Examples of Multi-Agent Based Simulations

1. The Biomas Model

Biomass flow modelling and simulation for organic waste management

Rémy Courdier, François Guerrin, Fenintsoa Andriamasinoro, Jean-Marie Paillat. Agent-based simulation of complex systems: Application to collective management of animal wastes, 23. In Journal of Artificial Societies and Social Simulation 5 (3).

http://jasss.soc.surrey.ac.uk/5/3/4.html

Examples of Agent-Based Simulations: BIOMAS

Problematic

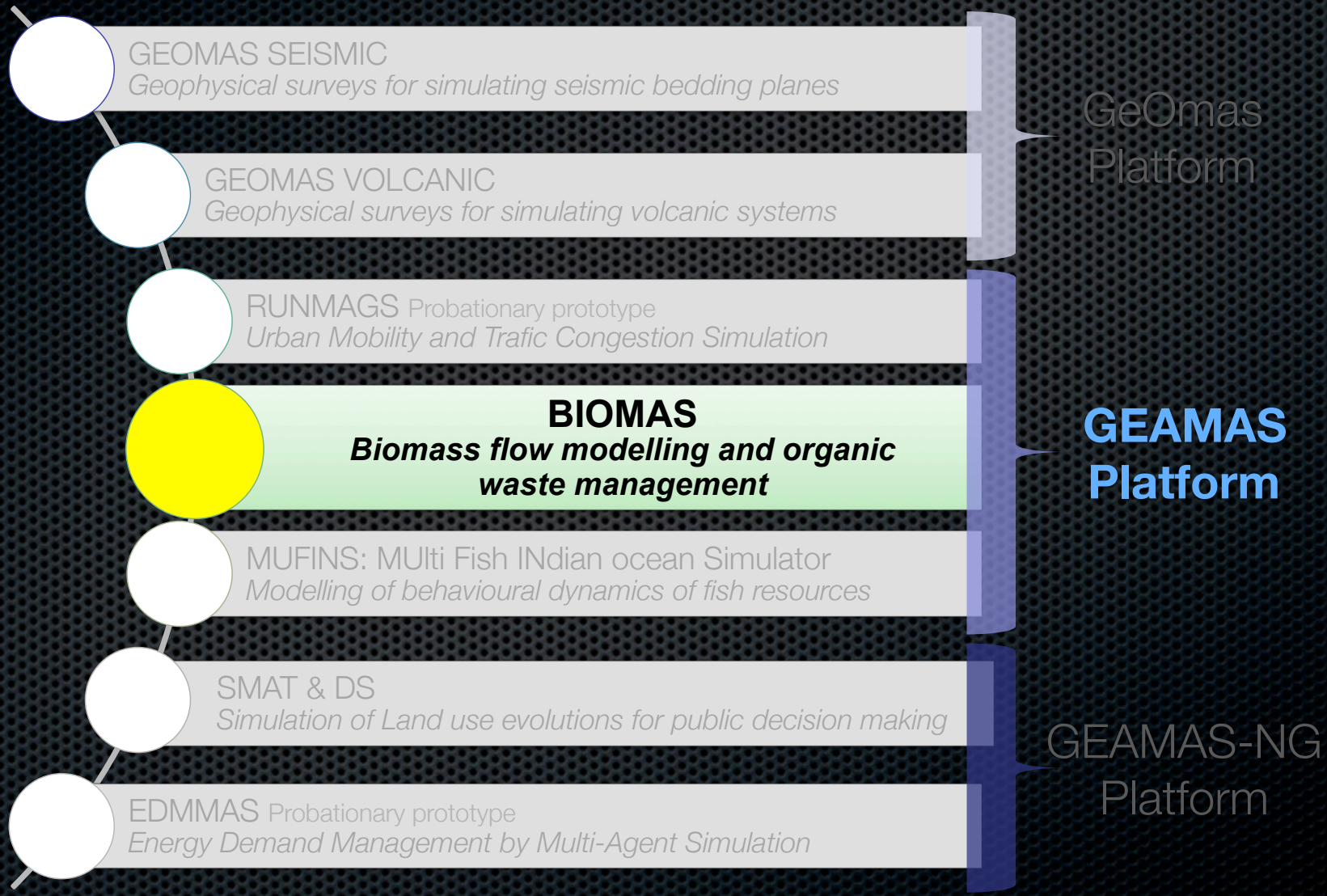
- Environmental Risks

- Governmental regulations

➡ Test the alternatives of organization open to the agricultural industry

Examples of Agent-Based Simulations: BIOMAS

Biomas application context



Examples of Multi-Agent Based Simulations: BIOMAS

Biomas Model : objectives

- **Simulate the individual and collective practices of waste management at a territory level:**
  - ✓ production and consumption of organic matter,
  - ✓ exchange of organic matter by considering spatial constraints,
  - ✓ negotiations between stakeholders (farmers, transporters, processing units ...).

- **Test alternative organizational actors to:**
  - ✓ reduce the risk of environmental pollution,
  - ✓ propose solutions valuation effluent.

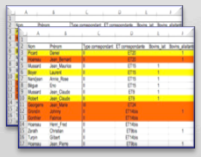
Soustainable development problem

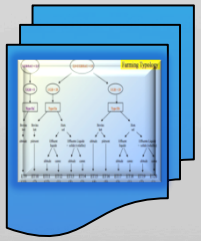
Examples of Multi-Agent Based Simulations: BIOMAS

Project components

CIRAD and INRA researchers → **MAS researchers** with CIRAD Modellers → CIRAD researchers **Public Decision Maker**

Investigations Fieldwork



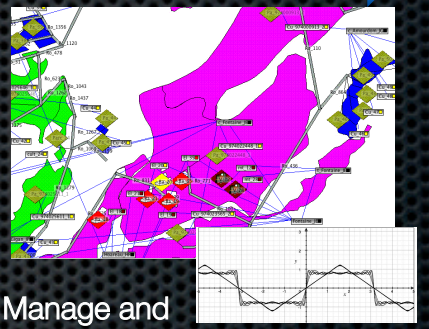


Formalisation

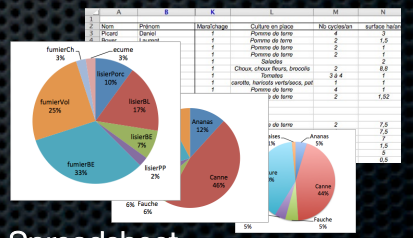
- Farms Social network
- Farms Typology
- Farm activity Models
- Waste Treatment Facilities Models
- Agricultural Crops Models
- GIS

GEAMAS Platform

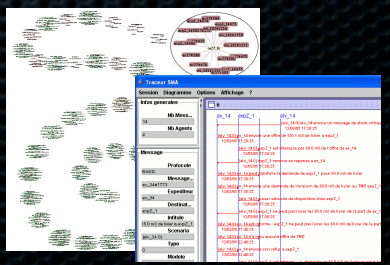
- Generic GEAMAS Model
- Biomas Model
- Simulations
- Log files
- Interactive Tools
- Batch Tools



Manage and visualise the simulation evolution



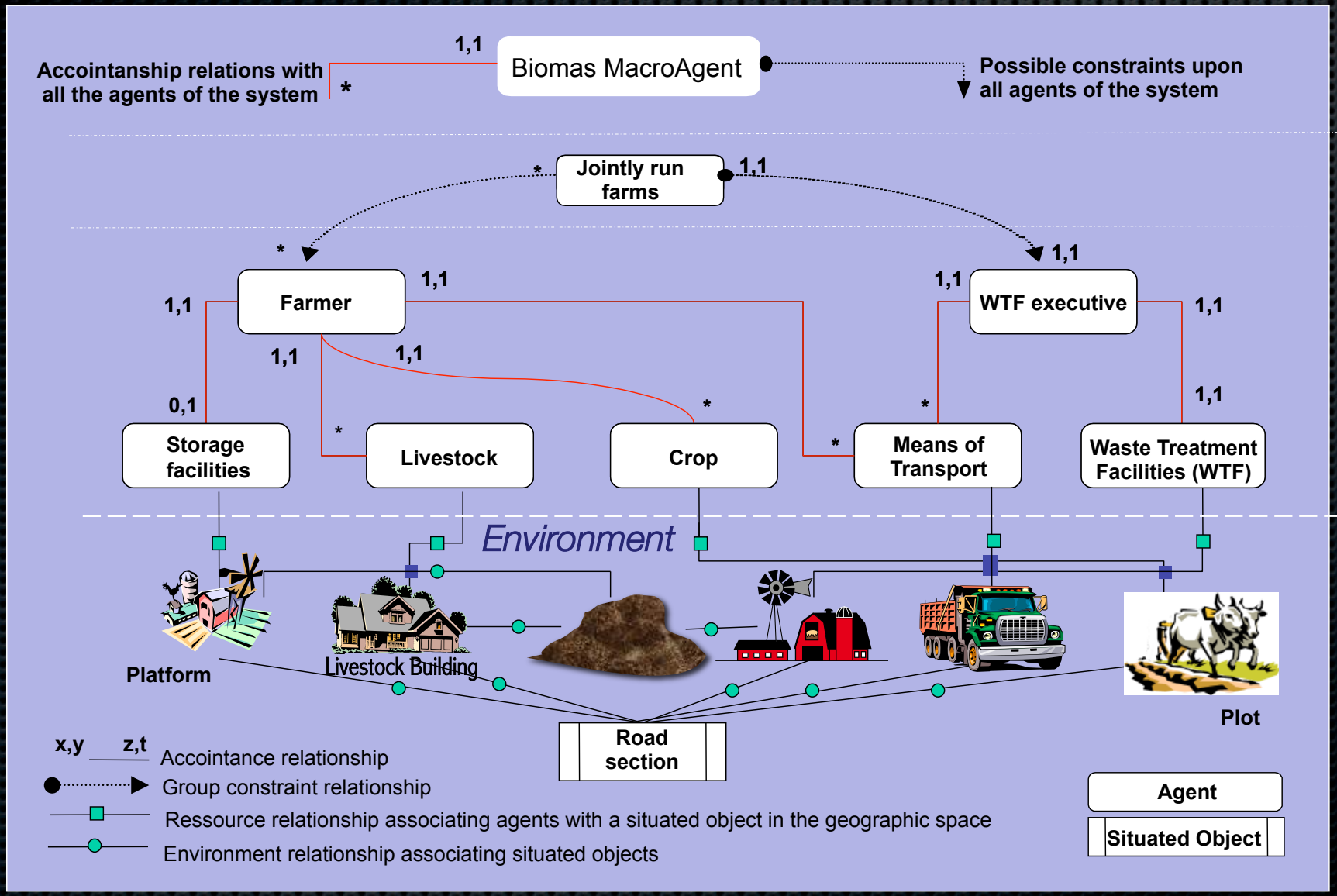
Spreadsheet Interfaces for scenario analysis



multi-agent conversations at various levels of analysis

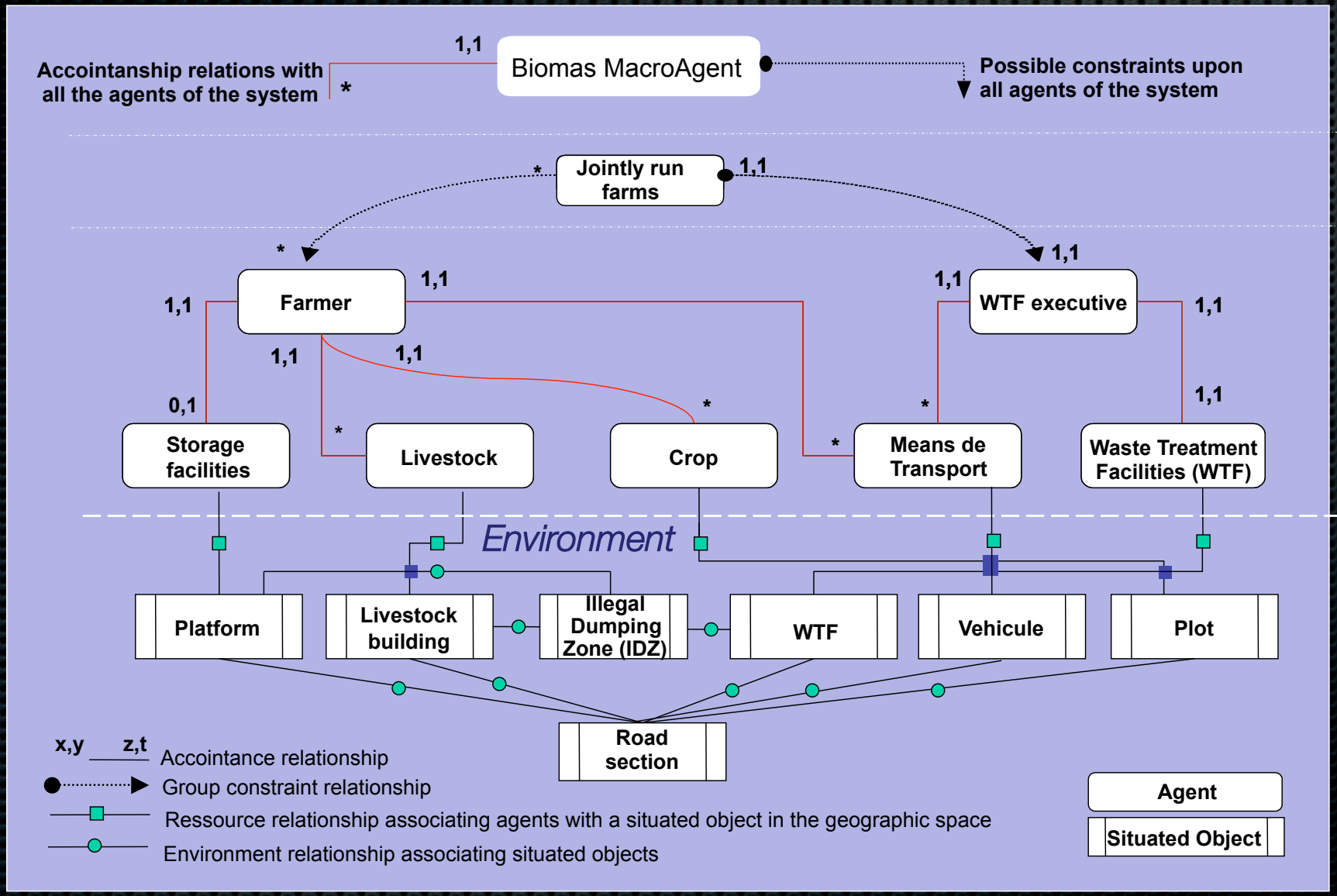
Examples of Multi-Agent Based Simulations: BIOMAS

Biomas Agent Model



Examples of Multi-Agent Based Simulations: BIOMAS

Biomas Agent Model



Examples of Multi-Agent Based Simulations: BIOMAS

Negotiation Process

Livestock farms create a supply of Organic Material (OM) and crop farms create a demand that must be met and that is conditional upon satisfying quality, quantity and availability conditions.

The process enabling the matching of the characteristics of supply and demand that lead to a transfer is called a negotiation.

The transportation from the place of storage (livestock farming buildings) to the place of use (plots) shall be effectuated if and only if a shipper can be found whose characteristics are compatible with the terms of the contract concluded between supplier and client-user (capability of transporting the OM, availability).

The shipment is the result of a negotiation between supplier of the OM and shippers.

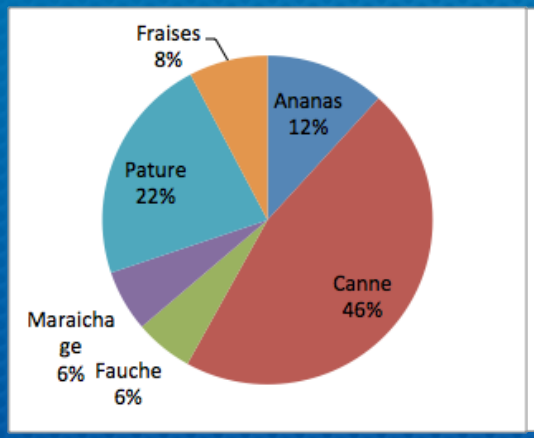
Case Study: Grand-Ilet, Le tampon

Area in the heart of the Reunion Island

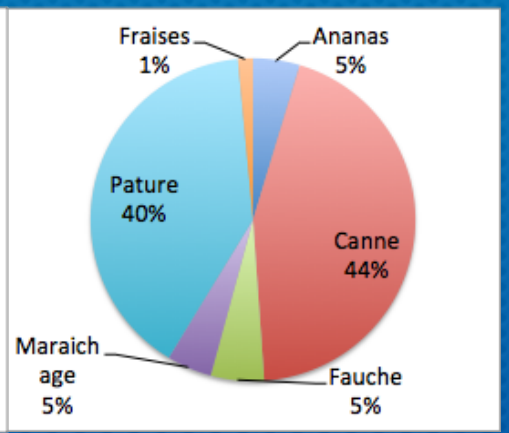
Examples of Multi-Agent Based Simulations: BIOMAS

Case Study: « le Petit Tampon »

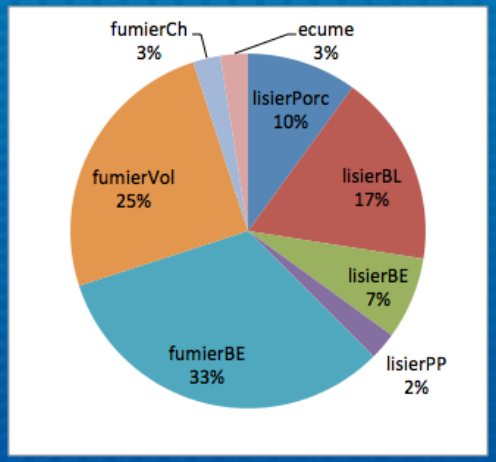
- **300 Crops** of 6 different types spread over 700 ha (Sugarcane, Pineapple, strawberry,…)
- **40 Livestocks** of 6 types (Sheep, poultry,…)



/ Total number of cultures



/ Crops Area (~ 700 ha)



/ Total number of livestock

Examples of Multi-Agent Based Simulations: BIOMAS

Tampon / Grand Tampon

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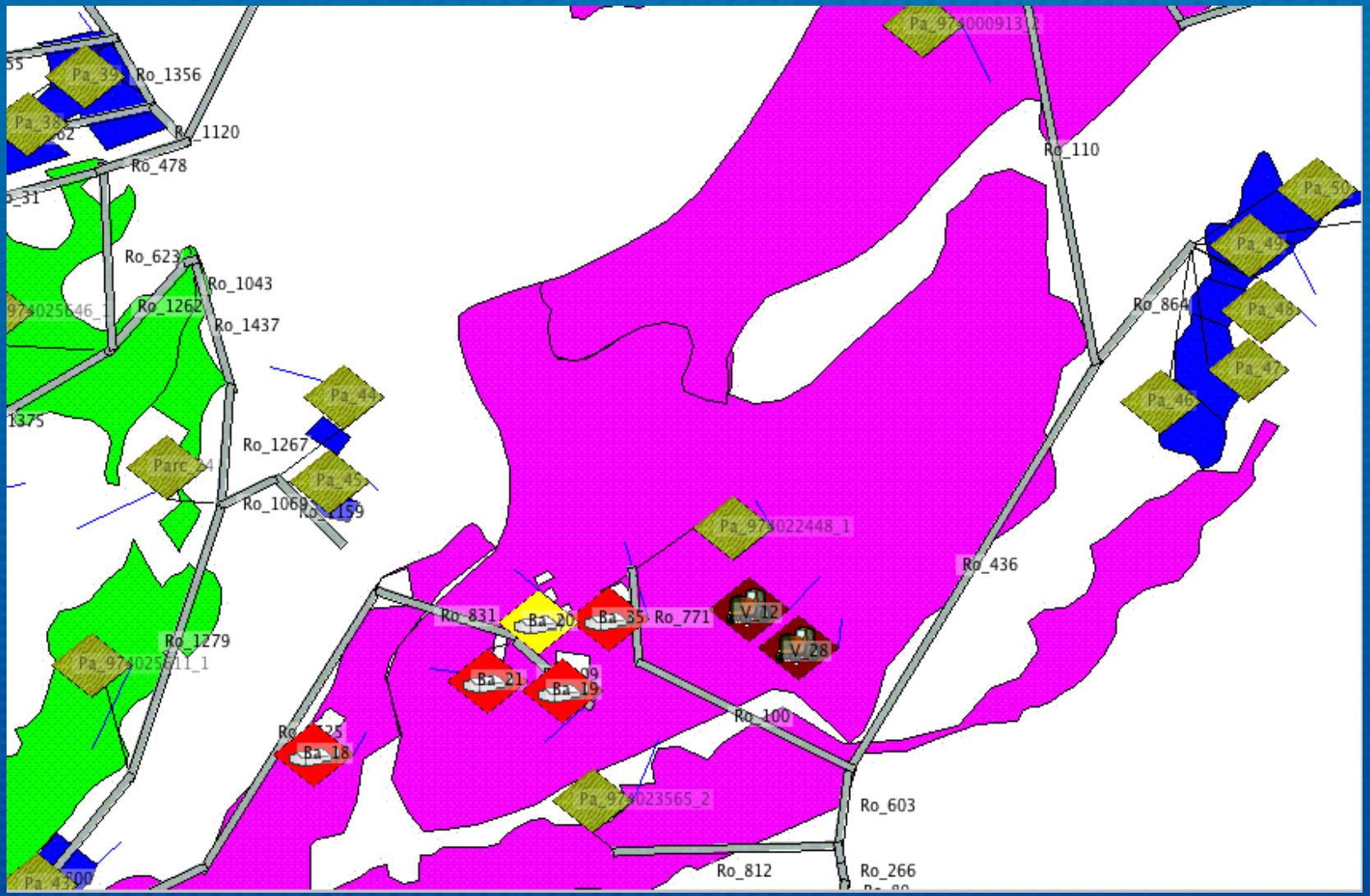

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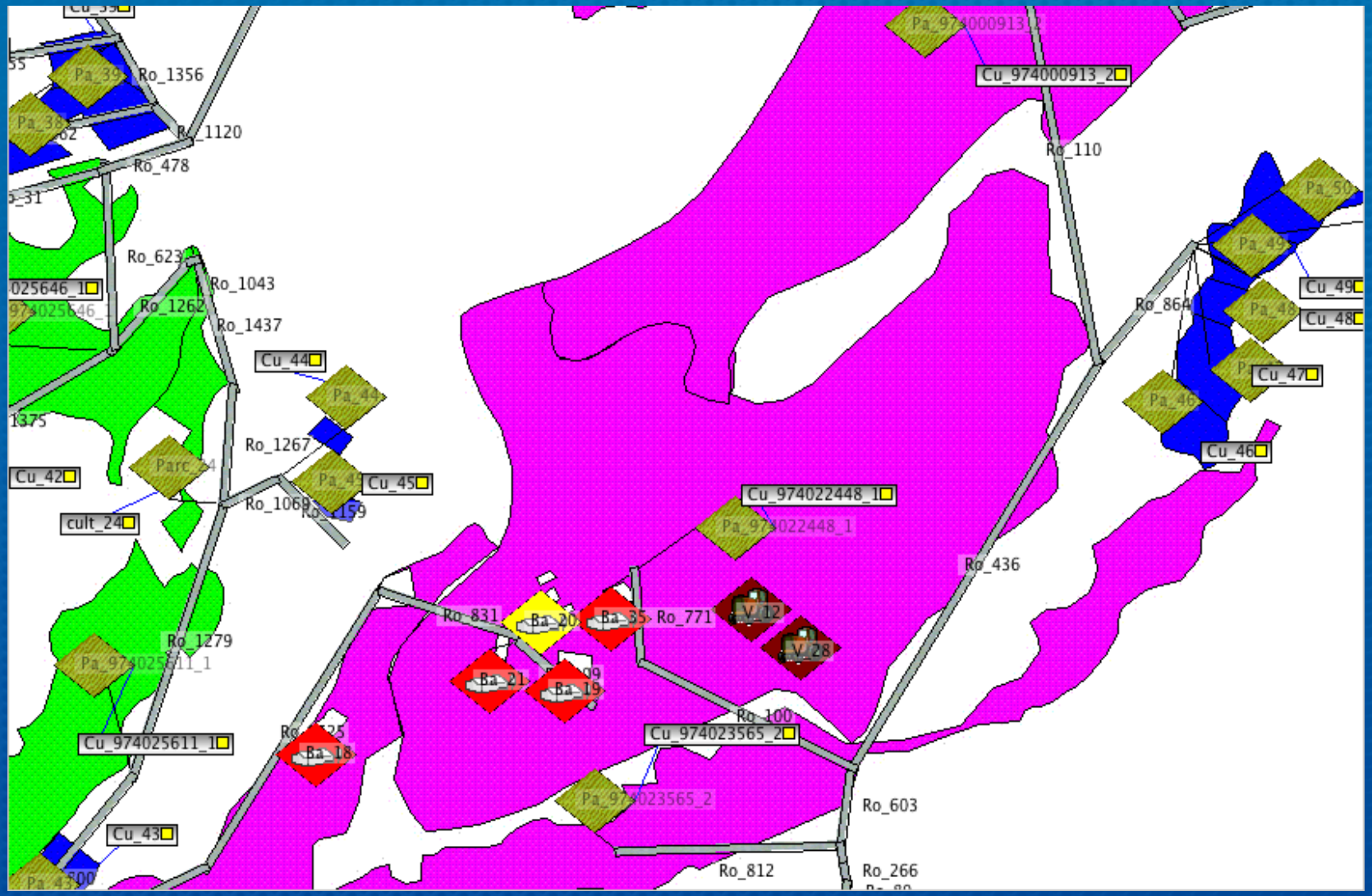

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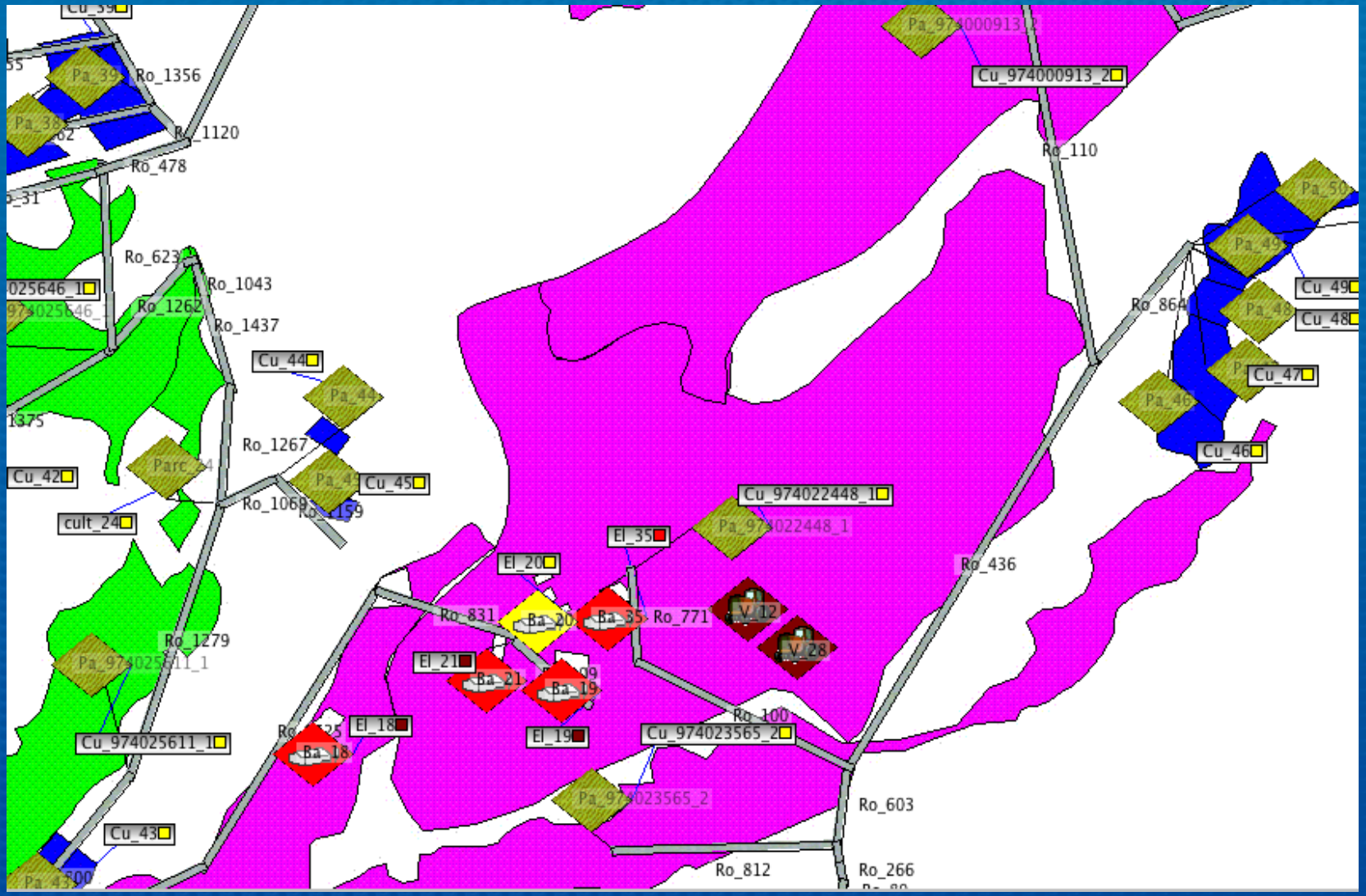

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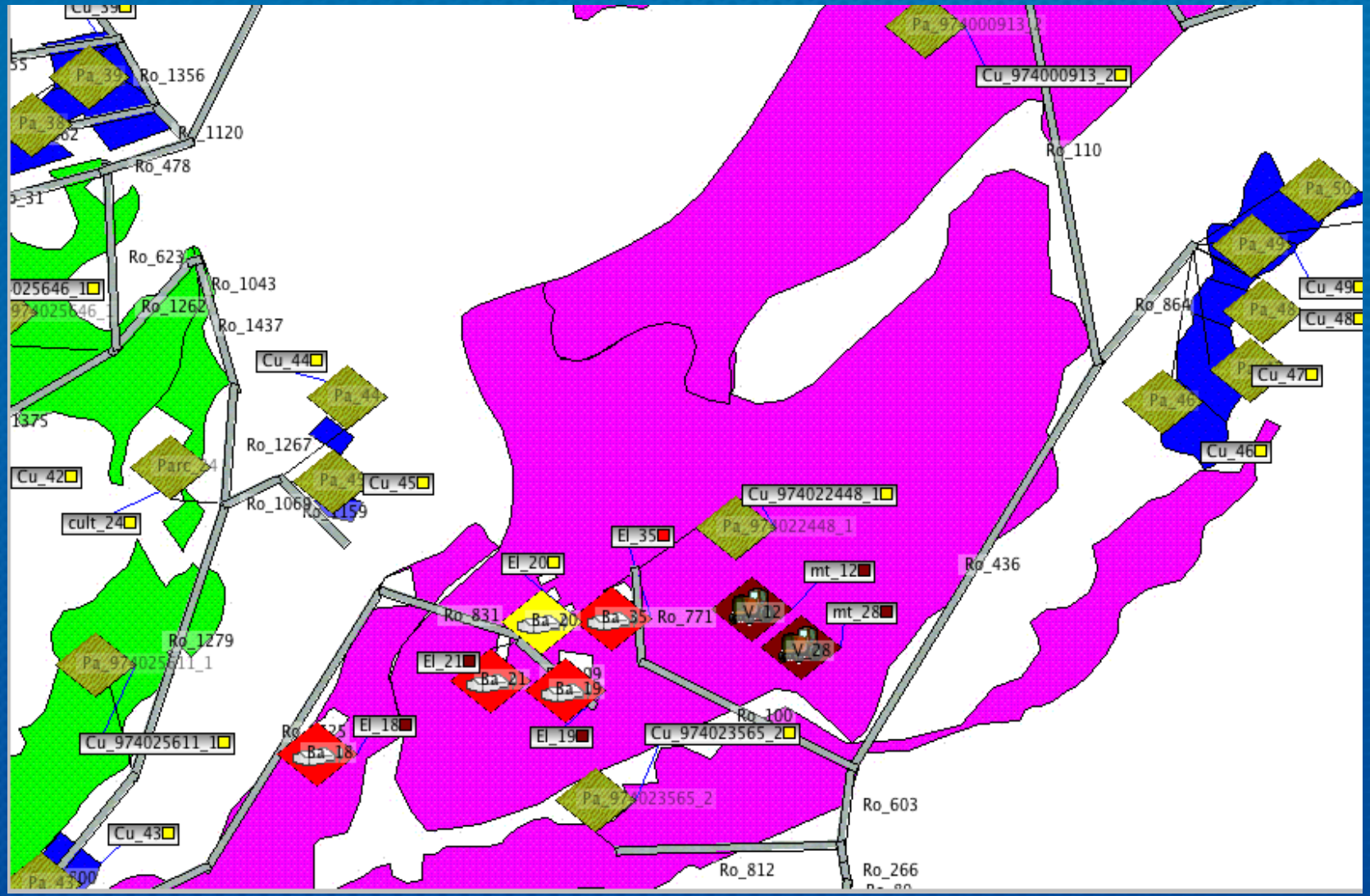

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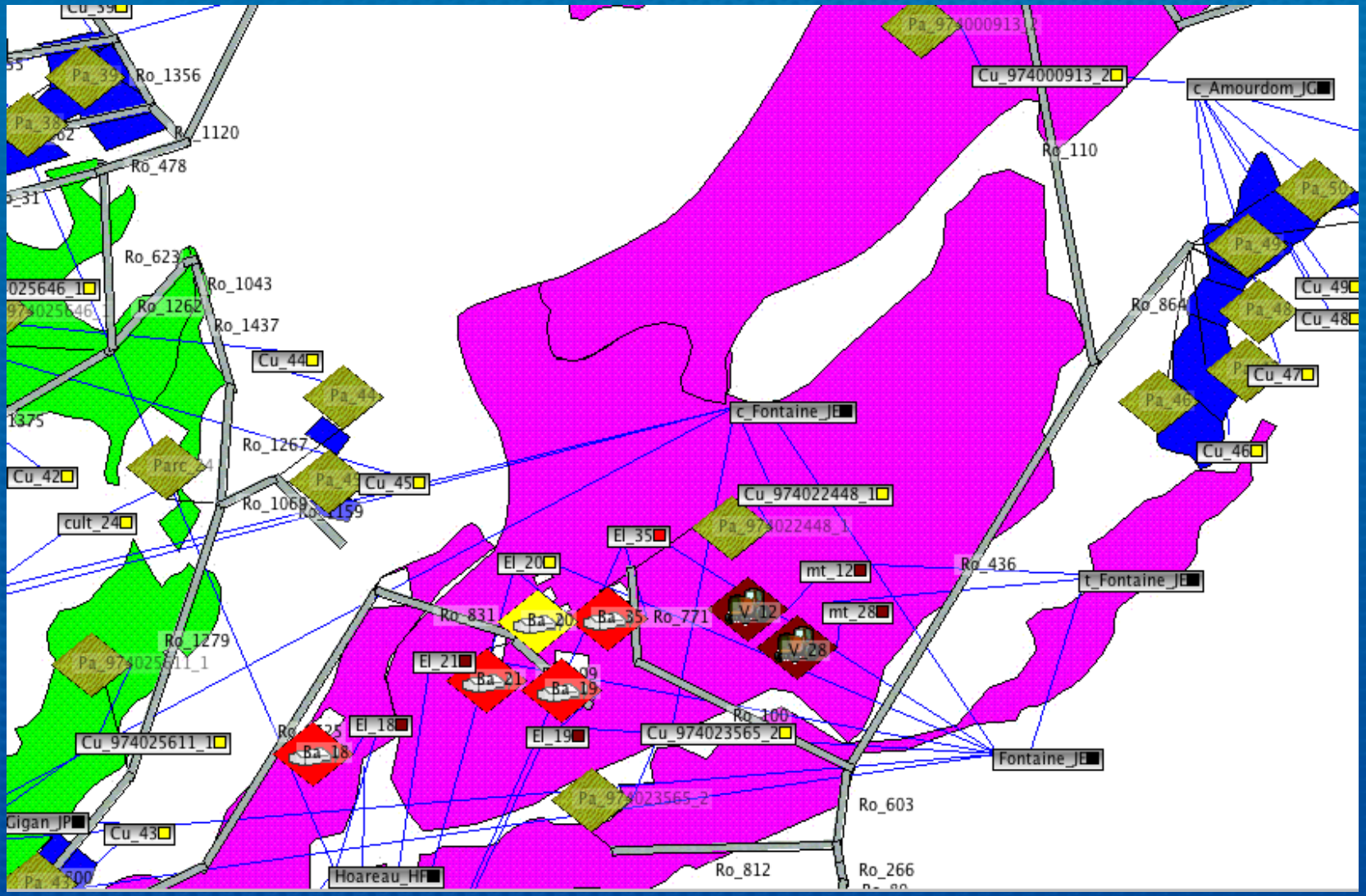

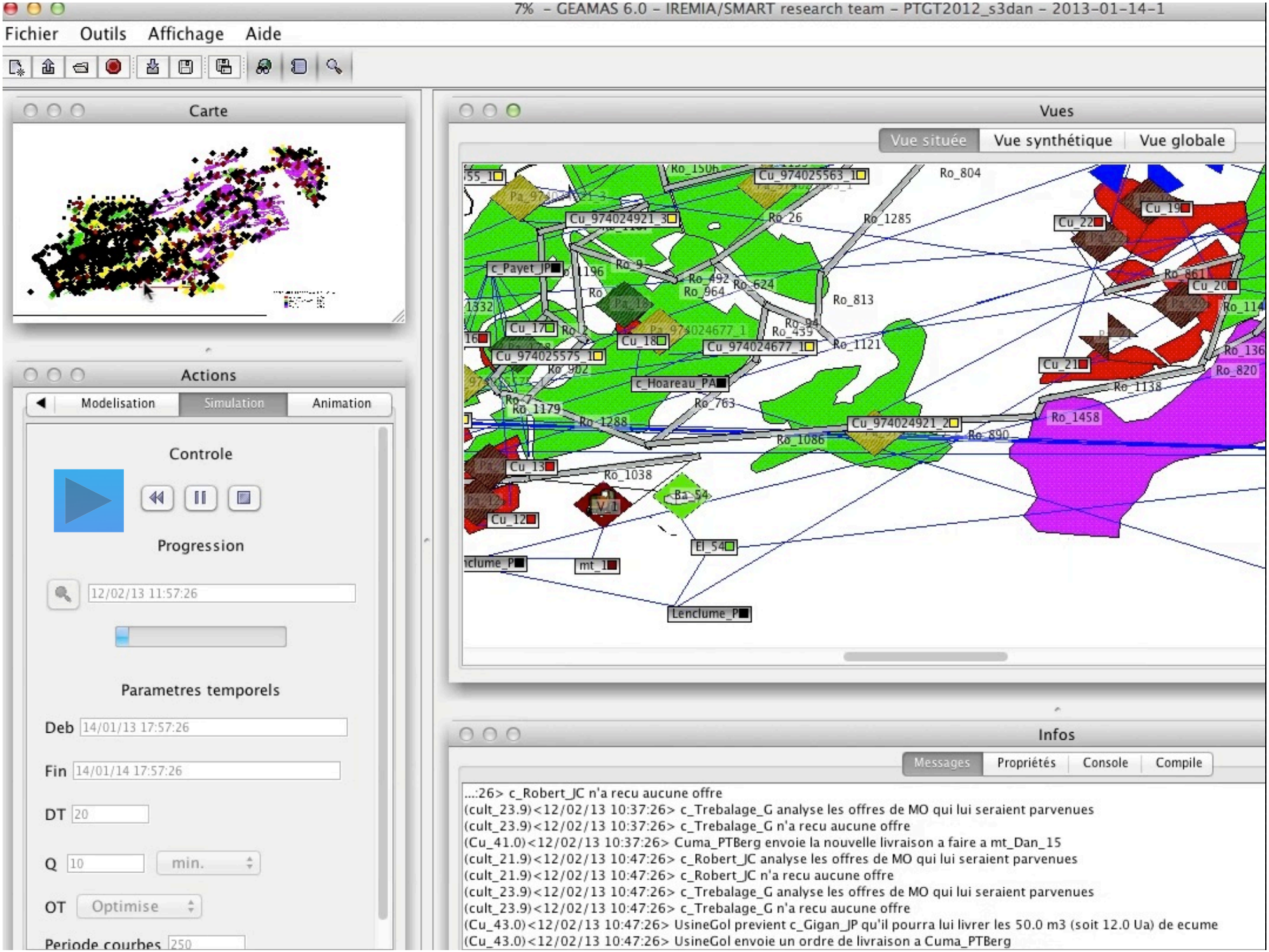
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Actions
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Animation
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Cu_18
Cu_974024677_1
Ro_1121
Cu_974025575_1
Ro_902
c_Hoareau_PA
Ro_763
Ro_1179
Ro_1288
Cu_974024921_2
Ro_1086
Ro_890
Ro_1458
Cu_13
Ro_1038
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Messages
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Console
Compile
...:26> c_Robert_JC n'a recu aucune offre
(cult_23.9)<12/02/13 10:37:26> c_Trebalage_G analyse les offres de MO qui lui seraient parvenues
(cult_23.9)<12/02/13 10:37:26> c_Trebalage_G n'a recu aucune offre
(Cu_41.0)<12/02/13 10:37:26> Cuma_PTBerg envoie la nouvelle livraison a faire a mt_Dan_15
(cult_21.9)<12/02/13 10:47:26> c_Robert_JC analyse les offres de MO qui lui seraient parvenues
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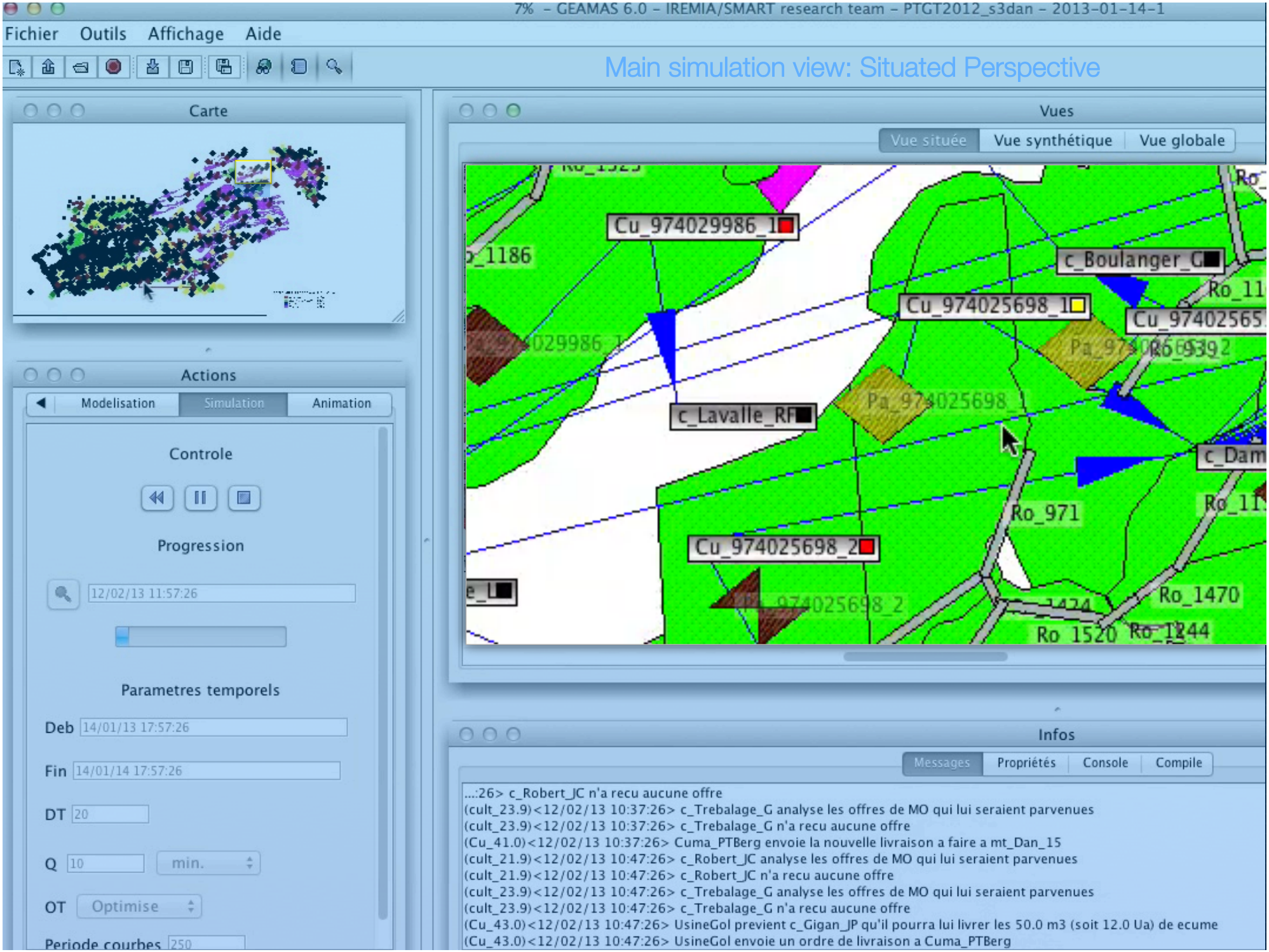
(Cu_43.0)<12/02/13 10:47:26> UsineGol envoie un ordre de livraison a Cuma_PTBerg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Vue synthétique
Vue globale
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c_Boulanger_G
Cu_974025698_1
c_Lavalle_R
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Cu_974025698_2
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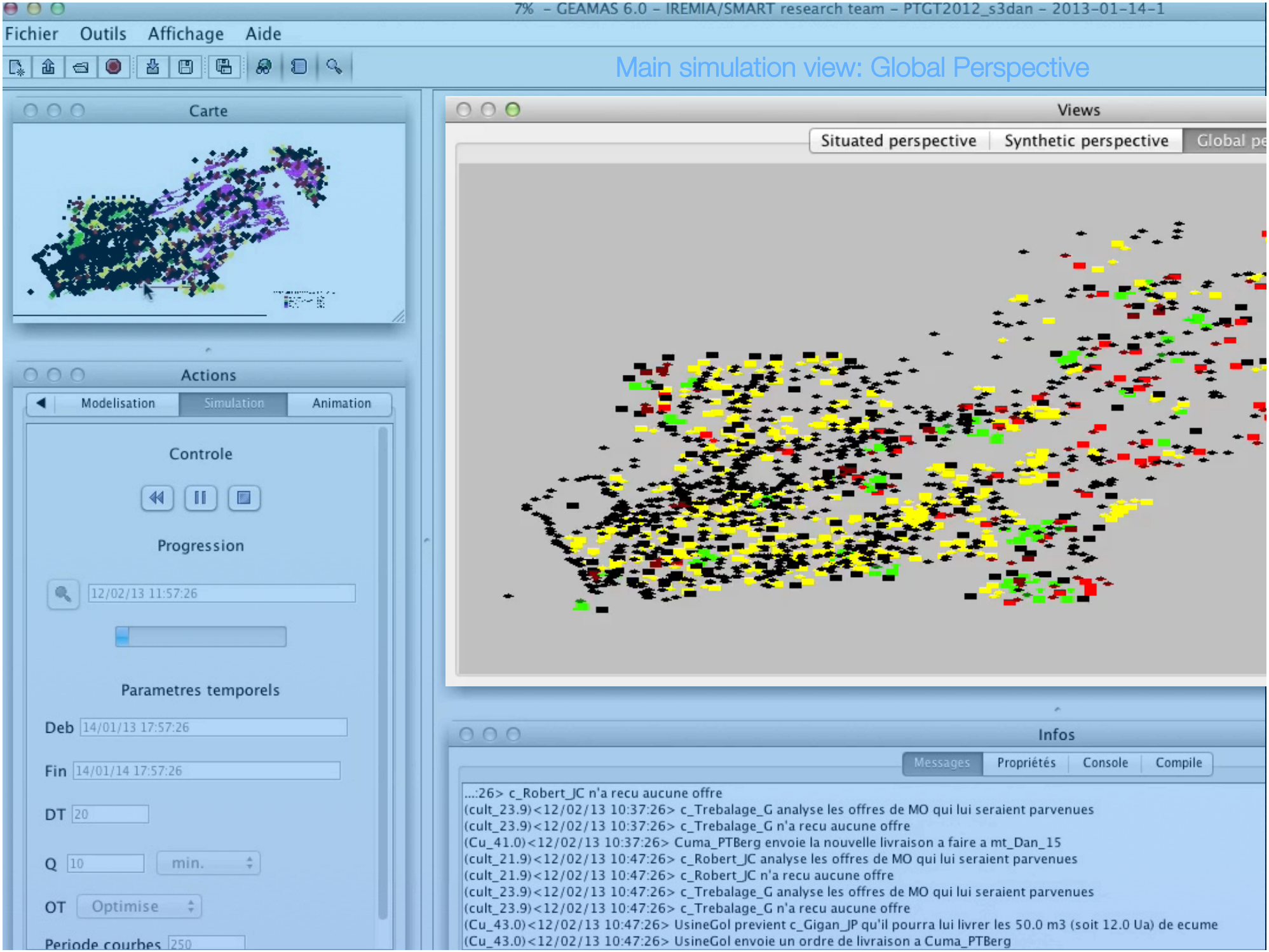
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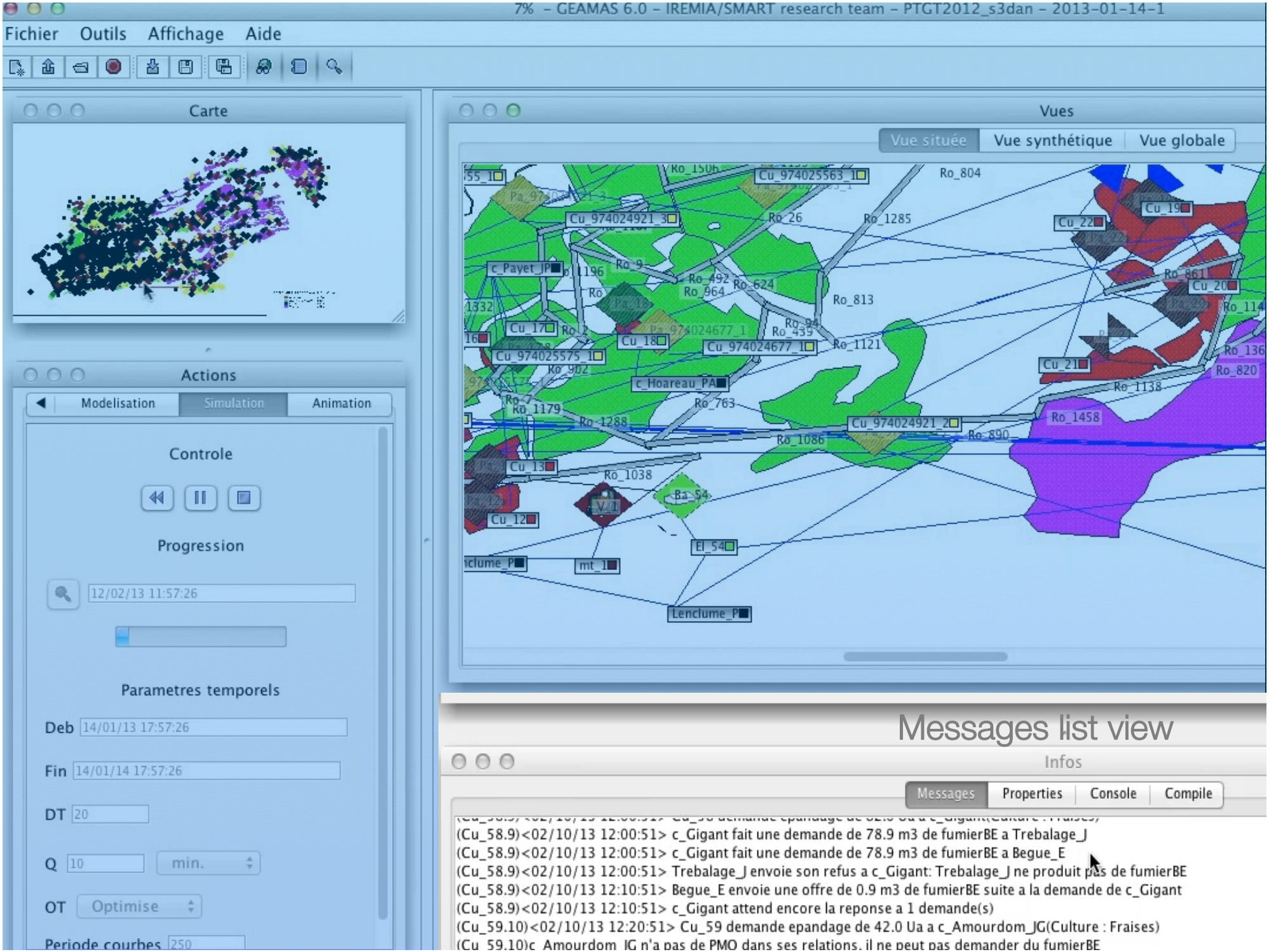
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Deb 14/01/13 17:57:26
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Q 10 min.
OT Optimise
Periode courbes 250
Vues
Vue située Vue synthétique Vue globale
Cu_974025563_1
Cu_974024921_3
c_Payet_JP
Cu_17
Cu_18
Cu_974024677_1
Cu_974025575_1
c_Hoareau_PA
Cu_974024921_2
Cu_13
Cu_12
El_54
mt_1
Lenclume_P
Ro_804
Ro_26
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Ro_9
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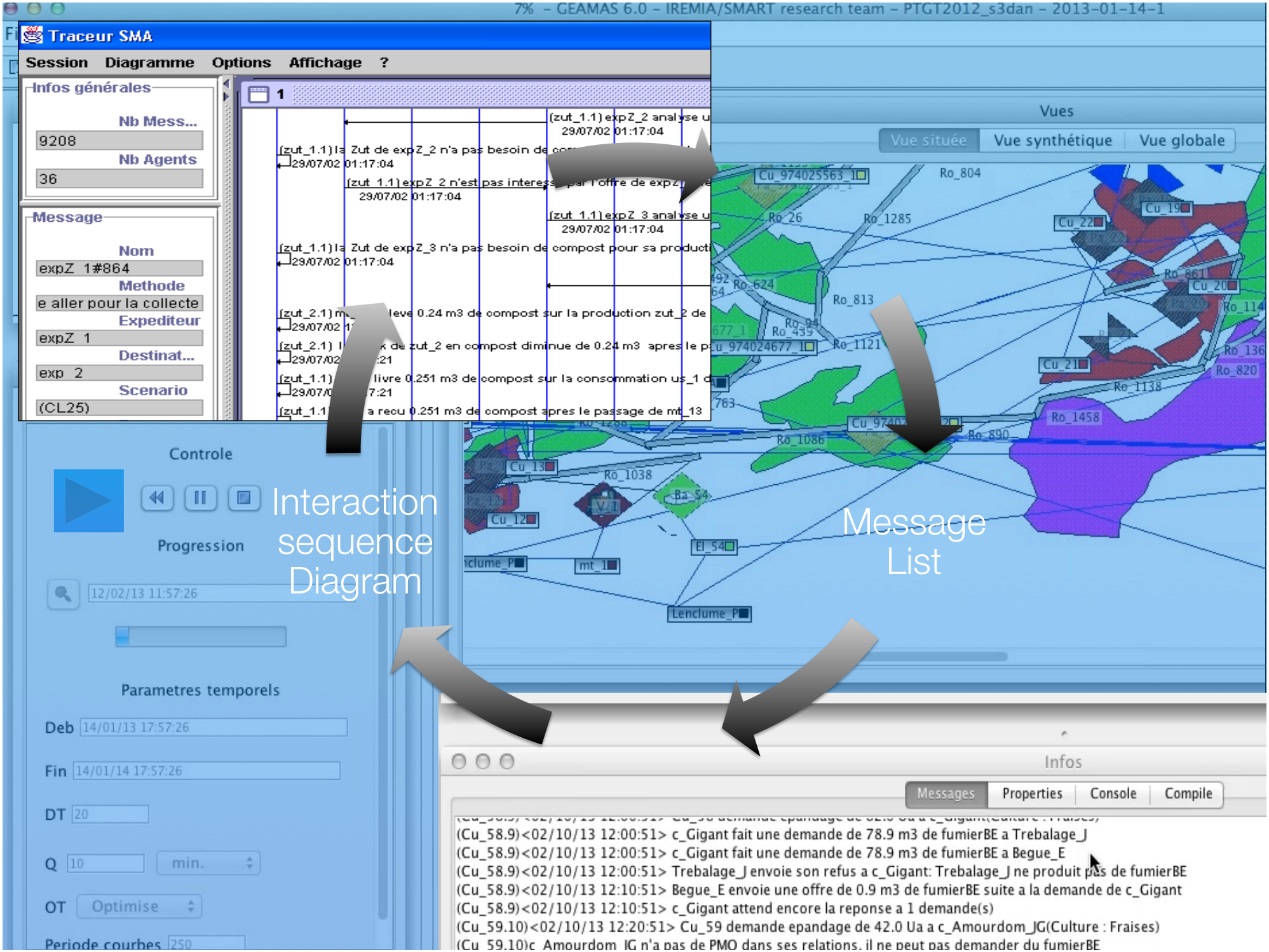
Ro_964
Ro_624
Ro_813
Ro_439
Ro_1121
Ro_902
Ro_763
Ro_1179
Ro_1288
Ro_1086
Ro_890
Ro_1038
Ro_1458
Ro_1138
Ro_820
Cu_19
Cu_22
Cu_20
Cu_21
Messages list view
Infos
Messages Properties Console Compile
(Cu_58.9)<02/10/13 12:00:51> c_Gigant fait une demande de 78.9 m3 de fumierBE a Trebalage_J
(Cu_58.9)<02/10/13 12:00:51> c_Gigant fait une demande de 78.9 m3 de fumierBE a Begue_E
(Cu_58.9)<02/10/13 12:00:51> Trebalage_J envoie son refus a c_Gigant: Trebalage_J ne produit pas de fumierBE
(Cu_58.9)<02/10/13 12:10:51> Begue_E envoie une offre de 0.9 m3 de fumierBE suite a la demande de c_Gigant
(Cu_58.9)<02/10/13 12:10:51> c_Gigant attend encore la reponse a 1 demande(s)
(Cu_59.10)<02/10/13 12:20:51> Cu_59 demande epandage de 42.0 Ua a c_Amourdom_JG(Culture : Fraises)
(Cu_59.10)c_Amourdom_JG n'a pas de PMO dans ses relations, il ne peut pas demander du fumierBE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Traceur SMA
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9208
Nb Agents
36
Message
Nom
expZ 1#864
Methode
e aller pour la collecte
Expediteur
expZ 1
Destinat...
exp 2
Scenario
(CL25)
1
(zut_1.1) expZ_2 analyse u
29/07/02 01:17:04
(zut_1.1) la Zut de expZ_2 n'a pas besoin de
29/07/02 01:17:04
(zut_1.1) expZ_2 n'est pas interes
29/07/02 01:17:04
(zut_1.1) expZ_3 analyse u
29/07/02 01:17:04
(zut_1.1) la Zut de expZ_3 n'a pas besoin de compost pour sa producti
29/07/02 01:17:04
(zut_2.1) m leve 0.24 m3 de compost sur la production zut_2 de
29/07/02
(zut_2.1) l de zut_2 en compost diminue de 0.24 m3 apres le p
29/07/02
(zut_1.1) livre 0.251 m3 de compost sur la consommation us_1 d
29/07/0 7:21
(zut_1.1 a recu 0.251 m3 de compost apres le passage de mt_13
Vues
Vue située
Vue synthétique
Vue globale
Cu_974025563_1
Ro_804
Ro_26
Ro_1285
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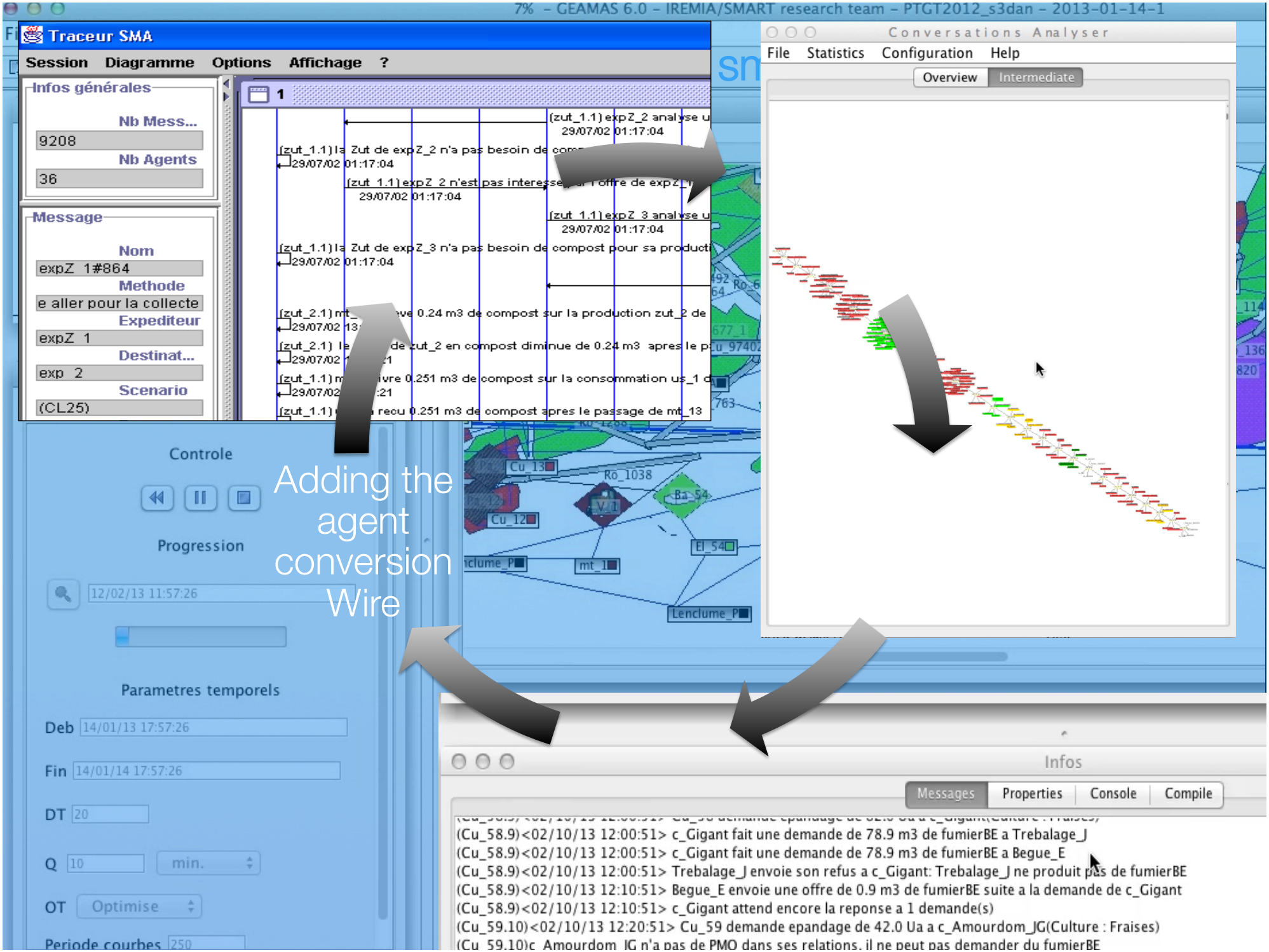
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(zut_1.1) expZ_2 n'est pas interesse
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recu 0.251 m3 de compost apres le passage de mt_13
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File Statistics Configuration Help
Overview Intermediate
Controle
Progression
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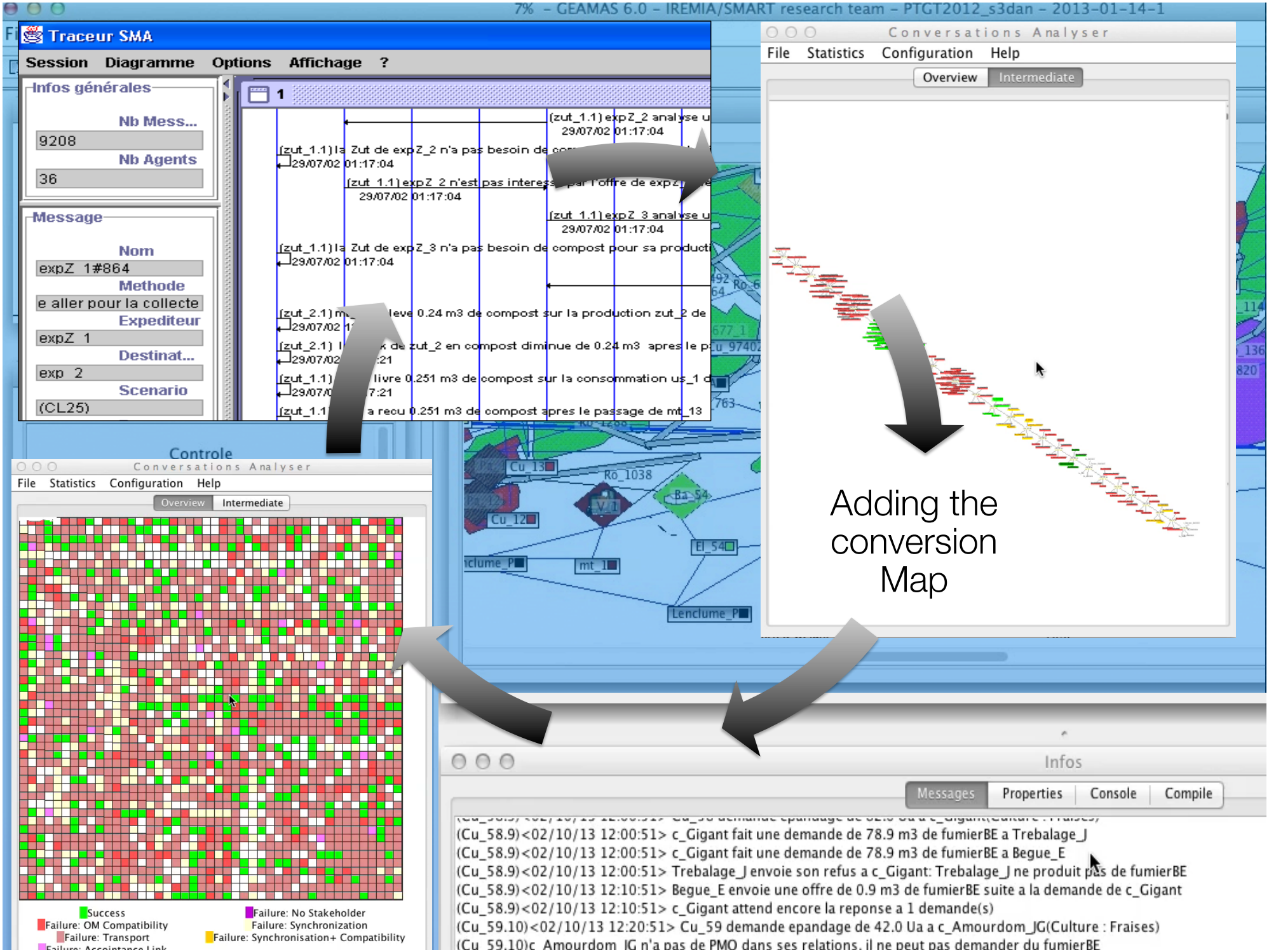
Parametres temporels
Deb 14/01/13 17:57:26
Fin 14/01/14 17:57:26
DT 20
Q 10 min.
OT Optimise
Periode courbes 250
Cu_13
Ro_1038
Cu_12
Bi_54
El_54
mt_1
Lenclume_P
Infos
Messages Properties Console Compile
(Cu_58.9)<02/10/13 12:00:51> c_Gigant fait une demande de 78.9 m3 de fumierBE a Trebalage_J
(Cu_58.9)<02/10/13 12:00:51> c_Gigant fait une demande de 78.9 m3 de fumierBE a Begue_E
(Cu_58.9)<02/10/13 12:00:51> Trebalage_J envoie son refus a c_Gigant: Trebalage_J ne produit pas de fumierBE
(Cu_58.9)<02/10/13 12:10:51> Begue_E envoie une offre de 0.9 m3 de fumierBE suite a la demande de c_Gigant
(Cu_58.9)<02/10/13 12:10:51> c_Gigant attend encore la reponse a 1 demande(s)
(Cu_59.10)<02/10/13 12:20:51> Cu_59 demande epandage de 42.0 Ua a c_Amourdom_JG(Culture : Fraises)
(Cu_59.10)c_Amourdom_JG n'a pas de PMO dans ses relations, il ne peut pas demander du fumierBE
Adding the agent conversion Wire


7% - GEAMAS 6.0 - IREMIA/SMART research team - PTGT2012_s3dan - 2013-01-14-1
Traceur SMA
Session Diagramme Options Affichage ?
Infos générales
Nb Mess...
9208
Nb Agents
36
Message
Nom
expZ 1#864
Methode
e aller pour la collecte
Expediteur
expZ 1
Destinat...
exp 2
Scenario
(CL25)
1
(zut_1.1) expZ_2 analyse u
29/07/02 01:17:04
(zut_1.1) la Zut de expZ_2 n'a pas besoin de
29/07/02 01:17:04
(zut_1.1) expZ_2 n'est pas interes par l'offre de expZ
29/07/02 01:17:04
(zut_1.1) expZ_3 analyse u
29/07/02 01:17:04
(zut_1.1) la Zut de expZ_3 n'a pas besoin de compost pour sa producti
29/07/02 01:17:04
(zut_2.1) leve 0.24 m3 de compost sur la production zut_2 de
(zut_2.1) de zut_2 en compost diminue de 0.24 m3 apres le p
(zut_1.1) livre 0.251 m3 de compost sur la consommation us_1 d
(zut_1.1) a recu 0.251 m3 de compost apres le passage de mt_13
Conversations Analyser
File Statistics Configuration Help
Overview Intermediate
Adding the conversion Map
Controle
Conversations Analyser
File Statistics Configuration Help
Overview Intermediate
Success
Failure: No Stakeholder
Failure: OM Compatibility
Failure: Synchronization
Failure: Transport
Failure: Synchronisation+ Compatibility
Cu_13
Ro_1038
Cu_12
El_54
mt_1
Lenclume_P
Infos
Messages Properties Console Compile
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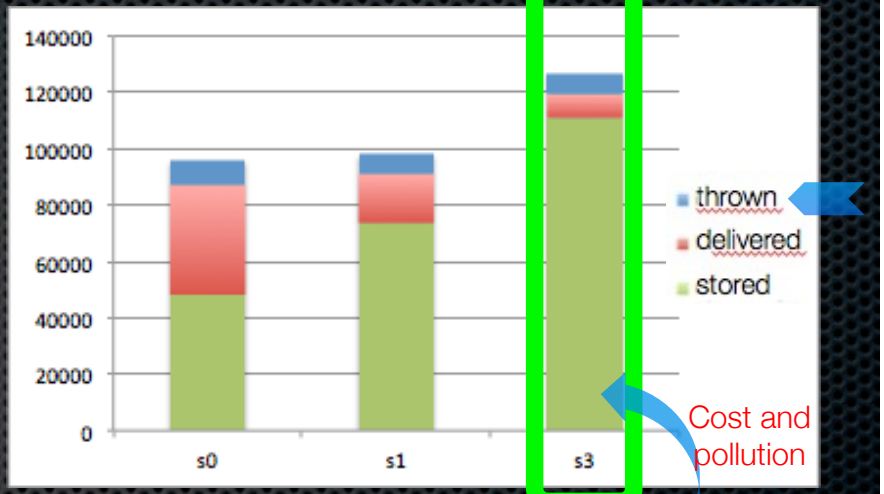
Examples of Multi-Agent Based Simulations

Batch simulation results analyses

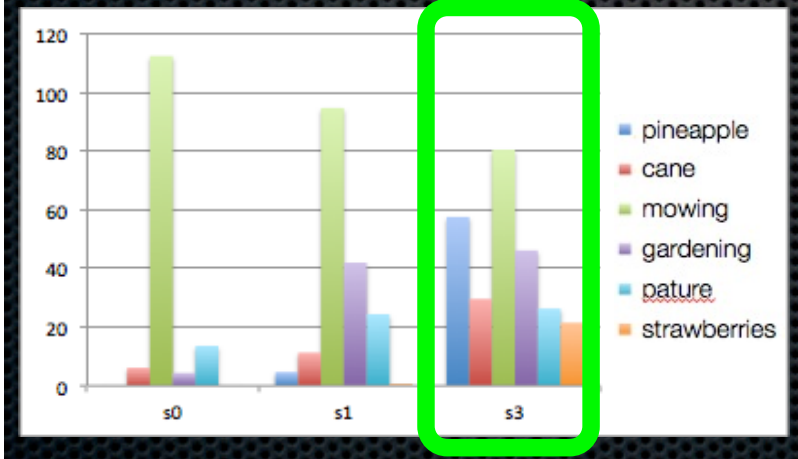
	s0	s1	s2	s2'	s3	s3'
Real situation		x	x	x	x	x
Agronomist Acquaintance			x		x	
+ Proximity Criteria				x		x
+ links with external Plants					x	x

Relevant towards waste management

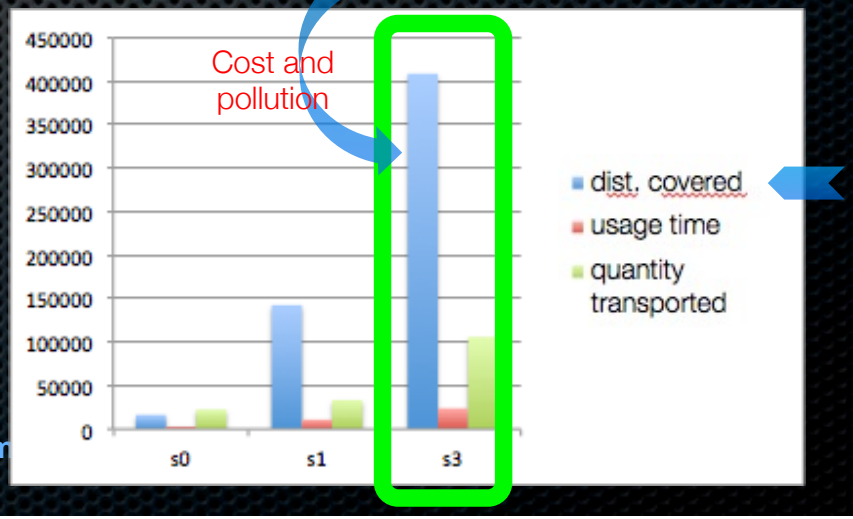


Spreadsheet connectivity

Relevant towards Food self-sufficient



Not relevant towards sustainable development



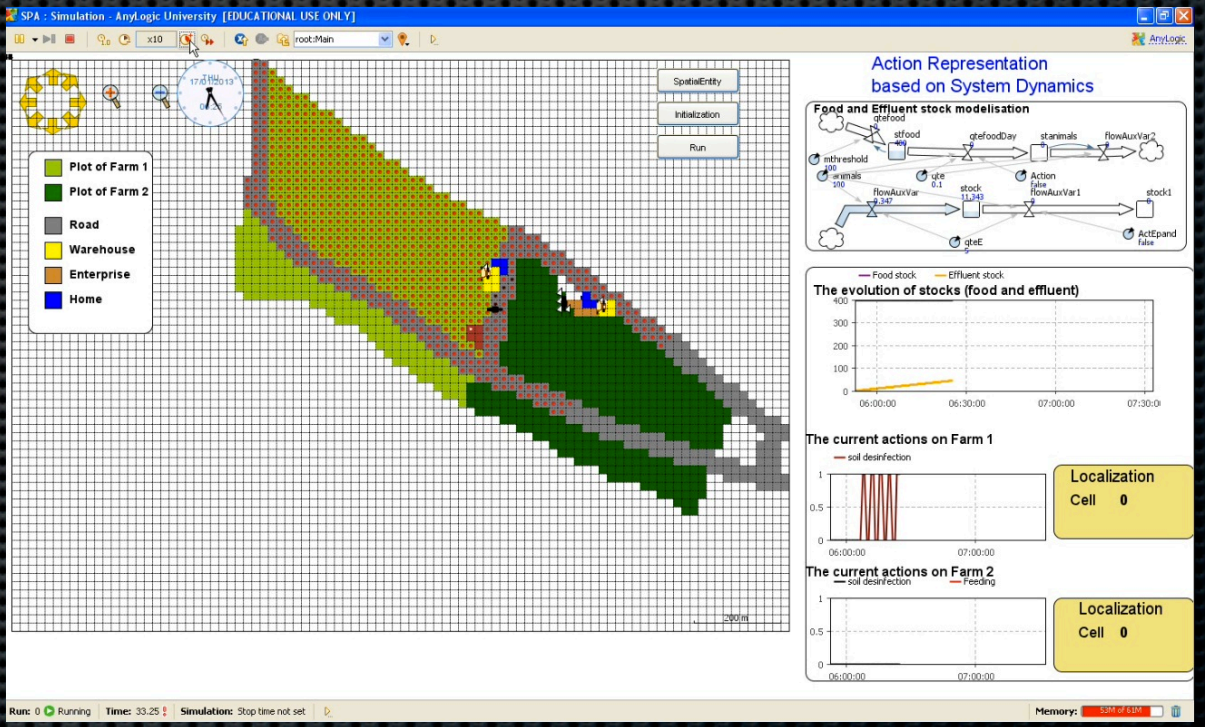
Examples of Multi-Agent Based Simulations

Biomas Project Evolution

XJ Technologies

Modelling human activities in farming systems based on the situated action theory

- We consider the environment as an intelligent entity that has the ability to decide locally, at given time and space, the actions to perform.
- Surrogates of real actors, called *actuators*, just execute the actions dictated by the agents embedded in the environment.
- The model is based on the affordance and stigmergy concepts



Zoubida Afoutni, Rémy Courdier, François Guerrin (2012) Modelling Situated Action based on Affordance and Stigmergy, 175-180. In IEEE International Conference on Self-Adaptive and Self- Organizing Systems (SASO).

Conversation = set of messages exchanged between agents

1) Critical situation alarm arising in an OMP (resp. OMC) farm:

- risk of effluent overflow in storages OR
- (resp. fertilization needs by crops)

2) Negotiation set-up:

- an OMP agent proposes OM to the agents of its social network OR
- (resp an OMC agent requests OM to the agents of its social network)

3) OM negotiation:

- matching OM supplies with demands in terms of type and quantity;

4) Transport negotiation with OMT agents:

- finding a carrier available with adequate capacity;

5) Actual OM deliveries.

4 Conversation parts

(1) A set of “sub-conversations”

- ✓ possibly empty

(2) “Metadata” :

- ✓ Synthetic and objective information

(3) “Knowledge” :

- ✓ Specific synthetic information

(4) “Message-id” :

- ✓ Message identifiers

Conversation : reduced and relevant information

(1) Concept of conversation

- ✓ (sub-conversations, metadata, knowledge and message identifiers)

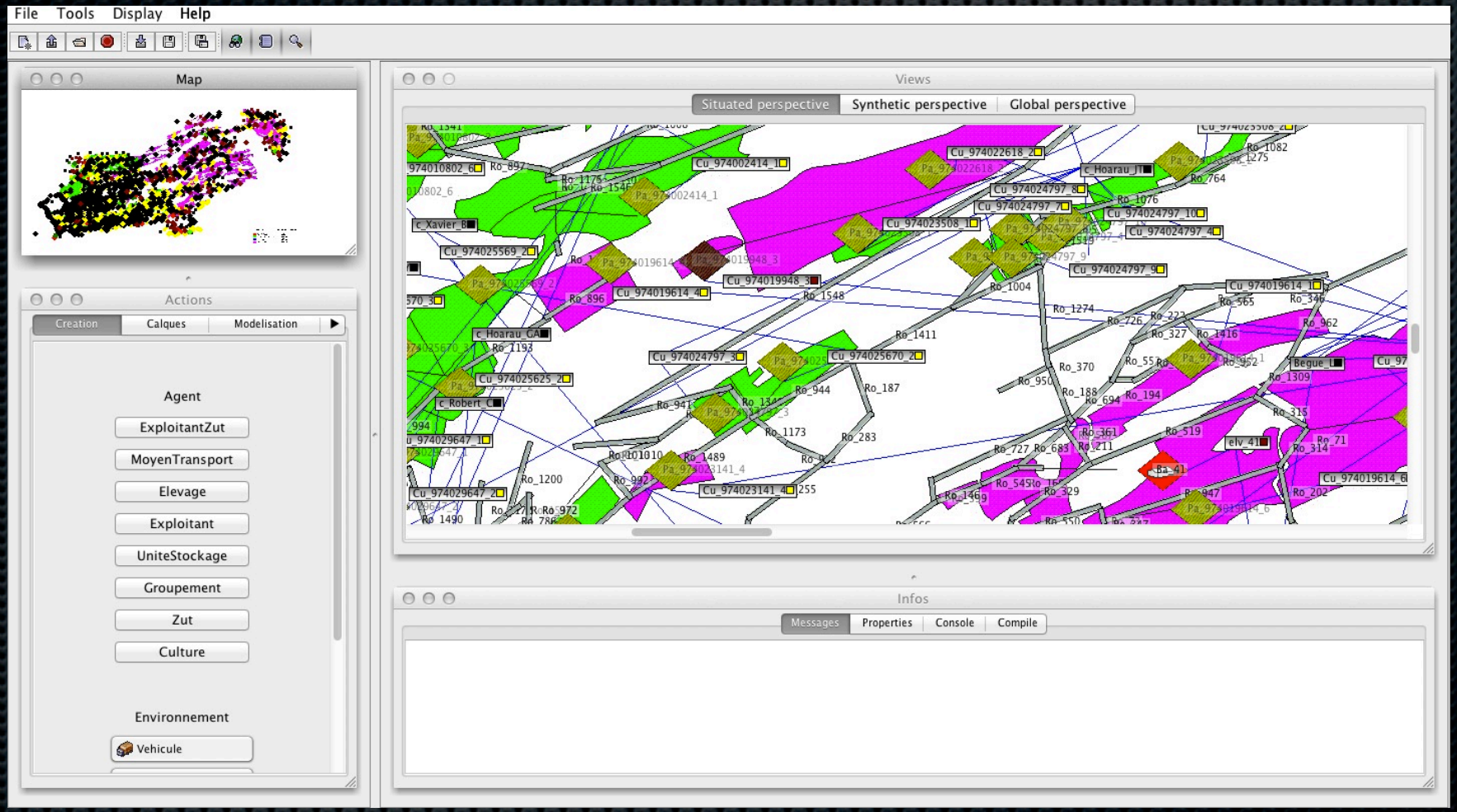
(2) Tools for visualisation at various level of analysis

- ✓ Conversation sequence diagram (local)
- ✓ Conversation wire (intermediate)
- ✓ Conversation map (global)

-> Better analyse real and large scale simulations results (interactions)

Future work

- Improve capacity of conversation interpretation
  - ✓ (cf. semantic web)


File Tools Display Help
Map
Actions
Creation
Calques
Modelisation
Agent
ExploitantZut
MoyenTransport
Elevage
Exploitant
UniteStockage
Groupement
Zut
Culture
Environnement
Vehicule
Views
Situated perspective
Synthetic perspective
Global perspective
Infos
Messages
Properties
Console
Compile