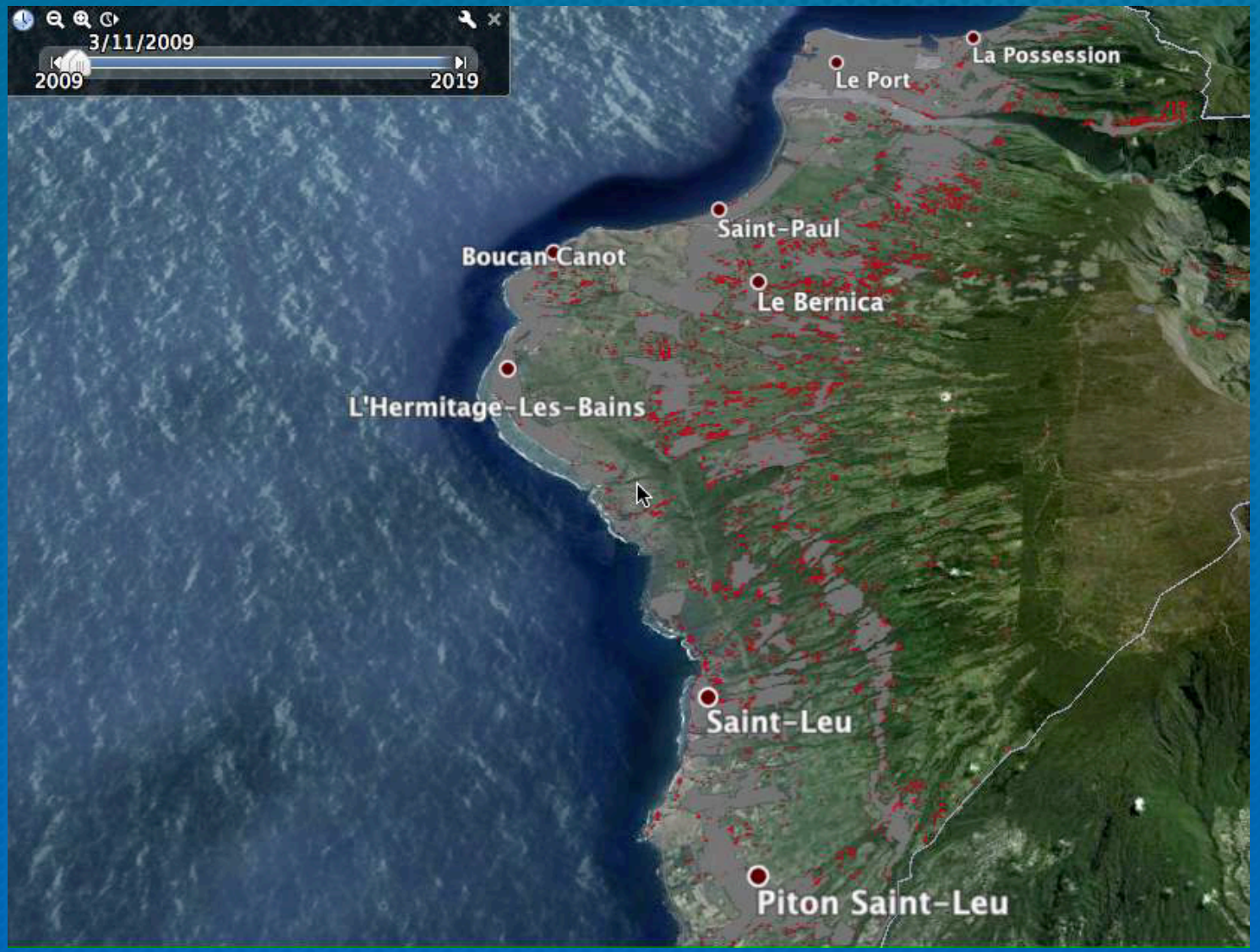
Detection and Materialization





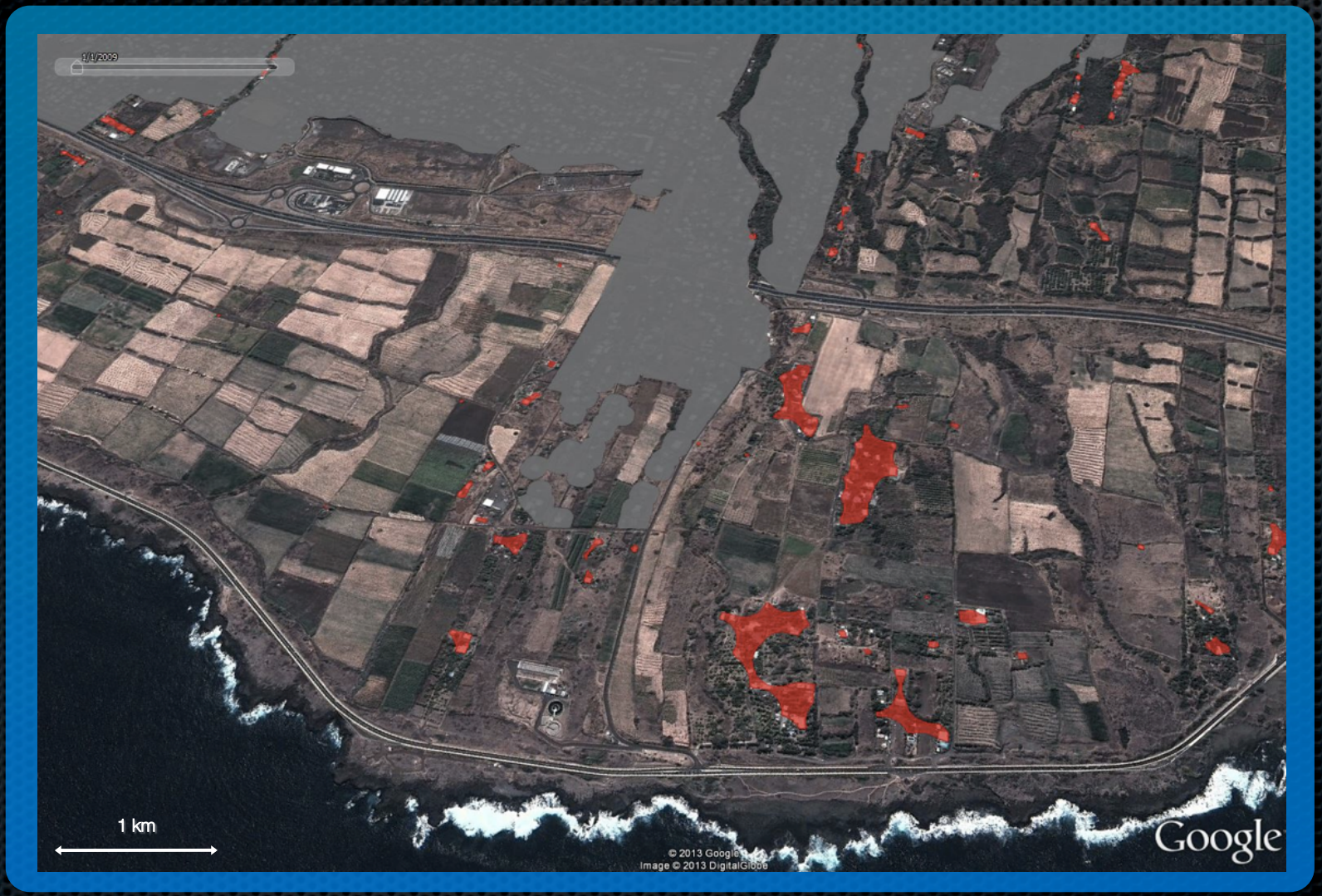
- Local phenomena
- Emergence Agents
- Interposition Elements

Child of DS…


3/11/2009
2009
2019
La Possession
Le Port
Saint-Paul
Boucan-Canot
Le Bernica
L'Hermitage-Les-Bains
Saint-Leu
Piton Saint-Leu

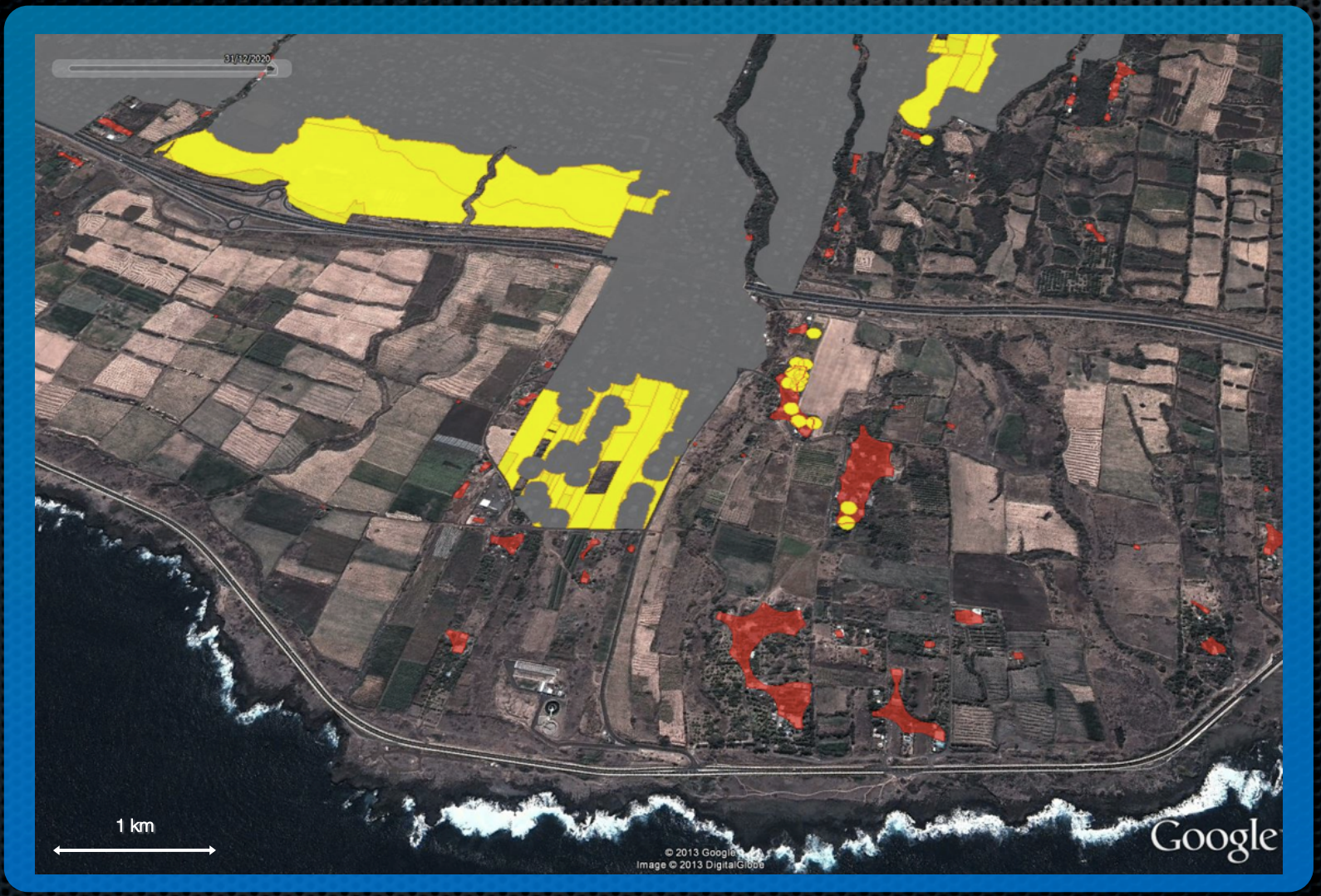
Planned urbanization - Coastal area

Scenario Comparison



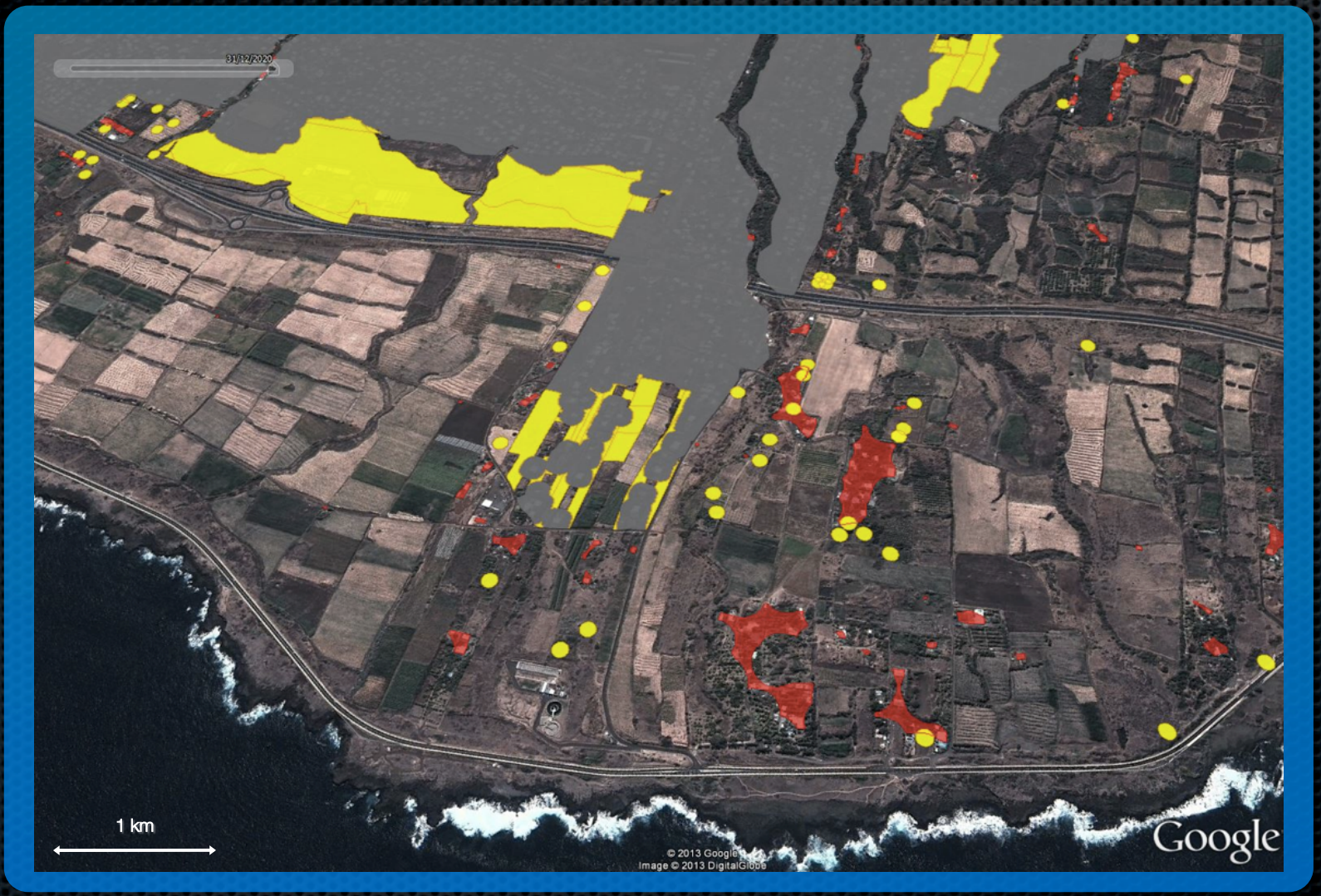
Initial state

Scenario Comparison



Final state - High housing densification hypotheses

Scenario Comparison



Final state - Low housing densification hypotheses