SOMERSET-P: An integrated modelling platform for territorial and environmental planning

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1. Problem and objectives

Social systems increase in complexity

- Increasing plurality of administrative authorities and processes
- Increasing plurality of interactions and feed-backs
- **Appearance of emergent phenomena**

1. Problem and objectives

Increasing difficulties for practitioners

- Territorial and environmental planning (TEP)
- Problem setting
- Decision making about the territory
- Implementation of actions

How to deal with complexity?

?

système complexe non-prédictif !

Possible futures ?

?

conflicts ?

?

values ?

Stakeholders?

?

…how to organize territorial intelligence?

Beliefs?

?

evolution ?

?

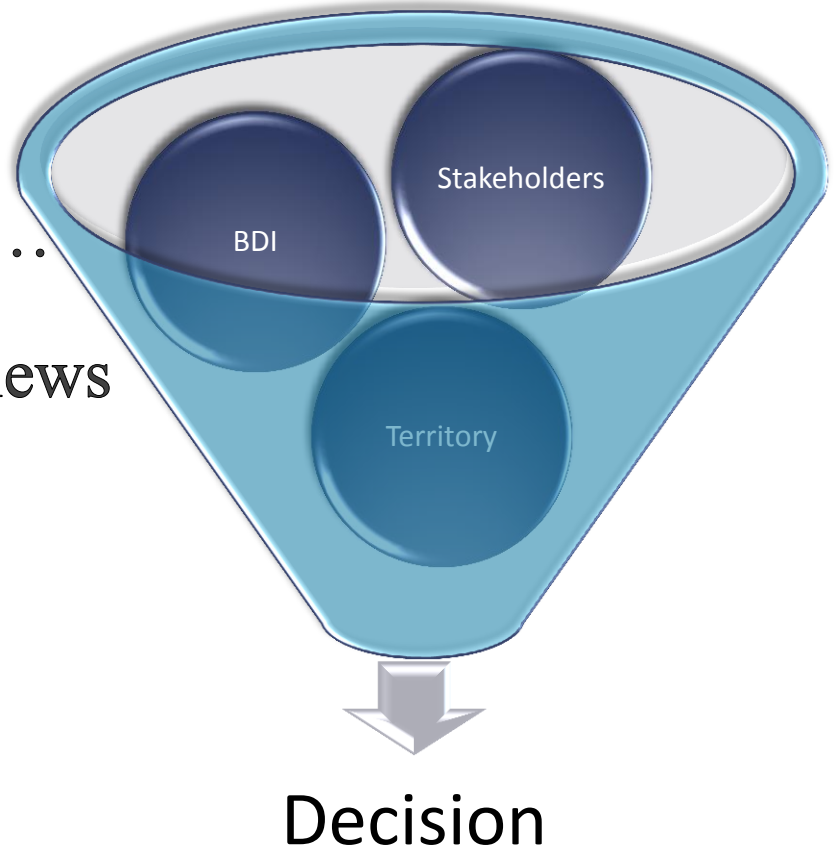
impacts ?

Conceptual implications

- ✓Vision and prioritization
- ✓Explicitness and transparency
- ✓Selection

2. Approach
2.1 Decision aid and TEP

- Decision aid (Definition from the 80s)
- Decision process: uncertainties, ambiguities, fuzziness, …
- Several stakeholders and potential conflictual point of views
- Diversity of cognitive schemes (BDI)
- Introduction of the georeferenced component



2.2 Modelling

Territory and its uses can be modelled…

…as well as social and environmental interactions

- What plan ?
- Where to plan?
- Which impacts ?

2.2 Modelling: three tools

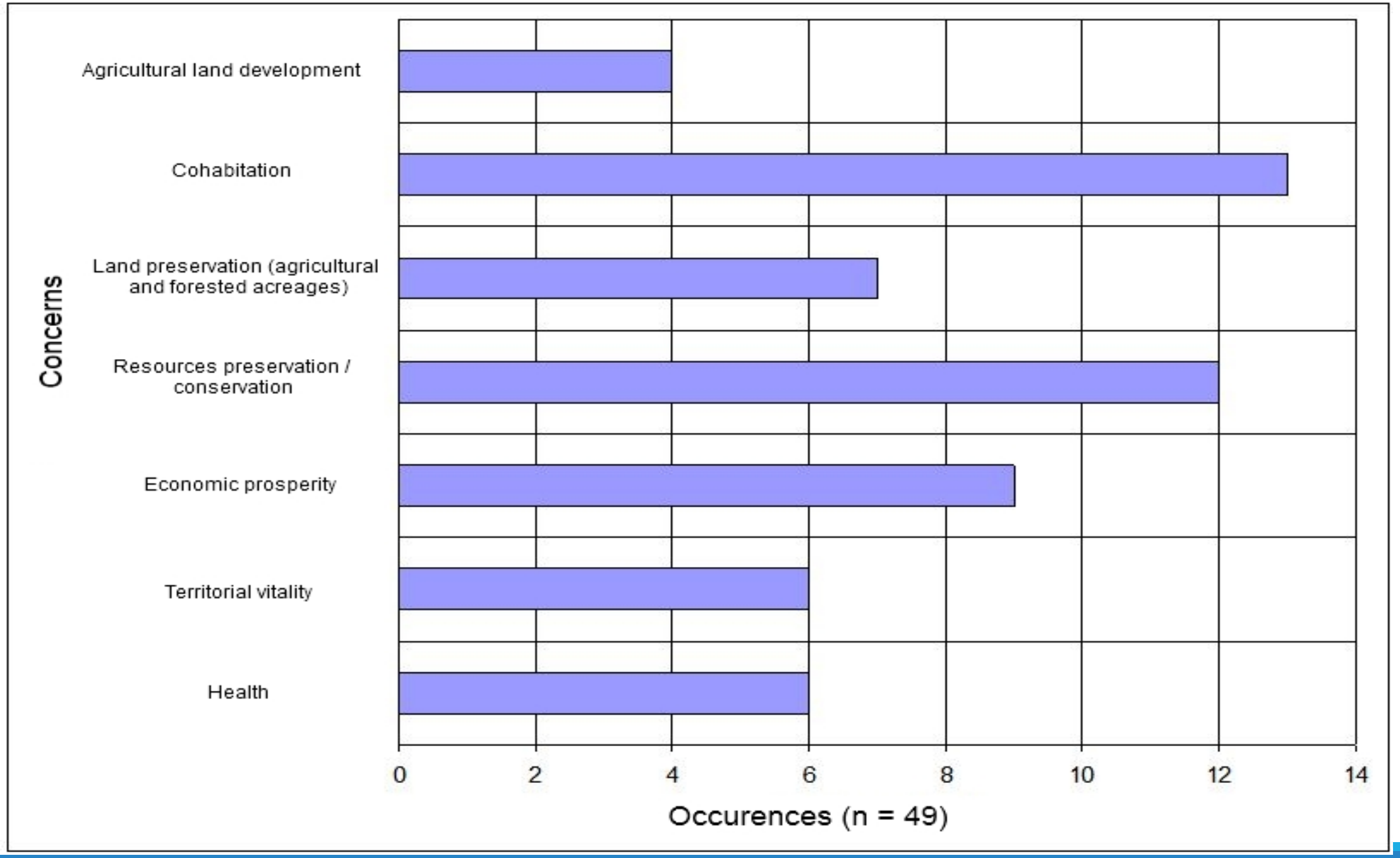
1. Conceptual model
2. Spatial model
3. Decision aid model

3. Data and results
3.1 Conceptual model

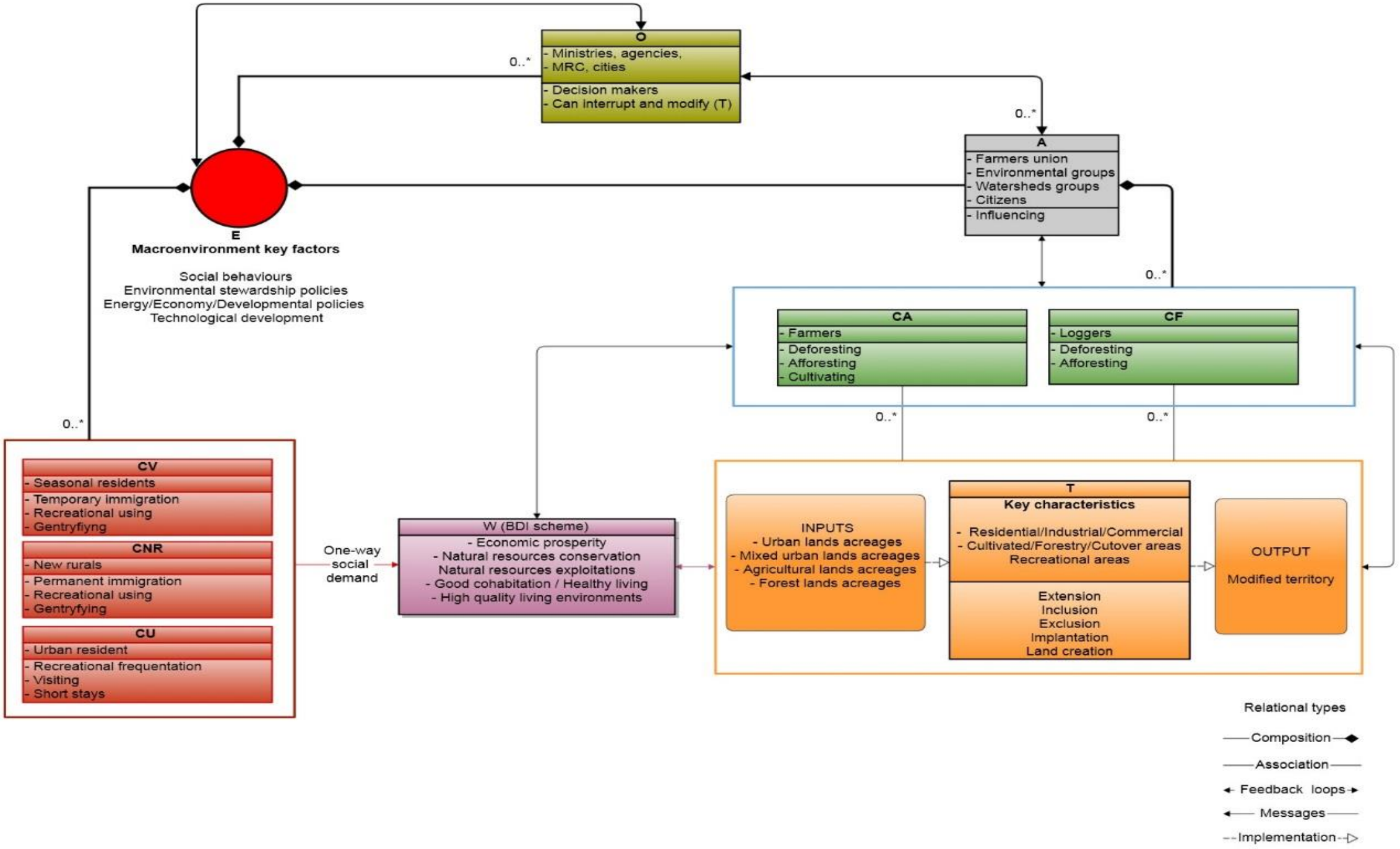
- Soft system methodology
- Systemic modelling approach
- Well suited for systems with strong social components
- Allow appropriate representation

3.1 Conceptual model : Problem structure and concerns

- Territory of the Bellechasse group of municipalities
- Context of public consultations o the future of agriculture
- Identification and content analysis of 50 memoirs
- All stakeholders are involved
- 10 years of empirical observation of the socio-ecosystem


Concerns
Agricultural land development
Cohabitation
Land preservation (agricultural and forested acreages)
Resources preservation / conservation
Economic prosperity
Territorial vitality
Health
0
2
4
6
8
10
12
14
Occurences (n = 49)

Résultats: modèle CATWOE



3. Data and results
3.2 Land-use spatial model

From previous identified concerns…

- **Identification** of environmental, social, economics issues…
- **Analysis** of the stakeholder preferences related to the issues
- **Translation** of the issues into criteria and identification of measurement indicators
- **Design** of 4 scenarios simulating spatial evolution (quantitative design variables) or perception evolution (qualitative design variables

Dimensions	Criteria	Indicators	Units	Scales
Economic prosperity	Agricultural vitality (ViAg)	Commercial cultivation areas	Hectares	Cardinal
	Logging (Coup)	Exploitable forest areas available	Hectares	Cardinal
	Agriturism locations (Lcl2)	Distance from the urban centroid of a public market	Meters	Ordinal
	Agribusiness locations (Lcl1)	Agricultural dynamic level	Integer	Ordinal
Management of urbanization	Concentric urbanization (UrC)	Lost cultivated areas	Hectares	Cardinal
	Diffuse urbanization (UrD)	Number of houses in AZ	Integer	Cardinal
Biodiversity and environment	Water resources protection (Hy1)	River buffer width	Meters	Cardinal
	Organic crops (Cbio)	Organic crop areas	Hectares	Cardinal
Forest management	Agricultural deforestation (Db)	Authorization to deforestation	Integer	Nominal
	Retrieving of abandoned agricultural lands (Fri)	Reforestation areas	Hectares	Cardinal
Moral health of the community	Social harmony (Str)	Level of harmony	Integer	Ordinal
	Contribution to empowerment (Emp)	Valorization of empowerment	Integer	Cardinal

3. Data and results
3.2 Spatial model: data

Georeferenced data on the territory

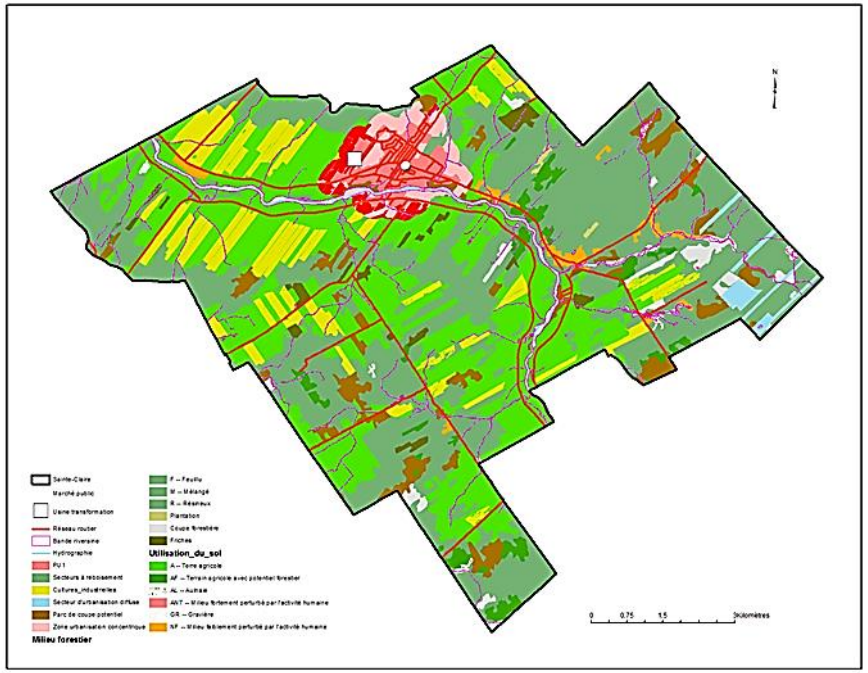
Agricultural centroids, forest polygons, urban perimeters, etc.

Data coming from spatial analysis

- Protection corridors, densities, Euclidean distances, etc.

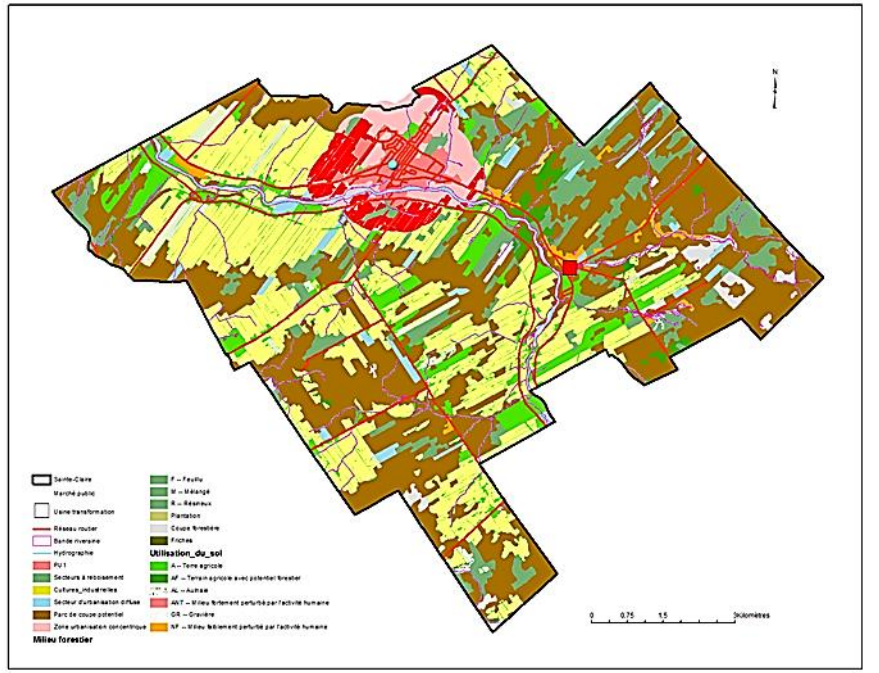
Simulation of the evolution

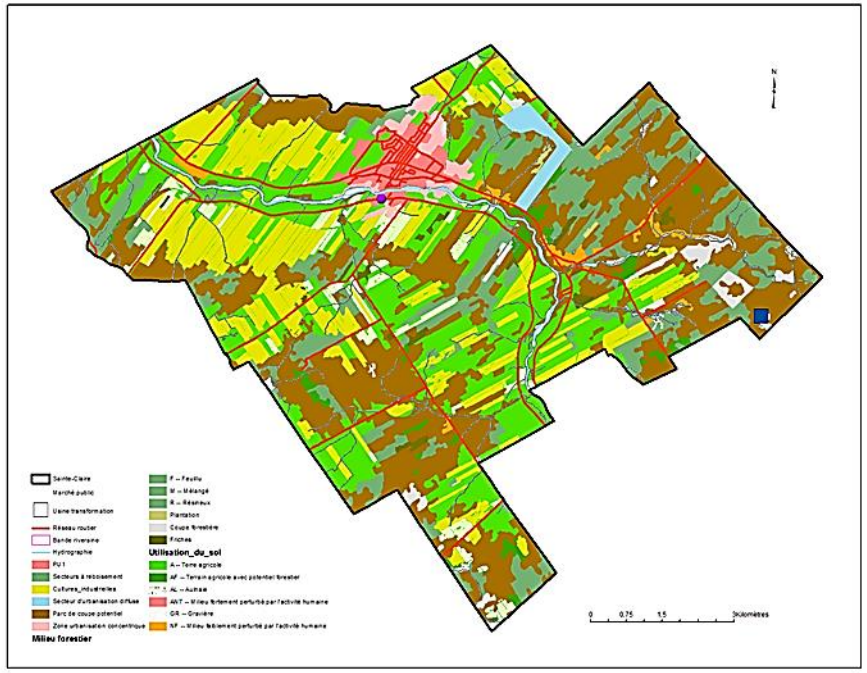
- Change in land-use maps, zoning changes, urban perimeters



Status quo

Growth





Environment

Equilibrium

3.2 Spatial model: evaluation table

Criteria / Scenarios	ViAg	Coup	Lcl1	Lcl2	UrC	UrD	Hy1	Cbio	DbA	Fri	Str	Emp
Scn1	720	428	1	225	92	8	3	10	1	61	1	1
Scn2	2 883	3 769	2	290	209	43	1	144	1	281	2	2
Scn3	288	1 739	3	500	0	100	5	1 641	0	183	1	4
Scn4	1 441	2 998	0	900	0	190	5	721	0	1	1	2

3. Data and results
3.3 Decision aid model

To decide :

- Recognize the existence of several views
- Recognize the conflictual nature of those views
- Choose among the potential scenarios
- Take responsibility for the decision

3. Data and results
3.3 Decision aid model

Combined GIS and multicriteria approach

- Allow acquisition and preservation of as much information on the structure and the spatial location of the problem
  - Several potential land-use scenarios
  - Several stakeholders (farmers, forestry workers, neo-rurals, urban…)
  - Several BDI schemes (*Belief/Desire/Intention*)
  - Scenario impacts : areas, zoning.
  - Stakeholder preferences about scenarios taking into account impacts, externalities, amenities.

3. Data and results

3.3 Decision aid model

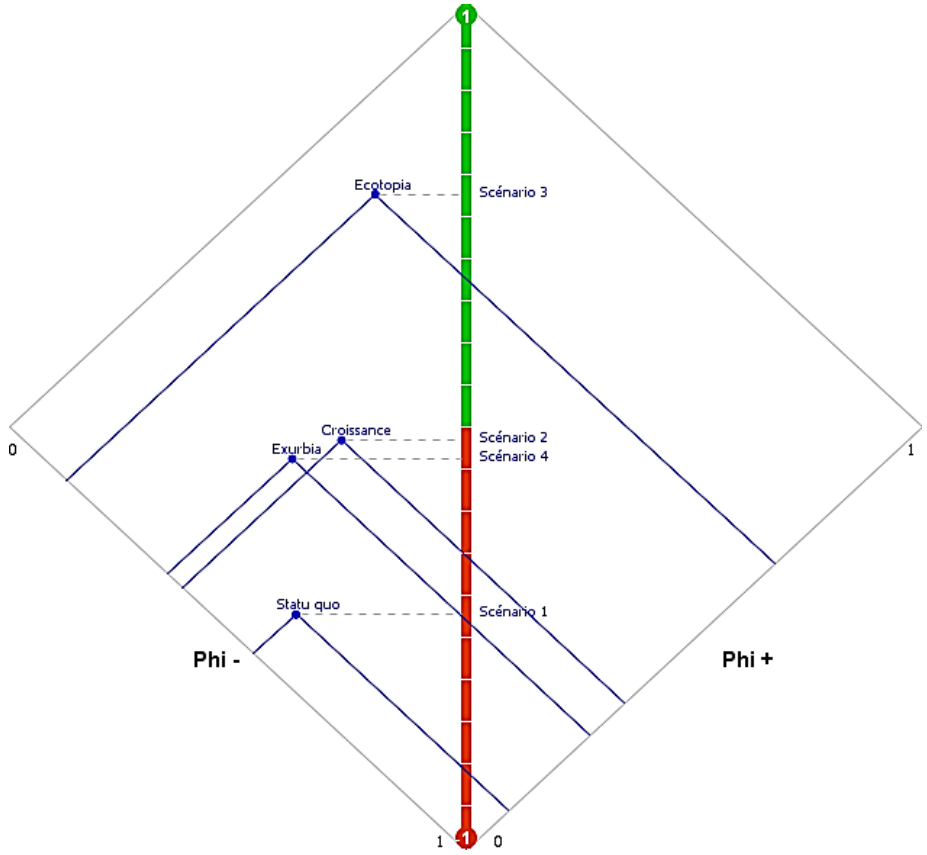
- Ranking problem of the territorial and environmental planning scenarios for each stakeholder and for the group
- Common understanding and sharing of the problem setting (scenarios and criteria) and of the data (evaluation table)
- Use of PROMÉTHÉE et GAÏA methods
- Software: ARC-GIS et D-Sight

Criteria	Type	Min/max	Function	Threshold	Weight	Unit	Scale
Agricultural vitality	Pair	Max	V-Shape	1000	15,17%	Hectares	Cardinal
Logging	Pair	Max	V-Shape	500	12,13%	Hectares	Cardinal
Agribusiness locations	Pair	Max	Usuel	2	1,52%	Integer	Ordinal
Agriturism locations	Pair	Min	V-Shape	250	1,52%	Meters	Cardinal
Concentric urbanization	Pair	Min	V-Shape	200	26,54%	Hectares	Cardinal
Diffuse urbanization	Pair	Max	V-Shape	150	8,85%	Integer	Cardinal
Water resources protection	Pair	Max	V-Shape	5	16,18%	Meters	Cardinal
Organic crops	Pair	Max	V-Shape	700	4,04%	Hectares	Cardinal
Agricultural deforestation	Pair	Max	Usual	1	3,15%	Integer	Nominal
Retrieving of abandoned agricultural lands	Pair	Max	V-Shape	100	5,85%	Hectares	Cardinal
Social harmony	Pair	Max	Usual	1	2,53%	Integer	Ordinal
Contribution to empowerment	Pair	Max	V-Shape	4	2,53%	Integer	Ordinal

3. Data and results

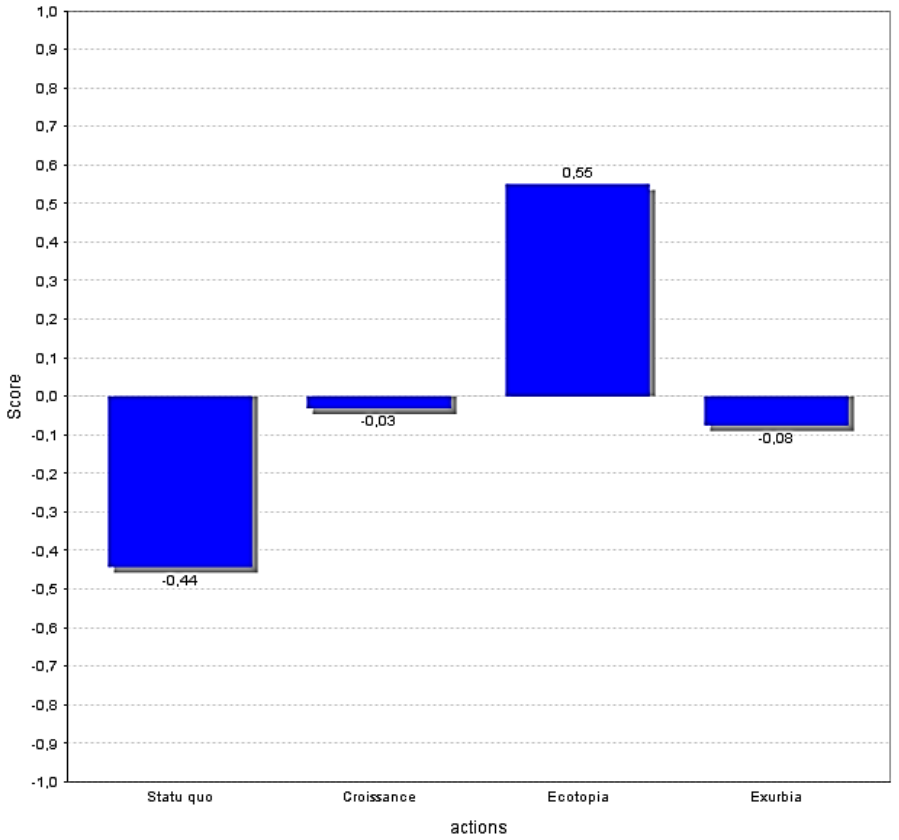
3.3.4 PROMÉTHÉE I : Exploitation of partial flows

- Entering flow $\Phi^-(a)$ and outgoing flow $\Phi^+(a)$
- Power of the scenario (position)
- $\Phi^+(a) = \frac{1}{n-1}\sum_{x \in A} \pi(a, x)$
- $\Phi^-(a) = \frac{1}{n-1}\sum_{x \in A} \pi(x, a)$
- Allow incomparability and indifference between scenarios
- Allow detection of conflictual scenarios



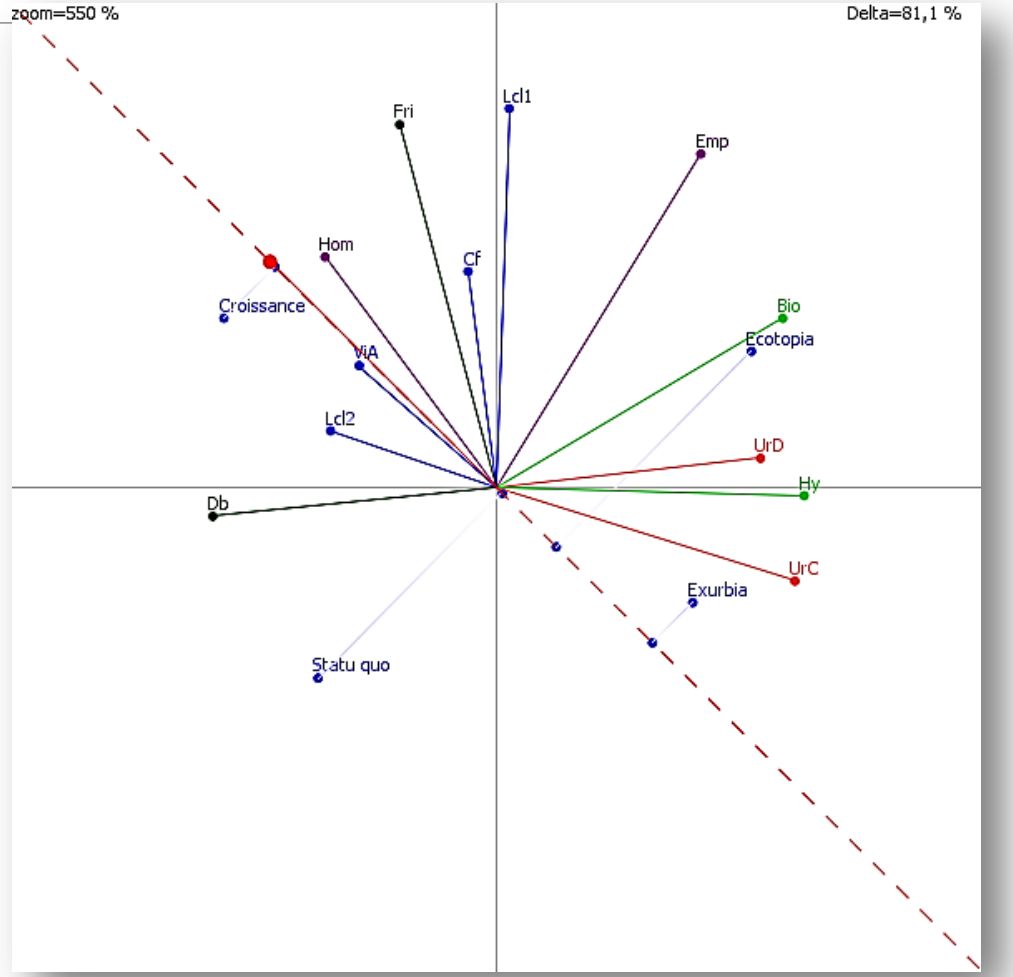
3. Data and results
3.3.5 PROMÉTHÉE II : Exploitation of net flows

- $\Phi(a) = \Phi^{+}(a) - \Phi^{-}(a)$
- Final score of the scenarios
- Don’t allow incomparability
- Information lost but complete ranking



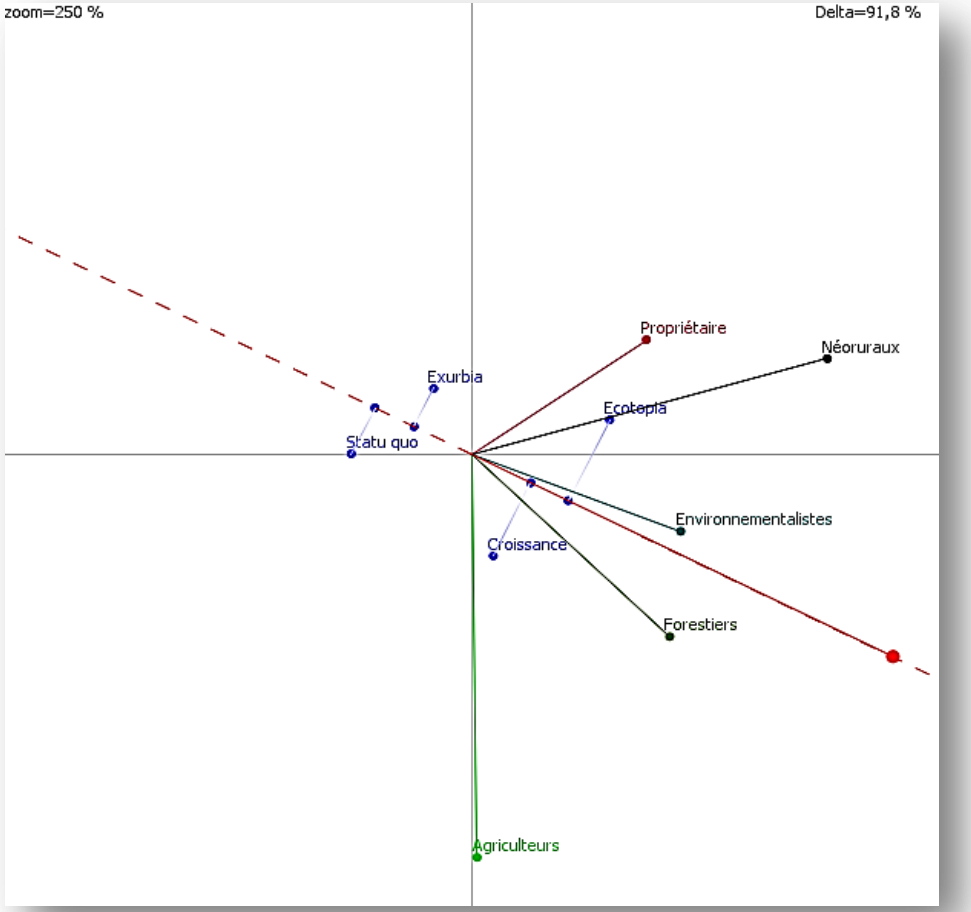
3. Data and results
3.3.6 GAÏA plane: criteria / farmers

- Interactive visualisation
- Unicriterion net flows
- Conflictual criteria : opposite vectors
- Length of axes : discriminant
- *Growth* : best scenario for this stakeholder

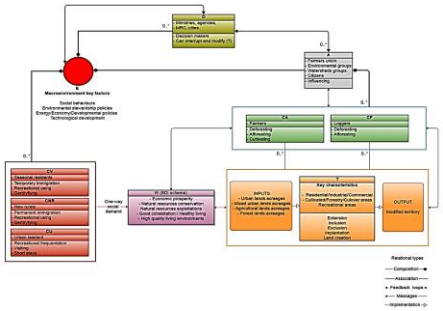


3. Data and results
3.3.6 GAÏA plane: scenarios and stakeholders

- Use of each scenario net flow
- *Decision stick :* weight vector
- *DS* length is discriminant
- Trade-offs



4. Conclusions



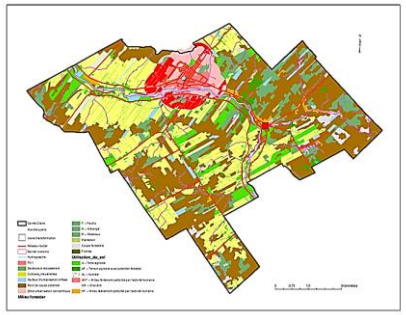
- Conceptual model:

1. Allow a hierarchical representation of the structures and the processes involved in the socio-ecosystem

2. Allow a better understanding of the stakeholder logic of action

3. Allow to better assess the scope of the decision to be taken

4. Conclusions

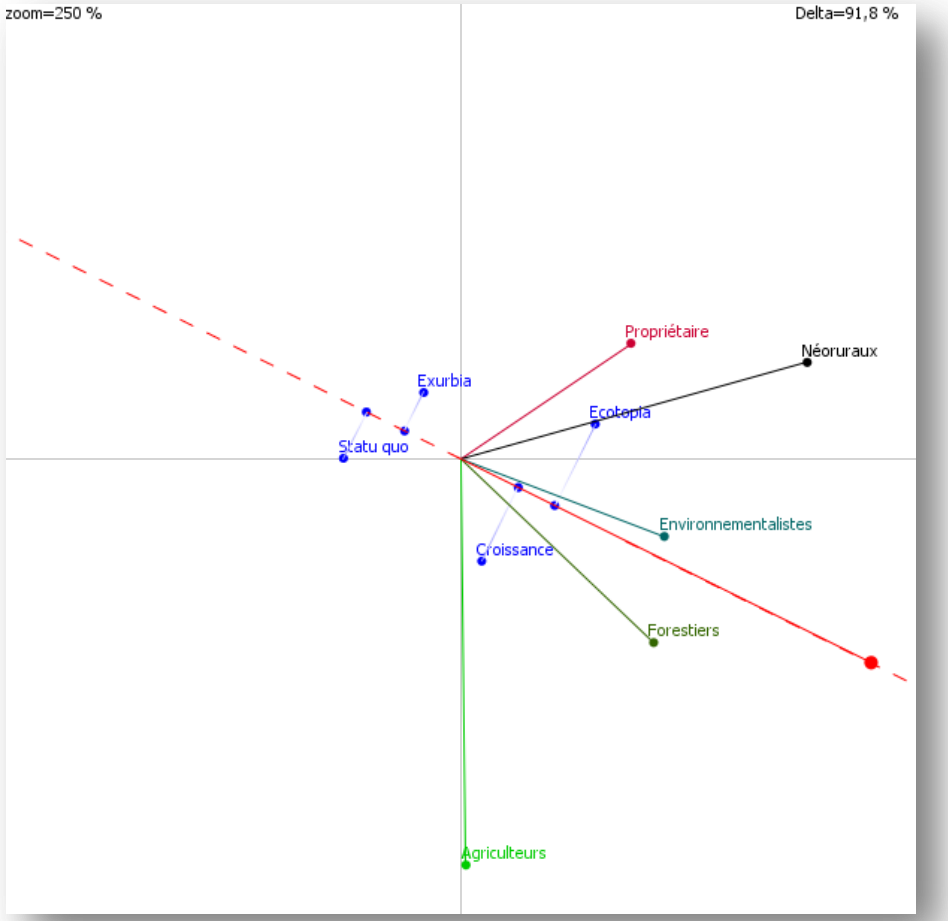


- Spatial model

1. Visualisation of potential futures to be chosen
2. Reducing the black box effect = more coherence, transparency and legitimacy
3. Perceptual criteria = link between the territory and the stakeholder, involved in the study of phenomena, lived experience and consciousness

4. Conclusions

- Decision aid model
  1. Allow prioritization of issues
  2. Adequate justification of the decision choice
  3. Stakeholder accountability



4. Future works….

- GIS and automata cellular
- GIS and multi-agent systems
- Immersive geovisualisation
- Modelling of socio-ecologic interactions

Thank you for your attention