

*Can we learn something from agent-based models ?*  
*Some lessons from the European Project IMAGES*

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Modélisations et simulations multi-agents de systèmes complexes  
pour les Sciences de l'Homme et de la Société :  
principes et méthodes de conception et d'usage

<http://perso.univ-rennes1.fr/denis.phan/PorquerollesXAgents/>

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*Outline*

- The IMAGES project : objectives
- The ideal methods we wanted to apply
- What actually took place
- Main results and problems
- Conclusions : changing perspective about AB models

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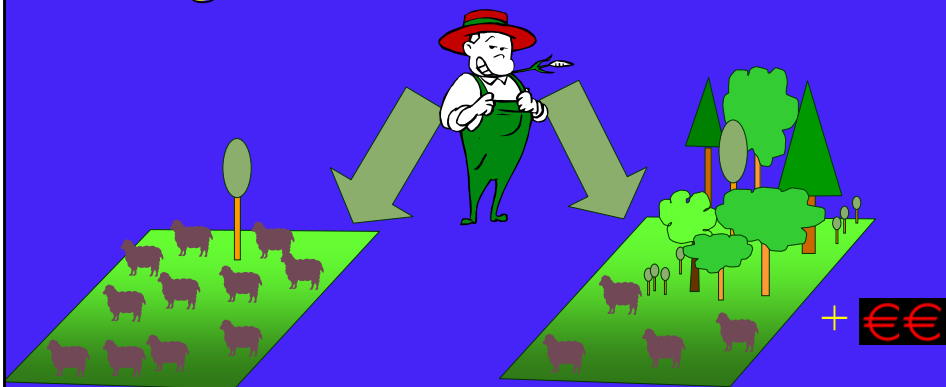
# *IMAGES project (1997 – 2001)*

Partners : Cemagref (F), Univ. of Surrey (UK),  
Ecole Normale Supérieure (F), Royal Agricultural  
College (UK), Univ. of Milan (I), Univ. of Udine  
(I)

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## *Agri-environmental measures*



- Pilot zones from 1986
- Generalised all over Europe in 1992 (regulation 92/2078)

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## *Objectives*

- Evaluate the potential of Agent based models for modelling agri-environmental measure adoption
- Develop a software illustrating this potential (downloadable from the web : <http://wwwlisc.clermont.cemagref.fr>).

## *Why agent based models ?*

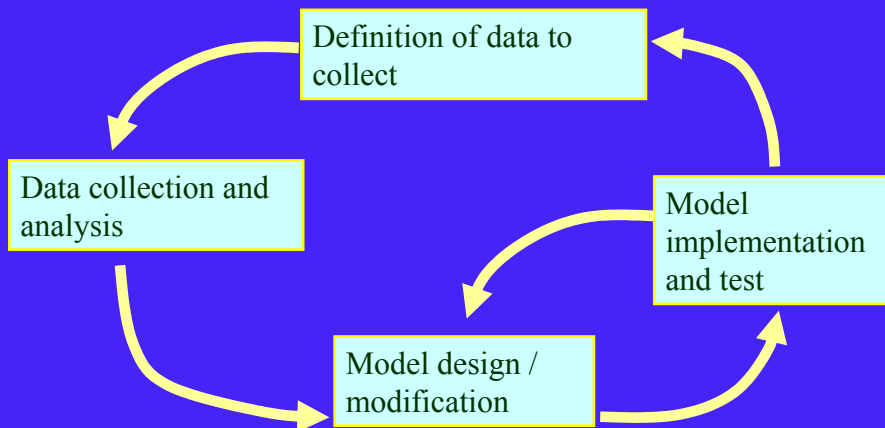
- The economic approaches failed to explain farmer's behaviour
- There seems to be other than economic factors which have a strong influence in the decision
- Potential clients : Policy makers (European commission, member state authorities, local bodies) who want to better define these measures

# *(Ideal) Methodology*

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## *General modelling process*



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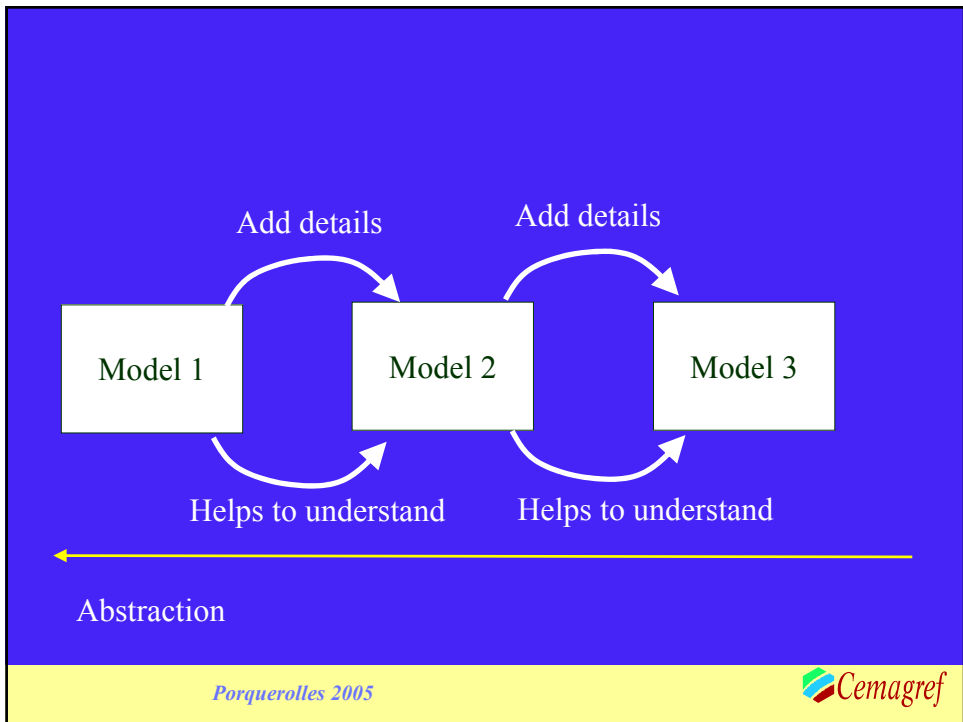


## *Data collection*

- 8 case studies in France, UK and Italy
- Interviews with farmers (350 in 2 phases)
- Interviews with local actors (80 in 2 phases)
- Detailed farm prototype economic data (RICA, FADN)
- Aggregated census data
- Local AEM adoption data over time

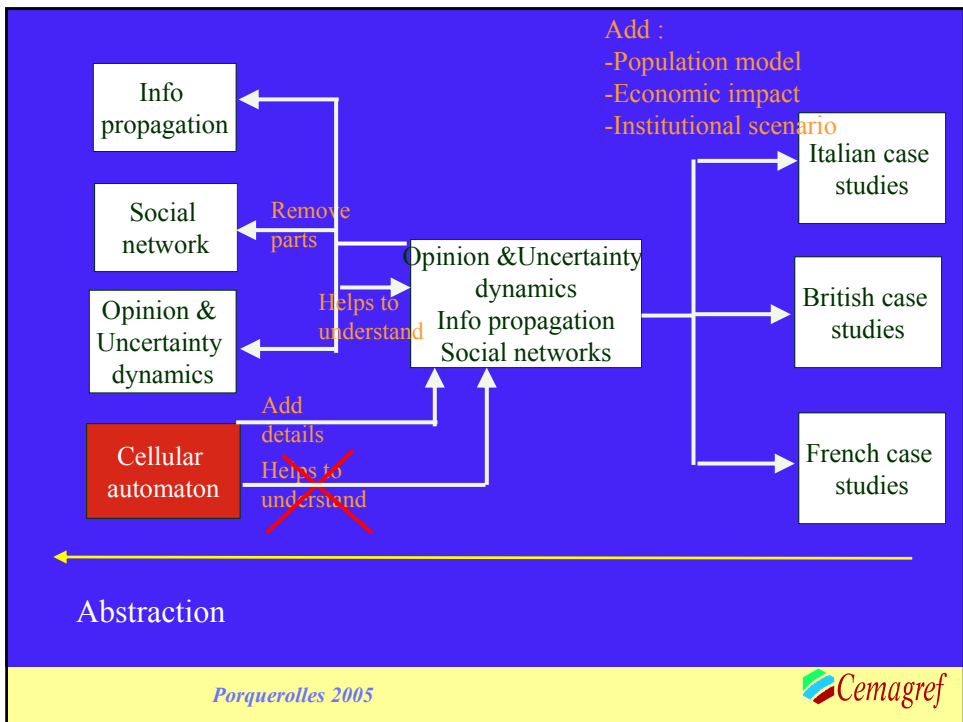
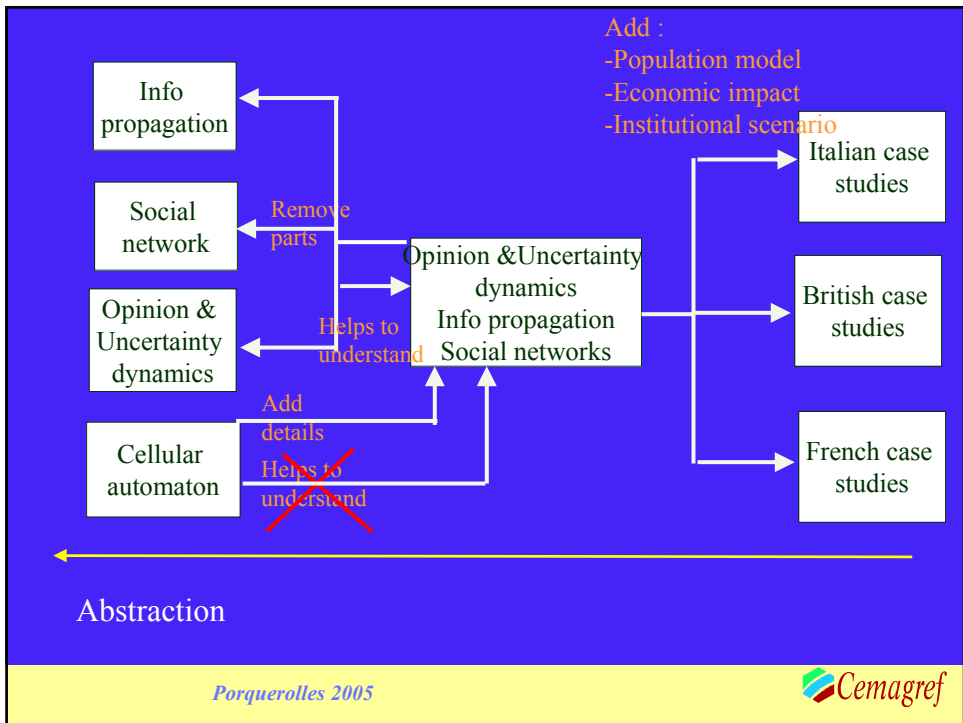
## *Decreasing abstraction*

- Build a range of models which incorporate more and more details
- The study of less detailed models helps to understand the more complex ones



*What actually took place*





# *Innovation diffusion (Valente 95)*



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## *Threshold (Ising) model*

- The variables describing an individual  $i$  are:
  - Its state  $s_i$  (+1 or -1) = adoption / non adoption
  - Its threshold (or intrinsic interest) :  $\theta_i$
- The dynamics is given by :

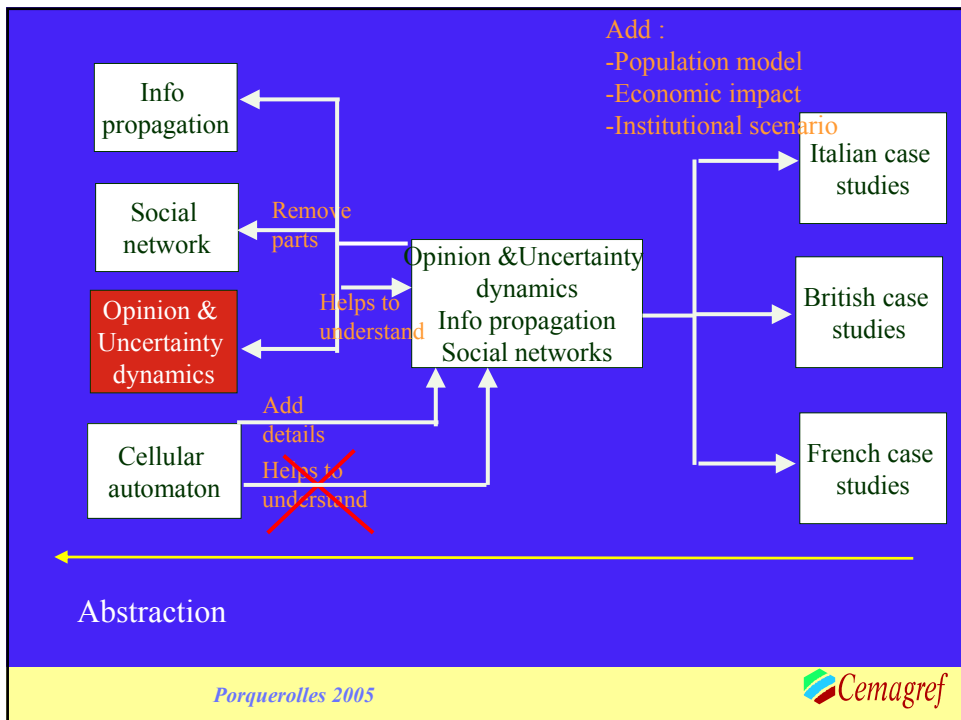
$$s_i(t+1) = \text{sgn} \left( \sum_{j \in N(i)} s_j(t) + \theta_i \right)$$

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# Problems

- For many social scientists of the project, the model was too close to physics.
- The interviews pointed out :
  - The important role of uncertainty
  - The existence of intermediate states between adoption and non adoption
  - The important role of information propagation



# Bounded confidence

(Deffuant et al. 2001, Hegselman & Krause 2002, Stauffer et al. 2004)

Each individual  $i$  has an opinion  $x_i$  has an uncertainty  $u_i$ .

First model : all agents have the same uncertainty

if :  $|x_i - x_j| < u$

Pair interactions :

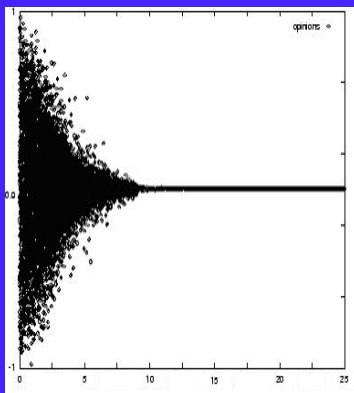
$$x_i(t+1) := x_i(t) + \mu(x_i(t) - x_j(t))$$

No dynamics on the uncertainty

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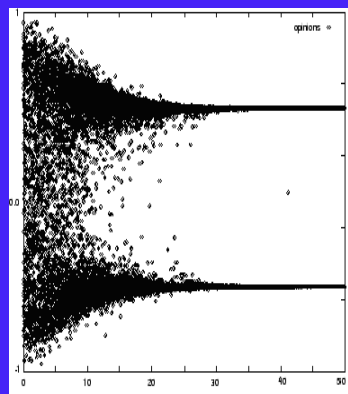


With a uniform distribution of the opinions of width  $w$



$[w/2u]=1$

nb attractors approximately the integer part of  $w/2u$

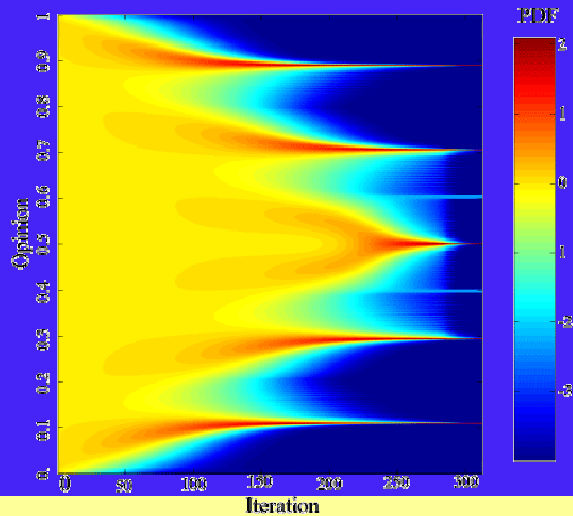


$[w/2u]=2$

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## *Opinion probability density evolution*



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## *Relative agreement*

*(Deffuant et al. 2002)*

- Modification of the dynamics :
  - More certain agents are more influent
  - The uncertainty is also changing (similarly to the opinion)

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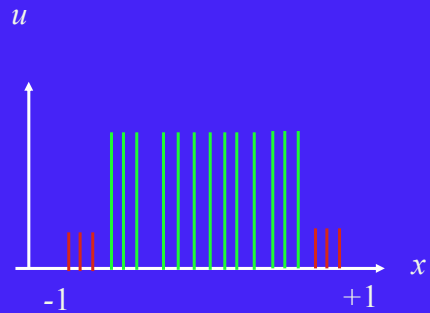
# Population with extremists

$U$  : initial uncertainty of moderate agents

$ue$  : initial uncertainty of extremists

$pe$  : initial proportion of extremists

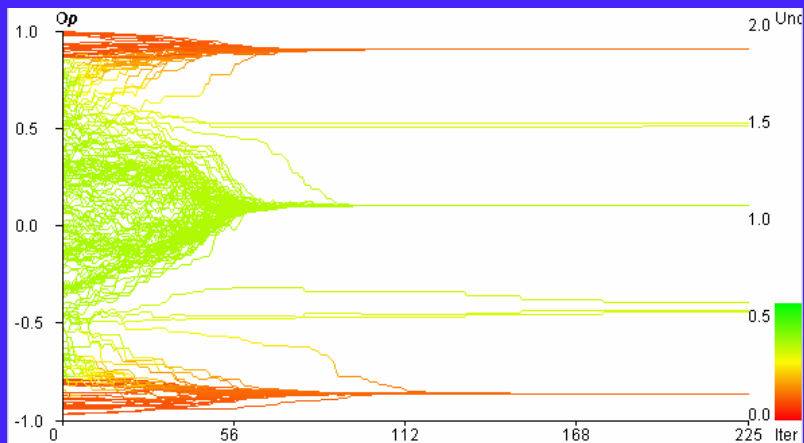
$\delta$  : bias between positive and negative extremists



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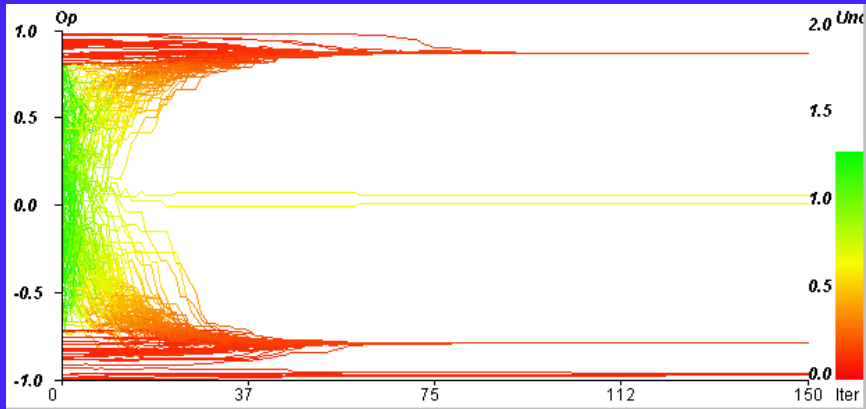
## Central convergence ( $U=0.4, pe=0.2$ )



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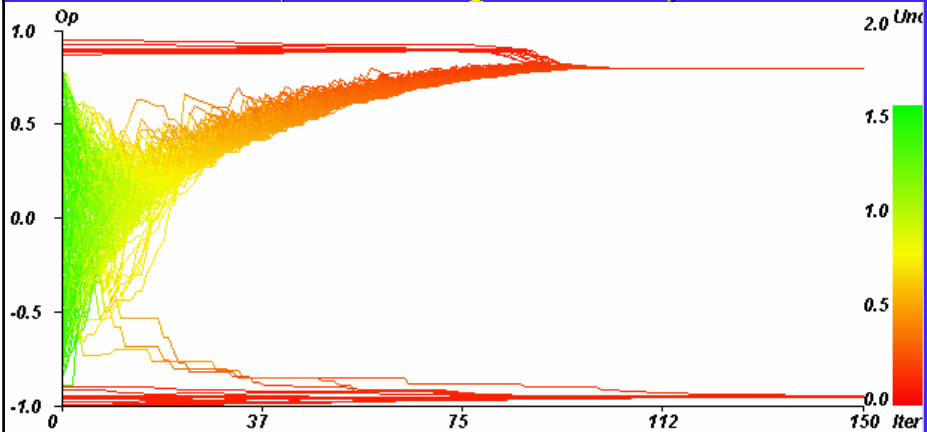
## Both extremes convergence ( $U=1.4, pe=0.2$ )



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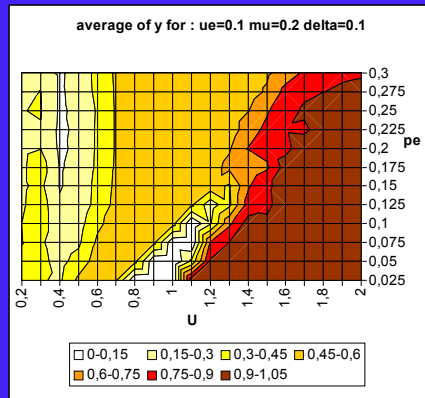
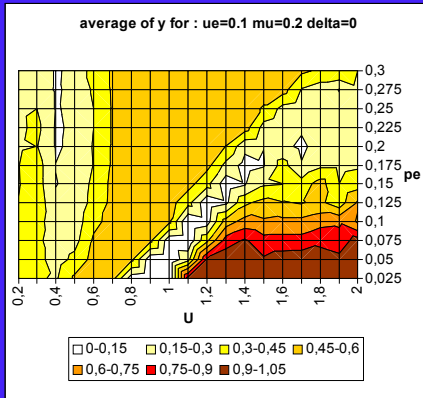
## Single extreme convergence ( $U=1.4, pe=0.05$ )



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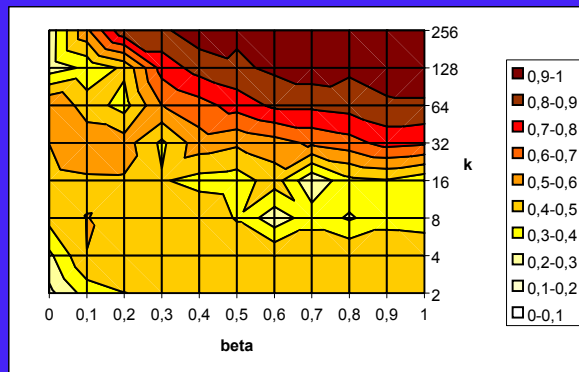
# Exploration of the parameter space



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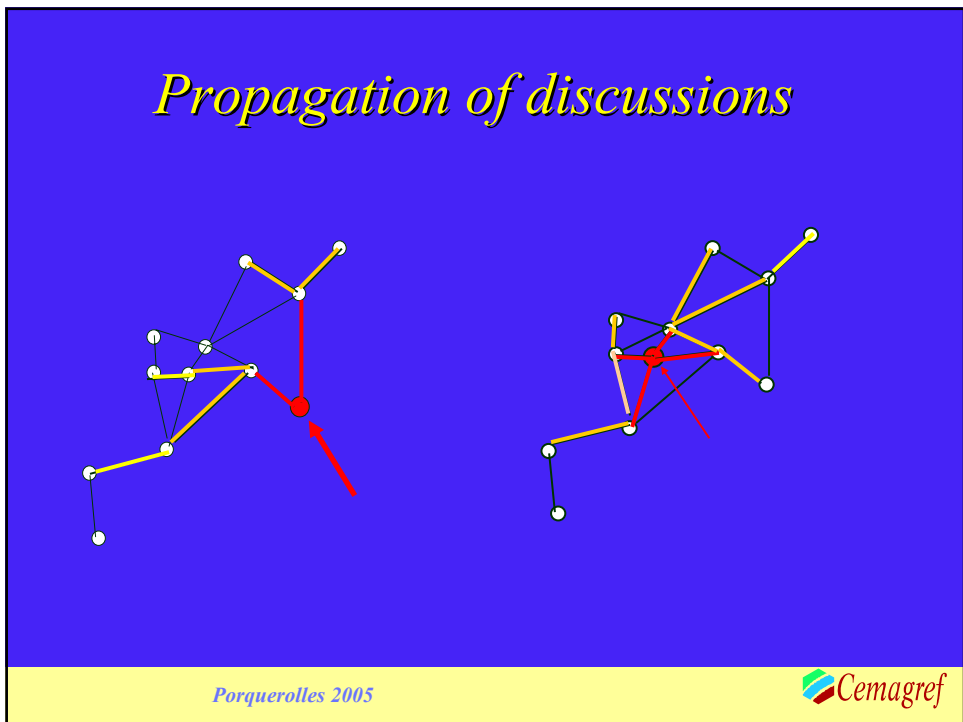
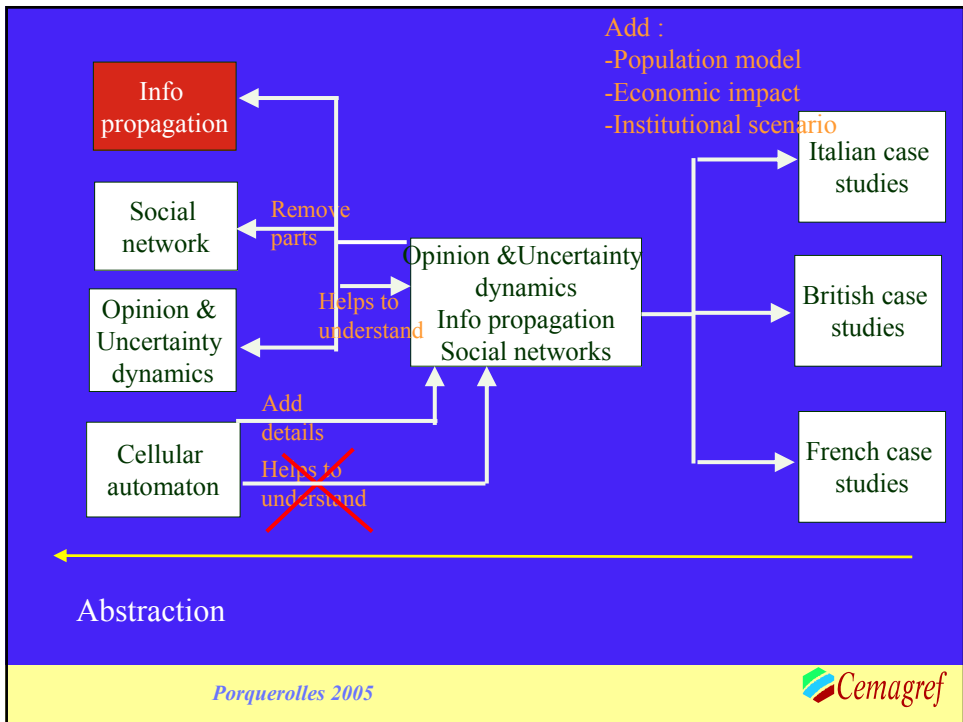
# Small world networks (Amblard & Deffuant 2004)



- $U = 1.8$ ,  $pe = 0.05$  (typical single extreme in total connection)

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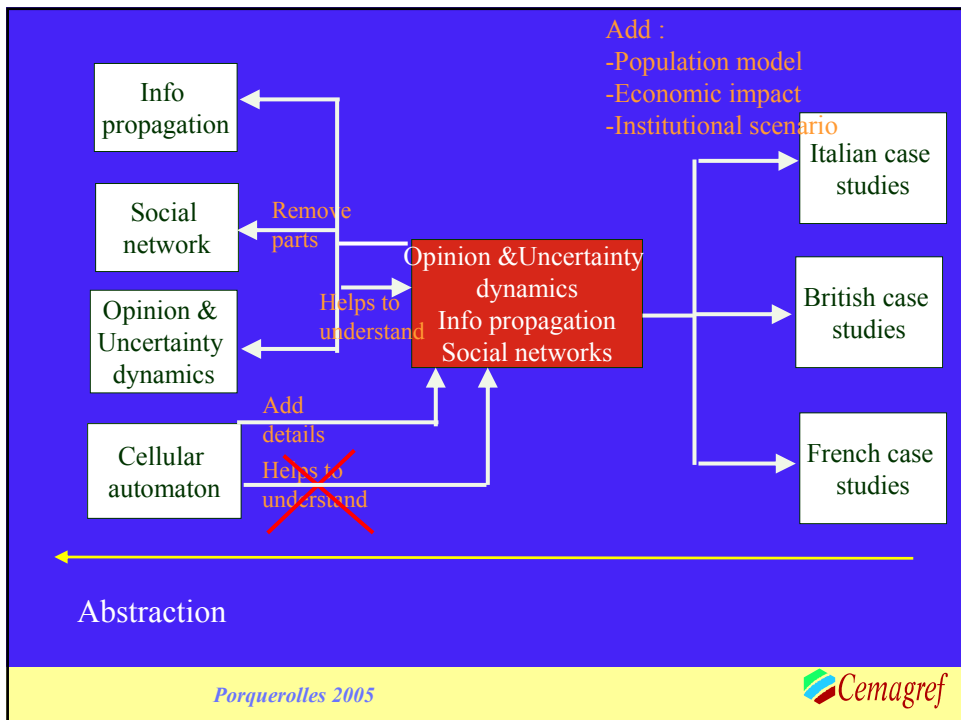




# Information propagation

- A priori not interested individual do not care about the information, and do not transmit it
- Interested people do care and tend to transmit it

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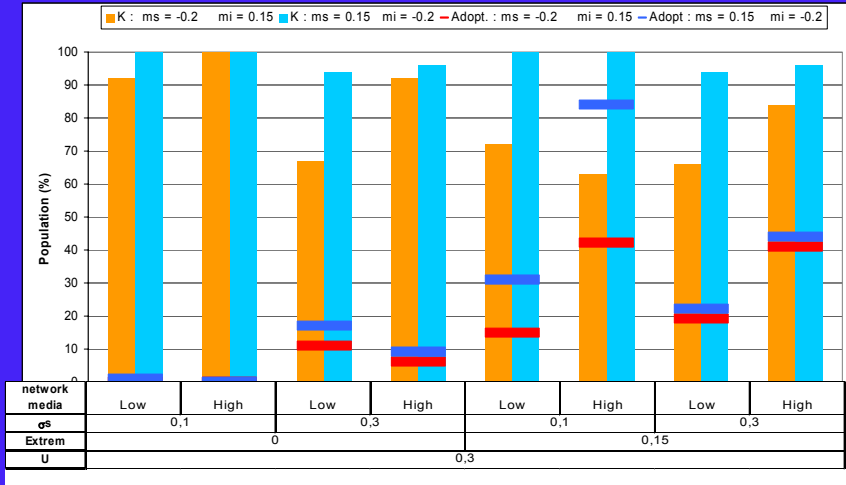
## *Coupling models*

- Decision based on :
  - a social value of the action
  - an anticipation about self well being, based on available information
- Information about the effect of the innovation is propagated
- Role of information flow : information is not transmitted by agents who have a negative social value of the innovation

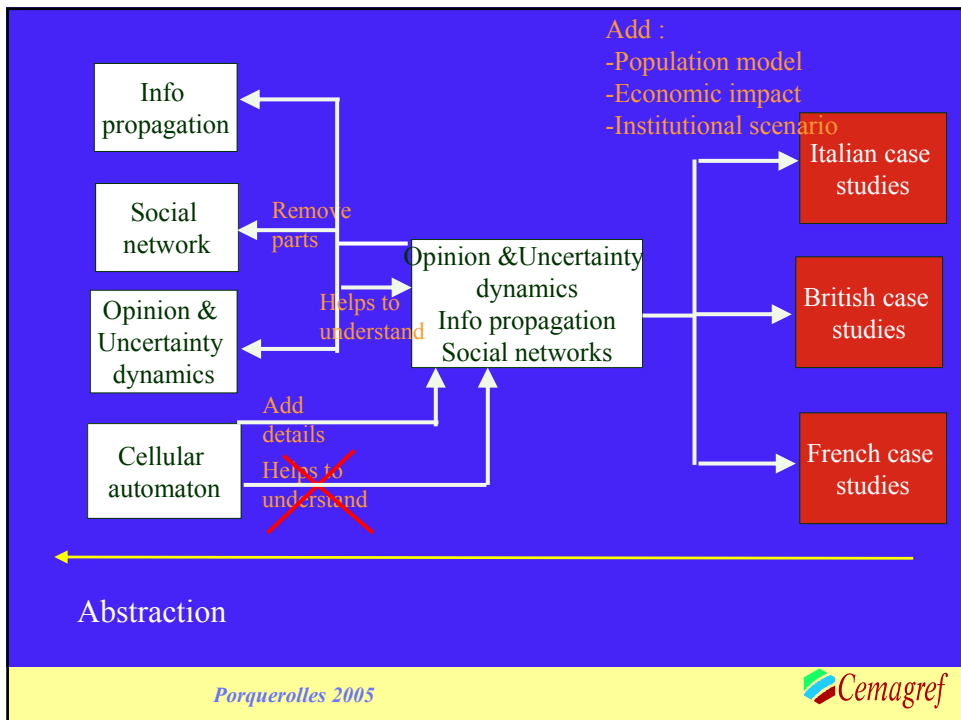
## *Exploring the model*

- Necessity to make experiment design :
  - Varying values of the parameters
  - Making many replicas for each set of values

# Good initial social value – bad for well being vs the opposite



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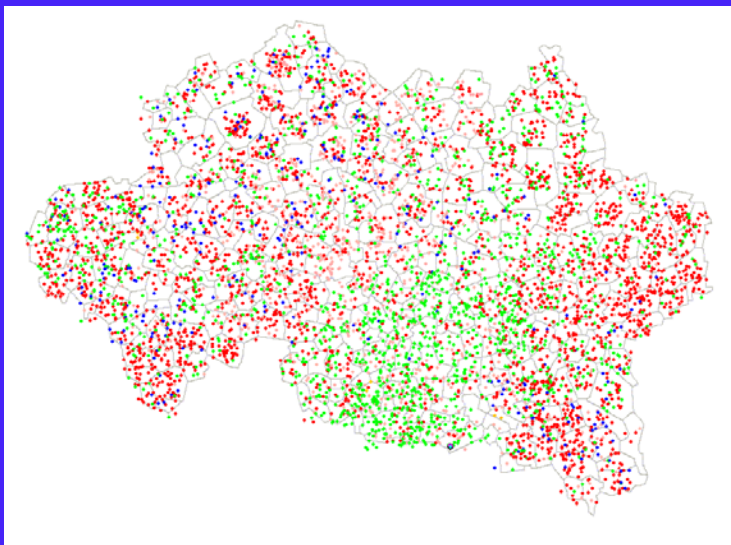
## *Generating populations of farms*

- Regional level : mixing detailed farm prototype data and aggregated census data
- For small populations : local data

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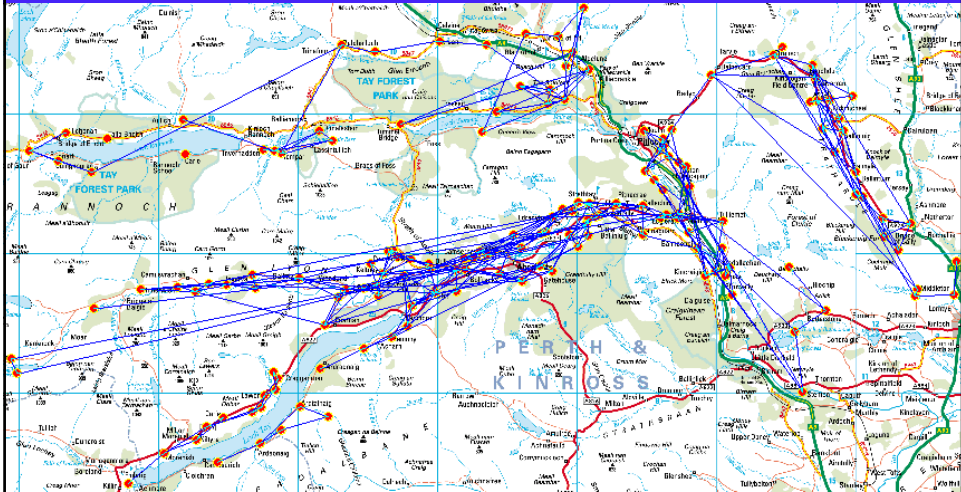
## *Allier département*



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# *Breadalbane ESA (Scotland)*



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## *Economic model*

- With local experts :
  - Connecting the characteristics of the farm and the potential benefit of adopting
  - Associated uncertainties

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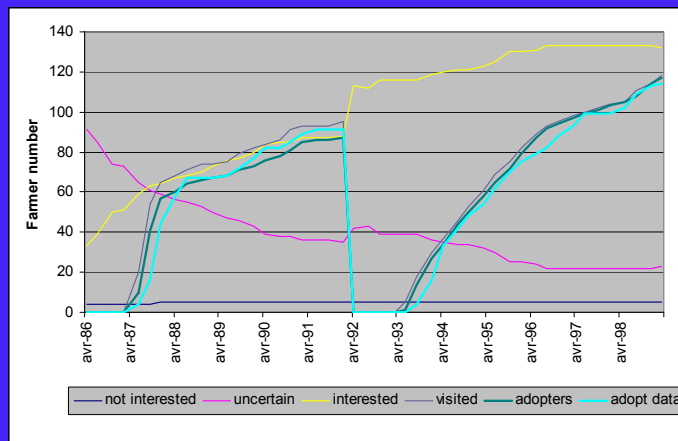
## *Institutional scenario*

- Reconstituting the particular actions of promotion of the AEM:
  - Meetings
  - Articles in newspapers...
  - Visits of advisors

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## *simulations vs adoption data ex: Breadalbane ESA*



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## *Main results and problems*

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## *Some clear results*

- The data show a cognitive filter is activated before even considering the decision, which has an important impact on the whole process
- The models give new and coherent views on :
  - How extreme opinions can propagate in a population
  - How social and individual opinion can interact in an innovation diffusion process

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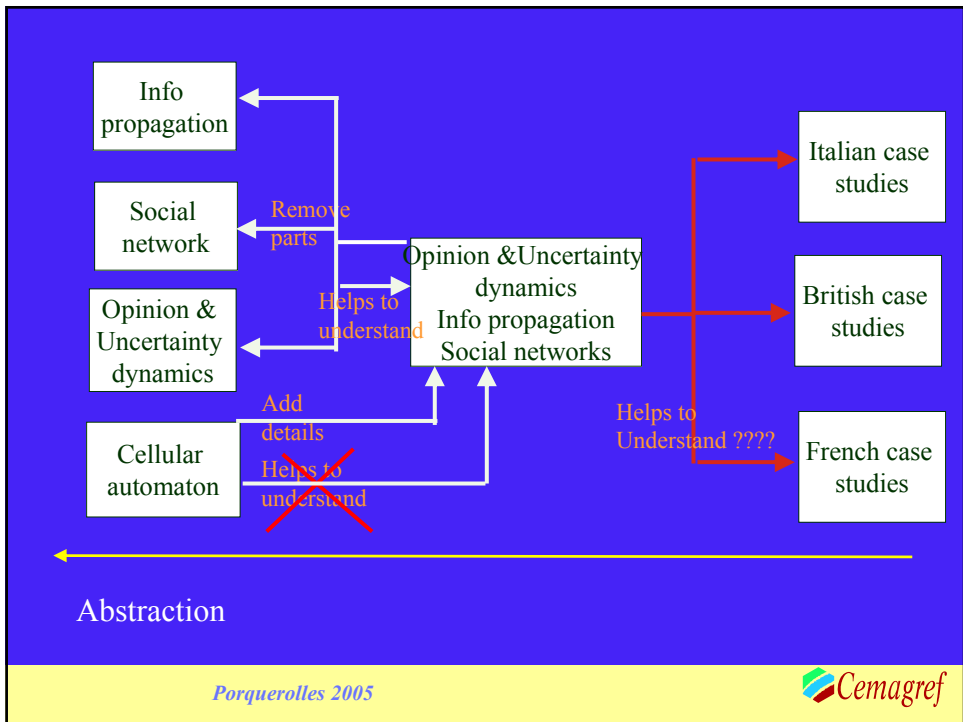


## *Modelling and data collection have different timing*

- It is much easier and faster to change a model than collecting data (especially interviews)
- → When the results from the data collection came, the modellers were not interested anymore, because they focused on other questions

## *Problem with the decreasing abstraction*

- Very heavy :
  - Not completed for some parts of the suite of models



*Conclusions*

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## *Problem with AB models*

- If you cannot give :
  - A strongly argued explanation of why you obtain a given result
  - A well established knowledge about the stability of the result
- Then a decision maker cannot use them
- They fail to really give a new perception of the phenomenon

## *Changing perspective about AB models ?*

- AB models are very powerful tools to explore the potential collective (complex) behaviours emerging from interactions
- They could be seen as virtual (potential) realities which can be studied much more easily than the real phenomenon (on which experiments are often difficult to perform)
- The modellers must do clearly understandable models of AB model dynamics : model of the global AB model dynamics

## *Need for new tools and methods*

- Tools for designing systematic numerical experiments on agent-based models (i.e. including complicated initial states in the input of the model) → SimExplorer, VLE
- Methods for identifying and explaining the observed global behaviour (making the model of the model) → Statistics, differential equations