

# **Evaluation by simulation of the social acceptability of agricultural policies for water quality**

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## **Abstract**

The Concert'Eau is a three years project launched in October 2006 to demonstrate the opportunity to involve agricultural actors of a territory to propose and apply new practices more in line with the need for preservation of water resources and natural environments. We present in this paper the sociological dimension of this multidisciplinary work, which focused on the evaluation of the social acceptability of these practices. This evaluation is based on the formalization of a well-experienced social theory, the Sociology of the Organized Action.

**Keywords:** modelling, meta-model, simulation, sociology of the organised action, concrete system of actions, social acceptability, agricultural policies, water quality

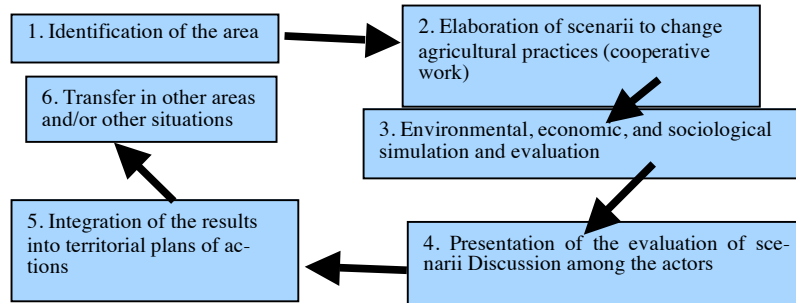
## **1 The Concert'Eau Project – The role of Sociology and Computer Science**

The observation of the degradation of water quality and aquatic environment in European countries, particularly in France, leads the European Union, through the Water Framework Directive (WFD), to settle policies to remedy this situation. Particularly, the observation that agricultural practices in use in European agriculture are an important source (about 60%) of pollution of surface waters leads the EU to plan the application of agri-environmental actions, within the framework of the reform of the Common Agricultural Policy. These actions, still voluntary, but sooner or later obligatory, will impose to the actors of the agricultural sector, rules of eco-conditionality likely to change significantly, even drastically, the practices and the agricultural economy.

The Concert'eau project - Collaborative technological platform for WFD implementation within agricultural context - (financed by the Life Environment European Program and by the Water Agency of Adour-Garonne) was launched in October 2006 for three years to demonstrate the opportunity to involve agricultural actors of a territory to propose and apply new practices more in line with the need for preservation of water resources and natural environments.

The project is organized around the main following phases (fig. 1):

1. Identification of an area; for the experimentation, the chosen area is the upstream part of the River Gers basin inside the Adour-Garonne River Basin District in the southwest of France which is classified like a nitrate vulnerable zone for several years.
2. Implication of the relevant actors of the eco-system and elaboration of alternative scenarii for agricultural practices. Thus, seventy persons representing about fifteen collective actors met them on the 4th of june 2008 and suggested fifty agricultural scenarii.
3. Evaluation of these scenarios through the simulation of the economical, social and environmental dimensions, according to the concept of sustainable development. These evaluations are conducted by scientists specialized in each of these dimensions
4. Back to the actors to discuss the scenarios from the evaluation results and negotiation on those emerging as the best ones for sustainable development; it took place on the 10th of december 2008
5. Definition of policies on the basis of proposals from the field
6. Transfer of the experience in other areas (the Navarre, Dordogne, Moselle departments).



**Fig. 1.** The process of the Concert'Eau project

On the environmental dimension, the evaluation consisted in simulating the effects of the proposed measures on the concentration of nitrogen molecules and pesticides in the surface waters of the Gers river and its affluents. The economists had to assess the potential effect of these measures on the working time of the farmers, on their gross farming income and on the direct cost for the community. The sociologists had to estimate the potential acceptability of each proposed measure for the whole system and just for the farmers (Vautier and Roggero 2008). We use a same integration tool<sup>1</sup> (Mulino 2004) to have a synthetic view of the simulation.

In this kind of projects, economic and biophysic aspects, which lead to quantitative studies, are generally put forward, while the sociological dimension is treated by informal indications. We think it can be one of the causes of the ineffectiveness of measures financed by the EU: if the social acceptability of the measures is not firmly established, it is likely that these measures will not be accepted by the actors in the field and therefore not applied. Thus, the originality of the work presented in this paper is to apply a rigorous theoretical and methodological framework to assess the social dimension of an environmental public policy.

We will only present in this paper this sociological work, performed with computer scientists. It is based on a well-known sociological theory, the Sociology of the Organized Action (SOA) (Crozier 1964) that we have formalized in a Multi-Agents platform, SocLab. In the Concert'Eau project, SocLab allowed to simulate the possible sociological consequences of any change in agricultural practices.

<sup>1</sup> Mulino (MULTisectoral INtegrated and Operational decision support system, or mDSS) is a software of multicriteria analysis which is able to integrate different kinds of data ; its aim is to support decision for the management of natural resources.

Therefore, the interventions of the sociologist gain in value by using a tool which is a “virtual laboratory”. The use of this tool has proved that it is possible to explore the social world with a complex eye in spite of the reduction made by the model and to help the social actors to deliberate and make concrete choices.

## **2 The formalization of the SOA and the SocLab platform**

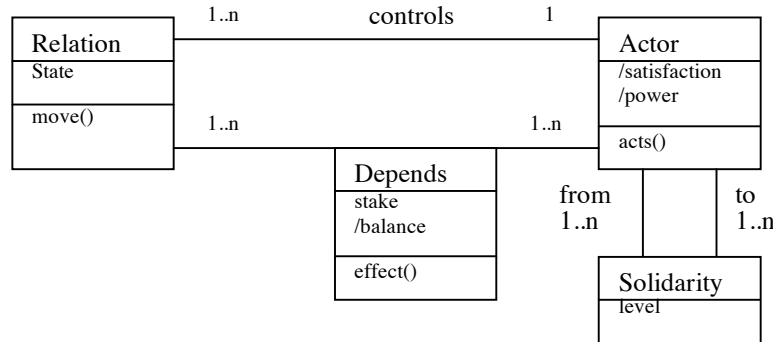
### **2.1 The sociological theory of organizations : The SOA**

The Sociology of the Organized Action (Crozier 1964 ; Friedberg 1993) is an operational and a potentially complex sociology (Roggero 2006), ie open to representations which are less reductionist than others. Moreover, this theory can be described in computer language; this allowed us to define an efficient and tractable model of organizations.

An other interest of this theory is to attract the researcher's attention to the informal components acting in an organization. If we are interested in the regulation of an organization, if we notice blocks when the organization is changing or when changes are only planned, because some actors reject these changes, this theory does not postulate that the actors are not clever, are reactionary or irrational (according to present-day canons: which clever actor could reject the change?). On the contrary, it postulates that the actors are perfectly rational when they reject some evolutions in the organization. Crozier defines the organization like « a complex set of intersected and interdependent games through which persons, often provided with very different assets, seek for maximize their gains, respecting the rules of the game which are not written and are imposed by the environment, taking systematically advantage of all their assets and seeking to minimize those of the others (...). The aim is not to remove power relations – which is an impossible and unproductive task – but on the contrary to recognize them in order to regularize them and to force the partners to directly trade, ie to communicate » (Crozier 1964). These intersected and interdependent games take place in so called Concrete Systems of Actions (CSA) which can be defined, in a given organizational context, as sets of actors and their alliances, their relations and the regulation of these ones. A CSA is then an interaction context which is quite precisely delimited and structures the cooperation between a well-defined set of actors, in a certainly restricting way but without depriving them of room to manoeuvre.

## 2.2 The formalization of the SOA: a meta-model of social organizations<sup>2</sup>

The figure 2 represents the architecture of the meta-model of a social organization, including the relevant Actors and Relations.



**Fig. 2.** The UML meta-model of social organizations

Various actors operate on each *Relation*: one controls it while other ones are dependent on it. The *Actor* who controls a *Relation* defines its *State* inside a space of choices.

While fixing the *State* of a *Relation*, the *Actor* who controls this *Relation* decides how the *Balances* are distributed between the *Actors* who are dependent on it; the *Balances* are calculated with an *Effect function* which defines, for each *Relation* and each *Actor*, the *Balance* received by this actor according to the *State* of the *Relation*. The state of relation corresponds to the behavior, more or less cooperative, of the controller-actor in the management of the *Relation*, while the *Balance* for an *Actor* corresponds to his resulting possibility to use the *Relation* to achieve his goal. The SOA postulates that any *Actor* in an organization has some room to manoeuvre and he exercises it through the *Relations* that he controls. In this way, we deny any person or collective who can not control any *Relation*, the status of *Actor*.

Considering that an actor is strategic comes down to attribute to him a purposeful behavior, ie « motivated by an aim, without more specify the nature of this aim or motive » (Friedberg 1993). This aim leads him to play with the relations that he controls in order to obtain from the other actors the means to achieve his goals. Each of these relations has more or less value for him; it is what the concept of *Stake* expresses: the more the rela-

<sup>2</sup> See (Sibertin-Blanc and all 2006) for more details.

tion is necessary to reach the aim and the more the aim is important for the actor, the more the *Stake* is high.

In addition, each actor may have some solidarities with others which intervene in his evaluation of his situation. Solidarities can be positive or negative according to the effective convergence or divergence of interests

As a result of such a model of an organization, any state of an organization provides each actor with an amount of *Satisfaction*, which corresponds to the extent of his capacity to achieve his goals. The SAO considers that the behavior of social actors is dictated by the search of a “high enough” level of satisfaction. The *Satisfaction* of an Actor  $a$ , when the organization is in a state  $e^3$ , is defined as:

$$Satisfac(a, e) = \sum_{b \in A} solidarity(a, b) * \sum_{r \in R} stake(b, r) * effect_r(b, e_r)$$

The dual concept of satisfaction is the *Power* of an actor, that is to what extent he contributes to the satisfaction of others. Social actors exercise their power on others in order to get a good satisfaction in return. The *Power* is defined as:

$$Power(a, e) = \sum_{r \in R; a \text{ controls } r} \sum_{c \in A} \sum_{b \in A} solidarity(c, b) * stake(b, r) * effect_r(b, e_r)$$

### 2.3 The SocLab platform

On the basis of this meta-model, we can construct models of social organizations. To support it and also to simulate the behavior of a social organization, we have developed a Multi-Agents platform, SocLab.

SocLab allows to describe the relevant organizational actors and relations, to give them features (which resources do they control?, which stakes and solidarities?), to provide actors with an appropriate way to search for the more suitable behavior and to make emerge by simulation a regulation of the system, that is a state of the organization in which each actor is satisfied by the behavior of others.

SocLab allows also to compute notable states of an organization with regard to the satisfactions of actors such as Pareto equilibria, Nash optima, the maxima or minima of satisfaction of a specific actor, or of the total satisfaction of all the actors. Then, the regulation state provided by the simulation may be compared with these notable states.

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<sup>3</sup> The state  $e$  of an organization is defined by the *States* of all the *Relations*.

### 3 Using SocLab in the Concert'Eau Project

Using SocLab in the Concert'Eau Project features two major differences with the models we had realized before.

On the one hand, the modeling concerns a real empirical case, ie it was not a case from the organizational literature but a case from the ground, not yet explored by the SOA. In accordance with the sociological doing, we have adapted the investigation methodology to the meta-model. We can not explain here in detail all of this methodology; we only say that, according to data from the ground, we have built a system which is composed by eight relevant collective actors; each one controls a relevant relation, ie a relation upon which other ones have well-defined stakes.

On the other hand, it was not a formal organization with well-defined frontiers (defined in a consensual way by the main actors and observers) but a diffuse system of action gathering a great amount of actors, actions, relations, strategies and a wooly frontier. Taking exhaustively all of them into account would have resulted in a model not very readable; especially, the differences of the results between the actors should have been too low to be significant. However, the necessary limitation of the number of actors requires to make choices which may seem drastic but which oblige to tighten at the most the model, ie to consider the main parts of the system. The actors who were considered in the Concert'Eau model are really the ones who, according to experts who know the environment and according to the interviews, are fundamental in the regulation of the organization.

The system is composed by eight relations and eight actors. We have decided to provide each actor with the control of a single relation which seems to be major means of his influence:

- Financing of the various projects related to agriculture and water, controlled by the Water Agency.
- Cofinancing (often, a financing is only possible associated with a cofinancing), controlled by the Regional Council.
- Data, which are the basis of the public policies, private actions (agricultural cooperatives, associations) but also of the objections of the established order; these data are very sensitive and are the center of a very affirmed struggle between the actors; they are controlled by the technical and scientific institutes.
- Consulting for the farmers concerning their technical route - the dates of ploughing, of seedling, of manuring, the doses of products to spread, and so on. - which is normally given by the Chambers of Agriculture and may be delegated (as in this case) in more or less large part to other actors like the agricultural cooperatives (who are thus product advisers,

prescribers and sellers). Nevertheless, in the model, it is controlled by the Chamber of Agriculture because officially it is the center of its activity.

- Majority lobbying led by the so-called conventional farmers who are represented by the local units of the « FNSEA<sup>4</sup> » (or of the « CNJA<sup>5</sup> » ): the cooperatives, the Chamber of Agriculture and mainly the conventional farmers are the actors of this lobbying
- Anti-establishment lobbying, led by natural farmers and the environmental associations, and opposed to the majority lobbying; for example, the GMOs are supported officially by the Chamber of Agriculture in its newspaper « La volonté paysanne » and refused vigorously by the anti-establishment lobbying.
- Legal inspection, which is exercised by the decentralized governmental services: the DRAF and the DDAF (Regional and Departmental Directions of the Agriculture and the Forest) and also the ONEMA (National Office of the Water and the Aquatic Environments)
- Interface: the agricultural cooperatives have direct relations with the farmers and constitute a kind of interface between farmers and other actors.

We have put together the information which has been collected during the ground investigation (tables 1 and 2):

**Table 1.** Stakes (in **bold** for actors-controllers of the resource)

	Water agency	DRAF DDAF	Region. Concil	Chamber of Agri. Agri.	Tech. coop.	Tech. Instit.	Conv. farmers	Natural farmers
Financing	<b>4</b>	3	2	1	0	1.5	2.5	0.5
Cofinancing	2	1.5	<b>4</b>	1	0	1.5	1	1
Data	2	2.5	1.5	1	1	<b>3</b>	0	0
Consulting	0	0	0	<b>2</b>	2	1	1.5	1
Majority lobb.	0	0	0	2	3	0	<b>2.5</b>	1
Anti-establish. lobbying	0	0	0	1	0	0	0.5	<b>3</b>
Inspection	2	<b>3</b>	2.5	1	1	2	1	2.5
Interface	0	0	0	1	<b>3</b>	1	1	1

The sum of each column must be equal to 10

<sup>4</sup> « Fédération Nationale des Syndicats d'Exploitants Agricoles » which is the french national federation of farmers unions

<sup>5</sup> « Centre National des Jeunes Agriculteurs » : National Center of Young Farmers



**Table 2.** The solidarities between actors

	Water agency	DRAF DDAF	Region Concil	Chamber of Agri.	Agri. Coop.	Tech. In-stit.	Conv. farmers	Natural farmers
Water agency	0.8	0.15	0.15	- 0.2	- 0.2	0.5	- 0.2	0
DRAF/DDAF	0.2	0.6	0.05	0.05	0	0.1	0	0
Region. Concil	0.2	0.25	0.8	- 0.25	0	0	0	0
Chamber of Agri.	0.1	- 0.1	- 0.1	1	0.2	0.1	0.2	- 0.4
Agri. coop.	0.2	- 0.1	0	0	0.8	0.2	0.2	- 0.3
Techn.instit.	0.1	0	0.1	0.1	0	0.5	0.1	0.1
Conv. farmers	0.1	- 0.1	- 0.1	0.3	0.15	0.2	0.8	- 0.35
Natural farmers	0.15	- 0.15	0.15	0.2	0	0	- 0.35	1

The table has to be read by row (for example, the solidarity of the Water agency for the DRAF is 0.15). The sum of each row must be equal to 1.

## 4 Results

On the basis of this model of the system of action focused on the impact of agricultural practices upon the quality of water, we can obtain results about the current situation and deduce an evaluation of the social acceptability (or feasibility) of the measures and scenarii proposed by the actors.

### 4.1 Simulation results about the current situation

The simulation module of SocLab calculates the levels of satisfaction and power of each actor, when the game is regulated (table 3).

**Table 3.** Actors' satisfaction and power at convergence

	Water agency	DRAF DDAF	Region. Concil	Chamber of Agri.	Agri coop.	Tech. In-stit.	Conv. farmers	Natural farmers
Satisfaction	68.4	50.7	61.4	71.4	78.1	52.0	72.0	38.0
Absolute power	146.6	41.5	74.2	25.0	65.1	141.8	101.7	56.5
Cooperative power	144.2	27.5	74.2	7.9	40.0	141.8	55.4	0.9

A value has to be read in relation with the others on the same row (for example, the satisfaction of the AEAG is greater than the satisfaction of the natural farmers).

The agricultural cooperatives, the Chamber of Agriculture and the conventional farmers are the most satisfied actors, while the natural farmers are the less ones. This situation is not surprising in a system which operates on a relative *statu-quo*: the domination of a productivistic concep-

tion of agriculture, combined with the habit of being subsidized to reach quantitative aims as well as to modify at the margin the practices. On the contrary, there is an apparent paradox that the more powerful actor is the Technical Institutes (apart from the Water Agency which is the main financier outside the European Union). But, if we consider that the data concerning the water-agriculture relation is subject to closely argued and recurrent fights between the actors, it is not surprising: some of them denounce constantly its unavailability, inaccuracy, even its no sincerity.

The table shows also two kinds of powers: the absolute and the cooperative powers. The cooperative one is the (sum of the) positive contributions of an actor to the satisfactions of others; the absolute one is the absolute sum of all his contributions. The study of the differences between these two powers shows that some actors are very cooperative while others are not. For example, the AEAG, the Regional Council or the Technical institutes are very cooperative (according to their function in the organization or their own interest) while the Chamber of Agriculture is not very cooperative (according to its lobbying activity). The conventional farmers, like the natural ones, are also not very cooperative but for different reasons: the first ones are allied to the cooperatives and the Chamber of Agriculture; they compose an agricultural oligopoly which keeps a leading power (if we add the powers of the three actors) and are more concerned with self-interest than cooperating. The natural farmers consider that they are isolated and that no other actor can (or wants) to embrace their cause.

These comments show that the results generated by SocLab allows interesting interpretations of the CSA, highlighting some facts that could be remained unseen.

## **4.2 Evaluation of the social feasibility of the proposed measures**

The *Life Environment* contract was to evaluate the social acceptability of the proposed measures for all the societal system and for only the farmers. We have analysed this acceptability as a feasibility – to what extent is it possible that the system finds a new regulation if these measures are adopted?

The starting point was the satisfactions at the current situation (table 3) given by the simulation. We made a second investigation to evaluate, for the actors, the acceptability of each proposed measure in comparison with the current situation. Each actor gave a mark to each measure: 5 for neutral, between 5 and 0 for negative (0 for very opposed to the measure), between 5 and 10 for positive (10 for very enthusiastic).

We have weighted the satisfactions given by the simulation with these marks to obtain the satisfaction of each actor for each proposed measure.

Moreover, the increase or decrease of satisfaction is not equivalent for all the actors: an actor with a high level of power and a significant increase (resp. decrease) of satisfaction will have the capacity to favor (resp. to block) the adoption of the measure, while a low-powered actor will not, or slightly. Therefore, we have merged the calculated satisfactions of each actor with his relative powers. Thus we have obtained what we call the feasibilities of each measure for each actor.

For each measure, we add up the feasibilities for all the actors to obtain the feasibility for all the societal system and the feasibilities for the two kinds of farmers to obtain the feasibility for the farmers (table 4).

**Table 4.** Feasibility of each measure  $m_i$  for all the societal system and just for the farmers<sup>6</sup>

	current	$m_1$	$m_2$	$m_3$	$m_4$	$m_5$	$m_6$	$m_7$
System	457	468.1	476.2	494	511.4	483	459	501.1
Farmers	90.5	60.3	60.3	90.5	98.2	96.3	88.5	114.6

The first column (“current”) gives the (sums of) satisfactions at the current situation. Then, we can compare the feasibility of each measure  $m_i$  with it. For example,  $m_1$  and  $m_2$  are not favourable to the farmers (60,3 is smaller than 90,5).

These feasibilities are injected in a tool, Mulino (Mulino 2004), which integrates the results of the environmental, economic and sociological dimensions. This allows the policy makers to have the position of each measure in the sustainable development triangle.

## 5 Conclusion

In theory, the models for sustainable development give an equal importance to the economic, environmental and social dimensions. In practice, little attention is paid to the social dimension and, as a foreseeable consequence, many public policies are ineffective to change the social practice toward the desirable direction. This lack of attention to the social dimension is due, to a large amount, to the informal and subjective nature of the results provided by sociological studies; they do not features the properties

<sup>6</sup> The table is an extract of the 35 proposed measures.

of scientific knowledge, and they are difficult to merge with the results provided by economics and environmental sciences.

In this paper, we have shown how, using a formalization of a well-experienced theory of social organizations, it is possible to provide reliable results that can be merged with results of others sciences. These results are gained by simplifying the complexity of social phenomena, but we believe that they caught the essence that what happens in organizations. Otherwise, some developments are in progress in SocLab to study other organizational issues, and our methodology needs to be experienced with other cases to become firm.

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