A New Institutional Approach of Resource Use Conflicts: The Case of Poitou-Charentes

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Abstract

New Institutional Economics, based on the Coasean comparative approach, offers a highly useful framework for research on environmental problems. We propose a tentative analytic framework for environmental problems and we try its heuristic power by first applying it to the Poitou-Charentes region, which encounters problems of negative externalities concerning its water resource. We can thus identify the characteristics of this environmental issue through the lens of the transaction costs theory. Finally, we draw conclusions about the relative efficiency of the various governance institutions potentially available to deal with the problems of externalities in the area in question.

Keywords

Environmental problems, the Poitou-Charentes region, New Institutional Economics, Transaction Costs.

JEL Classification

Q25, D62, D78

1. Introduction

Today, many areas are affected by coordination problems involving agents or groups of agents with respect to the use of localised resources, problems which can lead to resource use conflicts. These problems and their resolutions are usually analysed within the theory of externalities, especially through the opposition between Pigou (1932) and Coase (1960). We argue that New Institutional Economics, based on the Coasean comparative approach, offers a highly useful framework for research on environmental problems. This alternative approach, regarded as complementary to the theory of externalities, studies a continuum of arrangements, whereas Welfare Economics is only focused on the Market versus State opposition. In these alternative works, the emphasis is laid on the analysis of the features of environmental goods through the lens of Transaction Costs Economics.

Using this framework, we are able to discuss the relative efficiency of the different institutional alternatives.

The first contribution of our communication consists of a literature survey of several attempts to apply New Institutional Economics to environmental problems (Déprés, 2006 ; Bougherara *et al.*, forthcoming ; Richman and Boerner, 2006 ; Grolleau and Salhi, 2009). Starting from insights from Coase and Williamson, these works extend Transaction Costs Economics to other kinds of transactions such as externalities problems, by bringing out their latent contractual features (Williamson, 2002). Thanks to our literature survey, we insist on implications of applying this theoretical framework to the analysis of environmental problems, and more especially we underline the fruitfulness of the approach developed by Grolleau and Salhi (2009).

The second contribution consists in testing the heuristic power of this latter proposal through an empirical study of the French administrative region of Poitou-Charentes, which presents an important conflict with regard to the water resource between various agents and economic activities, especially farmers and shellfish farmers. This particular environmental problem, examined in Transaction Costs Economics terms, allows, on the one hand, to go one step further in the analysis by studying the role of other attributes of environmental transactions, not integrated by Grolleau and Salhi (2009), and on the other hand, to justify state intervention thanks to this "extended" typology of attributes, given the features of environmental problems regarding the water resource in Poitou-Charentes.

We first survey a number of attempts at applying new institutional approaches to environmental problems. We demonstrate the relevance of the approach developed by Grolleau et Salhi (2009), and from these works, we propose a tentative analytic framework for environmental problems. We then try the heuristic power of this framework by first applying it to the Poitou-Charentes region, which encounters problems of negative externalities concerning its water resource. We can thus identify the characteristics of this environmental issue through the lens of the transaction costs theory. Finally, we draw conclusions about the relative efficiency of the various governance institutions potentially available to deal with the problems of externalities in the area in question.

2. A tentative analytic framework for environmental problems

2.1. Application attempts

We can list several attempts at transposing the new institutional comparative method to environmental problems in a context of negative externalities, taking into account the specific characteristics for each of the transactions analysed.

Lévêque (2000) mentions that the "institutional analysis toolbox for approaching the issue of environmental regulations is empty in comparison to that available for answering the industrial 'make or buy' question, as developed by Williamson (1975). So it appears that the methodological orientations proposed by Coase to determine solutions for nuisance reduction have remained no more than mere general principles"*(our translation)*. As a result, several authors put forward the relevance of the transaction costs approach (TCA) for the analysis of environmental problems

(Richards, 2000 ; Paavola and Adger, 2005). But few of authors have actually tried applying Coasean insights through the development of a transactionalist analysis of environmental problems.

Transaction costs are usually disregarded in environmental economics because, as McCann and Easter (1999) put it, "Environmental policy studies usually implicitly or explicitly assume that transaction costs are negligible or that they differ little between policies". But integrating transaction costs into the analysis would allow to complete, and even modify, results regarding the determination of the most suitable instruments to deal with phenomenons of externalities. Comparing different institutional arrangements would thus cease to be based on the principle of abatement costs minimisation only (Bureau, 2005), once the costs generated by the coordination between agents are taken into account. So, new institutional approaches turn out to be complementary to the theory of externalities. Integrating transaction costs into the economic analysis of the ways to regulate environmental problems allows to observe the relative efficiency of the different arrangements with a total cost approach, that is to say an approach which takes into account both the nuisance reduction costs and the transaction costs (McCann and Easter (1999). The integration of transaction costs thus means a real advantage for the organisation of the institutional arrangements into a hierarchy. To that end, McCann and Easter (1999), and McCann et al. (2005) have tried to improve the possibility of integrating transaction costs, by introducing cost typologies and methodologies for the measurement of transaction costs.

Environmental problems can be conceptualised as instances of interdependence involving the existence of transaction costs. So, the application of the transaction costs approach appears particularly relevant for analysing the choice of suitable ways to manage environmental problems. "Starting from this basic tenet of economics, transaction cost analysis can provide a refreshing way to evaluate alternative methods of resolving conflicting uses" (Bougherara et al., forthcoming). So just as the market-firm opposition can be examined in the light of the transaction costs theory, this theory can also be used to analyse various ways of dealing with negative environmental externalities. In the same way, Husted (2004) states that "Although environmental regulation has not generally been viewed through the lens of transaction costs, the logic is quite similar".

Our review of the existing literature leads us to observe that several application attempts (Déprés, 2006; Richman and Boerner, 2006 ; Bougherara et al., forthcoming) take as their starting point the Williamsonian approach, based on the principle of aligning governance institutions on the characteristics of a given transaction. The important thing is then to specify the attributes of the transactions examined, so as to appreciate the efficiency of the different governance institutions. The authors use all or some of the basic categories in Williamsonian analysis - namely frequency, uncertainty, and asset specificity - and redefine their role in the context of environmental problems. Using these notions for environmental problems analysis allows to take into account some contractual risks. The goal is then to identify the governance mechanisms that would offer the best management of these contractual risks : " the specificity of the physical and human assets combined with frequency and uncertainty determines the choice of efficient contractual arrangements" (Déprés, 2006) *(our translation)*. So, it is possible to choose between different instruments of environmental problem management using the criteria identified by Williamson.

However, as McCann et al. (2005) stress it, the commonly identified categories of frequency, uncertainty and specificity are not necessarily the most relevant when it comes to handling the issue of negative environmental externalities. As a result, some authors propose to use other parameters

than those of Williamson, so as to integrate the specificities of environmental transactions (Déprés, 2006 ; Richman and Boerner, 2006 ; Bougherera et al., forthcoming). They seek to identify the origins of transaction costs in the context of environmental problems as precisely as possible. Three main factors can be identified : measurement problems (regarding the origin of the nuisance and its consequences (Husted, 2004)), the number and heterogeneity of the agents, and the property rights on environmental goods. Most environmental problems actually involve a high number of different agents and are characterised by a lack of property rights on the natural goods at stake as well as measurement problems concerning the relations between man and nature. (Déprés, 2006). Depending on the relative weight of these different criteria, state intervention can appear more or less justified (Bougherara et al, forthcoming). On the opposite, transaction costs can sometimes be overcome by implementing innovative processes (Déprés, 2008). Analysing the organisational implications in the context of environmental problems through the lens of the transaction costs theory can thus help us draw conclusions about the presupposed efficiency of different ways of dealing with environmental negative externalities.

Bougherara et al. (forthcoming) encourage researchers to continue their work on the implementation of Williamsonian analysis to environmental problems. Further research is needed regarding the definition of an environmental transaction and the precise identification of the key-attributes and involved agents. We consider that the research conducted by Grolleau and Salhi (2009) answers some of these questions, as they go one step further in the implementation process by truly adapting the analytic framework developed by Williamson to the context of environmental transactions. They don't re-use the transaction dimensions exactly as Williamson introduced them, but take up the same approach, defining the environmental transaction with the use of several parameters. They establish a new typology of transaction attributes applied to environmental problems, in order to characterise environmental transaction as precisely as possible, and identify contractual risks, and in turn transaction costs. This typology can then be used to analyse a given environmental problem in a given area, and allows to compare the situations observed in several distinct areas. The authors have thus formalised the relationships between the level of transaction costs and the dimensions characterising an environmental transaction.

As the contribution made by Grolleau and Salhi (2009), regarding the application of the transaction costs approach to environmental problems, appeared to us to be particularly interesting, we decided to use the analytic framework they introduced, while proposing a few adjustments.

2.2. Proposed framework for the analysis of environmental transaction attributes

- ***Property Rights System***

Property rights are defined as codified relationships between people, regarding the use of things. The exchange of property rights implies setting up a whole property rights system (universality, exclusivity, transferability and protection). The rights are then precisely defined, at the quantitative, qualitative and temporal (duration) levels. Rights owners are recognised as such and their use of the rights is protected. The right of property enables to exclude all agents who do not own this right, and any violation is punished. Transferability enables the owner to transfer his rights, by selling or giving them, in part or in whole, to one or several agents. An incomplete property rights system causes an increase in the information, exclusion and negotiation costs. So, transaction costs imply an exchange between two (bilateral exchange) or several (multilateral exchange) agents that will be both more

complicated, and more expensive. Williamson has actually stated, regarding the extension of transaction costs approach to other fields of analysis, that weak property rights could play a similar role to that of asset specificity, by generating contractual risks (Williamson, 2005).
There are no property rights on environmental goods in France : "Natural areas, resources and habitats, as well as the vegetable and animal species in their diversity, and the ecological systems they shape, are all part of our communal national heritage. Protecting them, enhancing their qualities, and restoring them to their original condition are in the general interest (...)" (French Rural Code, Article L.200-1, our translation) Environmental goods are, in principle, non-excludable. But if an appropriation is feasible, rights of use can be defined, however incompletely so in most cases, owing to technical difficulties or costs. (Hagedorn, Artz et al., 2002).

- ***Uncertainty : Measurement Problems and Imperfect Information***

The inherent characteristics of the environmental problem, often in interaction with the measurement problem, and in relation with limited and asymmetrical information on the environmental resources and nuisance, all add up to create complex situations.
The characteristics of the nuisance can be more or less complex depending on cases. The characteristics are linked both to the origins and the consequences of the nuisance. The nuisance generated can occur at a distance from or some time after an agent's action. The nuisance can be generated by a combination of causes, that were not harmful when taken individually. Moreover, it can sometimes be difficult to clearly trace back the causal chain. A nuisance can be more or less reversible depending on the possibility to stop it and to make up for the prejudicial effects generated. It can be consciously generated by an agent or an economic activity, or only result from a joint effect. Finally, a nuisance can be quite clearly limited to a particular area, with no propagation to other environmental goods or to other areas, or on the contrary be scattered and hard to localise.

Technical measurement difficulties or problems of measurement costs can arise. These measurement problems can arise from difficulties to define and measure the potential connection between an activity and a nuisance, or difficulties to adopt a course of action, and to make sure the latter is enforced. It may also be difficult to assess the potential efforts made by an agent to reduce the nuisance, as the visible effects, or whose impact on the environment, can take some time to appear,and therefore will not be measurable in the short term. Williamson (1991) considers that the capacity to measure represents a major dimension in the transactions, just as important as asset specificity or uncertainty. Barzel (2004) indicates that measurement capacity is more operational and general than asset specificity. When a nuisance is easily identifiable, and measurable, legal responsibility can be established more easily and with little expense. On the opposite, when measurement is more problematic, state intervention is justified (Husted, 2004), because it allows to save money on governance costs[1]. Finally, measurement problems also mean an increase of control costs, that also justify the intervention of a centralised authority such as the State.
Environmental problems are often affected by uncertainty, owing to imperfect or asymmetrical information. Environmental goods are mostly non-commercial goods, so they are affected by an uncertainty regarding the demand for activities and the increase in value resulting from the

[1] The OECD (2001) states that in a number of cases "calling upon Command and Control type instruments is necessary. It is especially the case when technical problems or measurement problems make it difficult to permanently assess the environmental damage attributable to individual agents [...]", since this type of situation is characterised by important transaction costs.

economic development of these activities. Some agents, more often than not those at the origin of the nuisance, have informational advantages over the other agents involved, in particular those who suffer from the nuisance. These instances of information asymmetry can lead some agents to adopt an opportunistic behaviour and seek to draw advantages from the situation (Bougherara et al., forthcoming), namely by encouraging the establishment of institutional arrangements in their favour, or that put their competitors at a disadvantage. Moreover, agents that have an informational advantage can be tempted to falsify the information they possess. Finally, the courses of action carried out to reduce the uncertainty linked to environmental problems also generate costs.
All things considered, "the coordination of transactions affected by uncertainties [...] is provided more efficiently by regulating mechanisms than by competitive mechanisms, all other things being equal" (Déprés, 2006, our translation).

- ***Transaction Structure : frequency, number of agents involved, degree of heterogeneity***

With reference to the market structure, the transaction structure depends on the transaction frequency as well as on the number and the heterogeneity of the agents involved.
Since the characteristics of the environmental problem in question will have an impact on the transaction structure. The frequency of a nuisance (occasional, isolated versus recurrent, long-term) will have an impact on the frequency of the environmental transaction (low frequency for an isolated nuisance versus high frequency for a recurrent nuisance (Déprés, 2006 ; Bougherara et al., forthcoming)). The frequency of a given transaction will have a negative influence on the cost observed when using a governance institution. The number and heterogeneity of the transactants (within a group of transactants or between transactants) will have an impact on the transaction costs, and ultimately on the relative efficiency of the possible ways to manage the environmental problem.
So, if the nuisance is not very complex (for instance, in the case of an isolated nuisance, identifiable and localised), we can assume that there will be a relatively low number of agents involved. (Déprés, 2006). If only two agents are involved (or two groups dealing with one another), the transaction costs are reduced, so Coase-type bargaining can be considered, but a bilateral-monopoly-type configuration complicates the conclusion of the environmental transaction[2]. This "face-to-face" type of transaction is not the most common : in reality, most environmental problems are complex and involve a great number of economic agents that are legally autonomous, which leads to high transaction costs. Olson (1965) considers that transaction costs increase with the number of transactants. The configuration involving several transactants makes it more complex to find solutions, as the coordination problem is no more limited to a bilateral transaction. (Déprés, 2006) and Richards (2000) indicates that a negotiation becomes impossible. However, the more the agents involved will be able to group together, the lower the transaction costs will be. So, in the case of a great number of agents, which will make the intervention of a centralised authority more adequate, grouping together will allow to reduce the number of transactants, which will make it possible to reach contractual arrangements.
Transactants heterogeneity refers to the discrepancies between the agents, between their actions and between the technologies at their disposal. Williamson (1985) considers that the number and heterogeneity of the parties involved in a transaction will have a positive impact on the level of the

[2] A monopsony, i.e. one single buyer and many sellers, allows on the other hand to reduce transaction costs.

transaction costs. The risk of opportunism is then more important, so trying to reach a voluntary agreement will increase the costs (Ostrom, 1990). Déprés (2006) stresses that a situation characterised by a great number of highly heterogeneous agents can be managed by regulatory agreements. Finally, there is a connection between the agents' heterogeneity and their opportunity cost, since heterogeneity will mean different opportunity costs (i.e. what the potential transactants have to lose in the eventuality of the transfer not taking place). The agent with the highest opportunity cost has the most important incentive to solve the environmental problem, and can decide to solve it unilaterally.

- ***Asset specificity***

An asset is said to be specific when the investment for a given transaction cannot be re-deployed for another transaction without a high cost. Due to these costs, ending the relationship is not desirable for the investor.

If a specific asset is present within a transaction, it can be a cause of contractual risks, linked with the potentially opportunist behaviour of one agent, who will want to capture the quasi-rent derived from the bilateral dependency of such a situation.

Williamson makes a distinction between 6 types of specificity : site specificity (asset value based on its localisation and high relocation costs), brand names (intangible asset that increases an asset value), human asset (highly specialised skills and experience, and hard to redeploy on other activities), dedicated assets, time specificity (an asset is time specific if its value is dependent on production deadlines being met) and physical asset specificity (specialised equipment)...

Opportunistic agents may prefer their personal objective rather than the collective objective (risk of adverse selection), hence an increase in transaction costs.

The market provides an organisational structure that will have low costs in the case of non-specific assets. On the other hand, transactions involving highly specific assets will be managed more efficiently by an authority than by the market, through the minimisation of costs related to this type of contractual risks (Déprés, 2006).

Environmental Transaction Attributes (adapted from Grolleau and Salhi, 2009)

Structuring attributes of the environmental transactions	***Further information concerning attribute contents***
Property Rights Systems	Recognised, defended and exchangeable property rights
Uncertainty : Measurement Problems and Imperfect Information	- Degree of complexity of the environmental problem's characteristics (causes and consequences) - Measurement difficulties (technical feasibility, cost) - Uncertainty (imperfect/asymmetrical information, cost)
Transaction structure Market structure	- Transaction frequency (high/low) - Number of agents involved (high/low number, grouping of agents) - Heterogeneity of the agents involved (shared characteristics of the agents, practices, techniques)

Asset specificity	Different types of specificity : site, physical, brand names, human, dedicated assets, time.

Based on the analysis developed by Grolleau and Salhi (2009), we have highlighted the attributes enabling to identify the contractual characteristics in the context of environmental problems. We propose to try the heuristic power of this framework by applying it to a particularly conflictual territory, namely the Poitou-Charentes region, characterised by problems of negative externalities concerning its water resource. Grolleau and Salhi (2009) stressed the importance of carrying out case studies in order to further research the implementation of new institutional approaches in the case of negative environmental externalities.

3. A few determining facts about the territory of Poitou Charentes and its environmental issue

The overall water resource in France is abundant (internal resource of around 170 billion cubic metres per year, i.e. 2,800 cubic metres per person and per year). But this resource is not evenly distributed on the French territory and its level varies depending on the season, as do the amounts of water removed from it. As a result, some French regions can suffer from a shortage of water for periods of time of variable durations. This type of environmental problems also entails economic problems, given the water-dependent nature of a number of economic activities. In the Poitou-Charentes region, a quantitative pressure on the water resource is exerted during the summer months, precisely at a time when its level is by nature at its lowest. During that period, the need for water exceeds the territory's capacity to "produce" water, as the region is characterised by important problems in the management of its territorial organisation, with issues of competition and negative externalities, that can lead to resource use conflicts over water.

The Poitou-Charentes region is composed of four "départements" : Deux-Sèvres, Vienne, Charente, and Charente-Maritime (the only coastal département). Poitou-Charentes is a rural, attractive territory (7th most attractive French region (Décimal n°269, January 2007)), but offers a sharp contrast between its inland part, rural and sparsely populated, and its coastal edge, attractive and densely populated. The leading economic activities of the region all depend on the water resource (see the map in the appendix). Agriculture, located on the territory's higher lands, exerts both quantitative (due the volume needed for irrigation) and qualitative[3] (fertilisers and pesticides) constraints on the water resource. The regional turnover generated by irrigated maize is more than 160 million euro. The water resource is also an important asset in the Poitou-Charentes tourist attractiveness (Charente-Maritime shoreline and an overall 2,600 km of rivers). The turnover generated by tourism exceeds 2.5 billion euro, and Charente-Maritime is the second most important département in terms of tourist attendance. This high number of tourists also implies a high demand in drinking water during the summer months (the Charente-Maritime population is almost doubled in the summer, as a result of tourism). Moreover, tourist and leisure activities such as swimming or fishing require an acceptable amount of water. Finally, shellfish farming, in the downriver part of the region, does not abstract water, but is dependent on its quality and quantity. Two distinct types of shellfish farming can be noted : oyster farming and mussel farming. The Poitou-Charentes region is

[3] However, we will focus here on the qualitative pressures

the first shellfish farming region in France, and the Marennes-Oléron bay, to the south of Charente-Maritime, is the most important in Europe. Shellfish farming is a very specific activity of the region, although its turnover is less important (around 250 million euro).

We conducted an analysis of the regional economic activities and studied conflictuality on the coastline of Poitou-Charentes, based on two complementary sources : the Regional Daily Press, with an analysis of articles from the Charente-Maritime edition of the daily newspaper "Sud-Ouest" relating environmental resource use conflicts in 2005 on the one hand, and interviews of around thirty Poitou-Charentes agents (professionals, institutions, local councillors, members of associations,...) on the other hand. Our fieldwork enabled us to identify the various agents involved in the environmental problems posed by the water resource in the region. We can differentiate between two types of water-dependent uses : the use that actually removes water - such as the use in irrigated agriculture, the use for the supply of drinking water (SDW)[4], or less importantly the industrial use - and the use that does not remove water - such as the use involved in shellfish farming, the use of the ecosystem (the interests of which are defended by several associations dedicated to the conservation of the environment), and some tourist activities (canoeing for instance). Even though all these uses are linked with the problems of externalities regarding the water resource, the most important resource use conflict involves two groups of economic agents, namely farmers and shellfish farmers, as well as environmental organisations. So our study will focus on this particular resource use conflict.

The overall amount of water abstracted at the regional level amounts to more than 380 million cubic metres, 36% being taken from surface water, and 64% from groundwater. (Adour- Garonne and Loire-Bretagne Water Agencies, 2006). Owing to incentives from the CAP and local policies in favour of irrigation, the agricultural activity has by far the most significant impact on the water resource. It accounts for more than 50% of the water abstracted at the regional level, and comes before the household use (around 39%), and the industrial use (less than 7%). In Charente-Maritime, the only coastal département of the region, the agricultural use even accounts for up to 60% of the water abstractions.

Gross water abstractions by département and by use in 2006

Millions of cubic metres (% of the total)	**Household use**	**Agricultural use**	**Industrial use**	**Total**
Charente	29.71 (35.80 %)	36.64 (44.15 %)	14.64 (17.64 %)	82.99 (100 %)
Charente-Maritime	49.07 (35.71 %)	81.81 (59.53 %)	6.53 (4.75 %)	137.42 (100 %)
Deux-Sèvres	32.06 (51.17 %)	30.13 (48.09 %)	1.47 (2.35 %)	62.65 (100 %)
Vienne	38.38 (39.36 %)	55.81 (57.24 %)	3.32 (3.40 %)	97.51 (100 %)
Total for the Region	***149.21 (39.10%)***	***206.39 (54.09 %)***	***25.96 (6.80 %)***	***381.57*** *(100 %)*

Source : Adour-Garonne and Loire-Bretagne Water agencies

[4] The supply of drinking water (SDW) includes all the activities of water production. This water can be used for drinking, washing, cleaning, organic waste disposal, plant watering, as well as for private gardens and pets.

The volume of water removed for agriculture is even more significant in net value, when we consider that only 30% of that volume is released back into the environment, whereas the figure goes up to 76% and even 93% for the household use and the industrial use respectively. (L'eau et ses usages en Poitou-Charentes 2008). So, the net volume of water abstracted regionally adds up to 35.8 million cubic metres for the household use, 144.5 million cubic metres for the agricultural use, and 1.8 million cubic metres for the industrial use.

As regards agriculture, we can observe a fast increase in the overall irrigated land area from 1979 to 1992, and a relative stabilisation from 1993 to 2004. The evolution of the volumes taken for agriculture over the period is not representative as counting and reporting was only made compulsory in 1997. Irrigation is primarily reserved for cereals, and most particularly for production of grain maize[5] : the Poitou-Charentes region comes third in terms of irrigated land area[6] (behind Aquitaine and Midi-Pyrénées).

Understanding resource use conflicts linked to phenomena of negative externalities implies a questioning of the coordination quality between the economic agents involved. To that end, we chose to try the heuristic power of our analytic framework, by confronting the attributes of environmental transactions identified to the Poitou-Charentes features with the aim of observing the explanatory power of these variables, and the potential evolutions with regard to the level or the nature of these variables. Moreover, once the dimensions have been identified thanks to their impact on the level of transaction costs, we will be able to identify the governance mode suited for the management of the given environmental problem.

4. Application of our proposed analytical framework for the Poitou-Charentes region

4.1. Property Rights System

In the case of the water resource, the 1992 water Act states clearly that water is a common pool resource ("Water is part of the national shared heritage. Protecting it, generally enhancing it, and developing the resource that can be used while respecting ecosystems are all in the common interest" and "Water use belongs to everyone")(*Our translations*). The 2000 Water Framework Directive states that "water is not a commercial product like any other, but rather, a heritage which must be protected, defended, and treated as such. By nature, water is a collective resource that cannot be treated as private property"(our translation). So, national public waters belong to the State whereas non-public waters fall under the private rights legislation. Due to the collective function of water, the landlord, in the case of groundwater, or the owner of the river basin in the case of rivers, can use the water resource but this resource does not belong to them. Moreover, the administration restrains and regulates these water uses (Jegouzo, 2006). The 1992 water bill also lays down the general principle for authorising or declaring all abstractions of surface water or groundwater, whether it is returned or not, and the administration can quantitatively limit the rights of use to protect the common interest. Farmers have thus been given rights to use the resource, and

[5] Cereals : 91 % including 89 % for grain maize, 7 % for fodder (silage maize), and 2% for oil crops and protein crops.

[6] Agreste – ASP 2008. The Poitou-Charentes region produces 10% of the national grain maize production and is the second most important cereal producing region in France (2007).

the use of these rights by their owner is consequently legal. However these rights of use are reduced every year , in order to try and stop the imbalance between the use and the resource to be used.
In theory, there are no property rights on the water resource in Poitou-Charentes. In practice, because of their abstraction licences and their corresponding water quota, farmers have rights of use over the resource. But these rights are temporary, non-exchangeable[7] between users, and the volume of water is quantified but not guaranteed, given that the administration can decide to revoke the licence before "full use" of the quota (maximum quantity that can be abstracted, and not that is to be abstracted) has been made. The only uses to be "theoretically" guaranteed are, first, the use for the supply of drinking water, and second, the environmental use (minimum needs guaranteed when setting threshold values for a balanced management of the resource)[8].

4.2. Uncertainty : Measurement Problems and Imperfect Information

The aim is to draw conclusions about the level of knowledge on the environmental problem with regard to the water resource in Poitou-Charentes. We can differentiate between clearly identified elements, and uncertainty elements.

We already know that there are several distinct uses of the water resource, with different effects on the state of the resource (abstracting and non-abstracting uses, and varying volumes of abstractions). The majority of the abstractions are simultaneous and concentrated over a limited period of time, in the spring and in the summer, at a time when the level and the flow of resource are naturally at their lowest. Farmers and the supply of drinking water both need the most water during the summer months, for irrigation and to provide water to the tourists that flock to the Poitou-Charentes coastline respectively. This concentration of quantitative pressures leads to a concentration over a period of time of the damage actually done to the water resource and of the difficulties encountered by the resource-dependent economic activities. The geographical distribution of water abstractions in the region means a corresponding distribution of the consequences (not concentrated in a particular area), with peaks depending on the vulnerability of the resource and the level of abstraction.
Although the environmental use is considered a priority use, the threshold values set for an adequate resource management are exceeded every year in several areas, despite the implementation of restriction and banning measures, and this situation has a negative impact on the aquatic ecosystem. The environmental organisations denounce the impact that the abstractions - mainly of agricultural origin -have on the quantitative state of the water resource. They consider that the threshold values are not only far too often violated, but also that these values are too low to protect streams efficaciously (they accuse the administration of being too lax). In practice, the problems that arise include recurring drying-ups and river flow failures, low piezometric levels, the disappearance of marshlands and an increase in fish mortality. The fact that a vast part of the region is included in the Water Distribution Zone (where the water resource is insufficient with regard to the needs) underlines the recurring and chronic difficulties linked to the imbalance between the water resource and the needs.

[7] Impossible, because the licence is attached to the farmer's pumping facility. With the implementation of the single organisation, the exchange between farmers could be an option.
[8] Priority uses established following the Environment Code.

Values below the MALWL and CLWL in Poitou-Charentes since 1995

Number of nodal points (management key-points)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Minimum Acceptable Low-Water Level (MALWL) (monthly average) defined for 14 nodal points	6	7	3	8	3	3	5	6	9	7	10	7	3	2	7
Crisis Low-Water Level (CLWL) (daily average) defined for 11 nodal points	4	6	3	8	5	2	2	4	8	7	10	7	2	0	7

Source : DIREN, SPCA and SPCVT (data non available for 2 stations in 2006, and 1 station since 2007)

These difficulties are more important downriver, as the decrease in the river flows also impacts on the development and reproduction of coastal animals, as a result of a modification in the physical parameters, namely the freshwater input. Shellfish farmers, well-implanted on the Poitou-Charentes coastline, denounce the impact that the heavy quantitative pressures have on their production level. We can also add that the low level of groundwater during the summer months, increased by the importance of abstractions, can induce a decrease in the water quality, especially in the confined ground water used for the SDW, due to the pollution of free groundwater. This phenomenon can compromise the adequate supply of drinking water in the summer, at a time when the high number of tourists make this particularly important. Finally, a decrease in the streams' level has negative effects on the boating activities on the river Charente.

A decrease in the pressures on the resource allows to remedy some of the most visible damage done to the aquatic ecosystem, such as drying-ups and flow reductions[9]. But this type of damage has lasting effects on the aquatic ecosystem (species dying out, important growth of algae and phytoplankton harmful to the streams, impacts of high turbidity levels, effects on animal migrations, decrease in the groundwater levels and impact on the water quality...). Moreover, the disappearance of wetland is permanent and irreversible. Finally, given that shellfish production has a typical four-year production cycle, any negative impact on the production will last several years.

Clearly, Poitou-Charentes is characterised by both an incompatibility of uses and episodes of excessive water abstractions. Identifying the activities involved is easily done, but measuring (quantifying) the damaging effects and the exact responsibility of the users is far more difficult to achieve. The relationships between abstractions and resource level are complex and non-linear. The results brought about by practical evolutions are only measurable in the medium or long term, and contextual factors influence the results (precipitation level, soil characteristics). There is a lack of scientific knowledge regarding the hydraulic system, in particular the way ground waters work, as well as the link between the surface resource and the ground resource (uncertainty about the volumes actually available, the current and future recharging of these resources, the degree of resource vulnerability to a potential degradation). Nobody knows precisely what the adequate volume of water for the resource to be in a good state is. We can also point out uncertainties

[9] We can note that some streams have difficulties getting back to their "natural" hydrological régime.

concerning the added value for the water resource generated by the economic activities using this water.

The most publicised resource use conflict, between farmers and shellfish farmers, is based on a lack of scientific knowledge. Shellfish farmers invoke, as we have just explained, the impact of water abstractions on their production activity, but no scientific study has ever clearly identified the link between the resource in freshwater and the level of shellfish production.

However, some improvements of the level of knowledge in Poitou-Charentes can be noted, concerning negative externalities on the water resource from a quantitative perspective. In the past, the water removed by farmers was not measured or reported, and it was impossible to localise and calculate the volumes of abstracted water. Today, every farmer that has been granted an abstraction licence is legally obliged to measure the volume abstracted with a meter, and report the data to the administration, so that the latter can verify whether the authorised level has been observed, and monitor the abstraction levels (global volume of water abstracted over a given period of time, rather than abstracted flows, leads to an uncertainty about abstraction distribution within a period of time). Moreover, The Regional Centre for Aquacultural Research and Engineering (CREAA in French) has demonstrated with the help of a probe located on the Charente river that the volume of water is stagnant, which proves the absence of any freshwater input downriver, what had always denied by the agricultural world. We can observe, in relation with knowledge improvement, a growing awareness among farmers of the impact their activities have on the ecosystem and the other water-dependent uses. Finally, to put a stop to the recurrent instances of below-threshold values, the administration is currently working, as part of the implementation of the Common Organisation for the Collective Management of Water Abstractions, on the assessment of the volumes of water that can actually be removed.

We can also indicate that it is not always easy to make a clear distinction between a problem of "sheer" uncertainty, and the exploitation of this uncertainty by the agents for their own ends, in order to undermine the potential negotiations.

4.3. Transaction Structure : frequency, number of agents involved, degree of heterogeneity

First of all, owing to the fact that most of the abstractions occurs at a time when the water resource is naturally at its lowest, quantitative problems around the water resource in Poitou-Charentes reach a peak every year during the high season. So, the question of managing this environmental problem is a recurrent one, hence a high frequency of transactions.

Then, if we look at the collectives present in Poitou-Charentes, the situation appears to be rather simple. We have already mentioned that there are three abstracting uses (agricultural, industrial, SDW) that generate a nuisance for the other uses (environmental "use", and shellfish farming). From the outset however, we can somewhat adjust this first general impression, for a number of reasons. First, though all these uses are legal, they have different "statuses". Two uses are considered as priority uses and are as such theoretically protected by the administration (SDW and aquatic ecosystem), so their needs are integrated into the calculation of the threshold values for the resource management[10]. The other three uses are pure economic activities, the water resource being

[10] The threshold values are established so as to guarantee that the needs of these two uses (supplying drinking water and maintaining a healthy aquatic ecosystem) are met before economic uses. The MALWL (Minimum Acceptable Low-Water Level) is the minimum value that guarantees that the needs for all uses are met, whilst maintaining a healthy aquatic ecosystem, 8 years out of 10. The CLWL (Crisis Low-Water Level) is the value below which the SDW and/or aquatic

a raw material for the production activity. Among the abstracting uses, only one is granted rights of use : agriculture. Shellfish farmers do not abstract water but they need it for their activity, and suffer heavily from the pressures exerted on the resource, because they are located downstream of the river Charente. As a result, shellfish farmers are highly vulnerable owing to both their geographical and institutional situations. Due to this disadvantageous position, the shellfish farmers' opportunity cost to tackle the problem of externalities is more important than that of the other agents. Second, the water consumption profile changes depending on the uses : farmers exert the most quantitative pressures on the water resource, and the difference with the other abstracting users is even more important when we think in terms of net abstractions, given the low volume of water released back into the environment by farmers, in comparison with the other users. In total, there are three sources of nuisance in Poitou-Charentes, but the quantity of the water abstracted varies dramatically depending on the use. There are also discrepancies between the three abstracting uses regarding the mode of abstraction : agriculture abstracts 81% from groundwater through pumping and wells, and only 13% from surface waters and 6% from hill reservoirs (Agreste, RICA 2007), whereas the SDW abstracts water primarily from groundwater and the industry mainly from surface waters. Finally, a vast number of agents are involved in these uses and consequently involved in the water resource issues at the regional level. The number of irrigating farmers comes close to 4,000, for around 15 industrial companies, over 450 water collection points for the SDW, and more than 1,200 shellfish farming companies. This high number of agents means a great number of abstraction points scattered all over the region[11]. The users have grouped together and formed collectives in order to defend their interests. As we can see, this finer analysis of the various Poitou-Charentes agents allows us to better comprehend the heterogeneity of the different collectives' situations.

Finally, if we now analyse the situation within the collectives themselves, we can also notice a strong heterogeneity, that has been increasing over the past few years. This can be explained by recent evolutions due to political pressures, at the European and national levels, social pressures (including social claims and the role played by the public opinion) and economic pressures, and these pressures increase the collectives' internal heterogeneity.

Shellfish farmers seem to offer a united front when seen from the outside. But internally, there are rivalries - linked to differences in the way the future of the profession is perceived - concerning the production activity itself as well as its spatial implantation. The first and oldest subcategory among the shellfish farmers tries to defend the age-old practice of producing on the foreshore, and the image of a traditional and natural product. This category is consequently highly vulnerable to the pressures exerted on the water resource, and finds itself in a situation of direct conflict with the irrigating agents. The other subcategory, younger and more innovative, tries to break away from the constraints weighing on the activity. It uses the most up-to-date innovations in shellfish farming, including "off-bottom culture on ropes" and controversial "triploid" oysters, and counts major entrepreneurs. So, an internal division is taking shape among shellfish farmers, with small structures that use traditional production techniques on one side, bigger structures open to shellfish farming innovations for intensive production on the other.

As for the agricultural world, it is undergoing an evolution that is the result of a twofold and relatively collective rising awareness. The first aspect of this awareness questions the image of agriculture that

ecosystem are at risk. While the SDW has been preserved these past few years, the aquatic ecosystem has suffered from water shortages, as the threshold values were crossed at several nodal points in the region.

[11] The regional land area adds up to 25,809 square kilometres and the river Charente, the biggest river of the region, is 381.4-kilometre-long, but as the crow flies, there is only 160 km between the source and the mouth of the river.

farmers want to offer to the other agents and more generally to society. The agricultural authorities have understood the necessity to show the public, and first of all the other regional and departmental institutional agents, that agriculture is changing its practices towards a greater respect of the environment. The second aspect is internal and less pronounced, due to the power struggles within the agricultural circle. We can witness the existence of segmentations within the profession concerning the productive adaptations and new approaches developed as a response to the water issue. In front of the growing weight of shellfish farmers, the increasing importance of environmental claims, and the internal dissensions over the agricultural production model, farmers can hardly stick to their line and further deny their responsibility on the state of the water resource, both quantitatively and qualitatively. They are evolving towards a more conciliatory attitude, and the agricultural collective appears far less homogeneous than what is was thirty years ago. The results brought about by these evolutions materialises in a variety of different productive configurations, and consequently different pressures on the resource.

The situation that we have explained speaks in favour of an analysis of individual cases so as to get a precise idea of the heterogeneity in productive configurations, and their impact on the pressures and dependence towards the resource.

4.4. Asset specificity

In Poitou-Charentes, the agents involved in the negative externality with reference to the water resource have made important investments in specific assets.

The SDW requires important investments for the construction of a number of pumping stations or water collection facilities. These investments have a dimension that is directly linked to tourist attendance (these investments must supply enough drinking water to a population twice as important in the summer as during the rest of the year). Consequently, the "profitability" of the investments made is highly subject to tourist attendance. The configuration of these facilities depends on the type and the location in which the abstractions takes place (surface waters or ground waters mainly), and these investments cannot be redeployed from one site to another in the event of an aquifer running dry.

Farmers have invested in real estate and in irrigation equipment that is adapted to their needs as well as to the configuration of the fields they farm and of their crops. As we can see, there is a site specificity since any relocation would be hardly feasible technically, and also very expensive for the farmer. Moreover, the farmers' needs for water are at its highest in the summer, due to the crops in progress and crop rotation. A shortage of water for a constant agricultural structure means a important financial loss and this loss cannot be compensated by a significant water input at another time of year, in the spring or the autumn for example. Drought episodes lead to a slower plant growth and reduce the leaf surface. Though some crops are capable of withstanding drastic water shortages with no effect on the yield, some others, such as maize, see their productivity plummet with the first water restrictions, all the more if the drought stress comes at a "critical stage" (essential in the crop cycle), the flowering stage in the case of maize. When a significant water limitation occurs in-between these critical stages, the consequences on the production are benign. The regional irrigating agriculture, primarily specialised in the production of maize, presents an important time specificity.

Shellfish farmers have also made significant investments in specific assets. They located their concessions granted by the Maritime Affairs. Moreover, the Marennes-Oléron bay, to the south of

the Poitou-Charentes region, is renowned worldwide for its specificity. So, the regional shellfish farmers benefit from this label's popularity (brand name specificity). Any attempt at relocating would have an enormous impact in terms of costs and would be almost impossible to achieve, since ,first, their activity requires a location offering a strict mixture of freshwater and salt water, and there are only a limited number of shellfish farming concessions in France, and second, any relocation of the production would mean losing the Marennes-Oléron label. For these reasons, shellfish farmers are in a situation of geographical lock-in. Finally, once again, the shellfish farmers that have kept to the traditional production mode have needs for freshwater at key stages during the production cycle (for reproduction and fattening), as oysters and mussels need a strict mixture of freshwater and salt water in the spring and in the summer, otherwise their vital process is compromised. But the significant upstream water abstractions during that period means a reduction in the freshwater available in the estuary, and as a result impacts negatively on the shellfish production. And once again, a significant freshwater input at other periods of the year has no compensating effect on the production but is actually harmful (the important discharge of freshwater by farmers in the winter is also negative for the shellfish production).
Finally, the water-dependent economic activities have developed skills specific to their production. Re-deploying these skills would be complicated and have a cost, in the event of the employees having to stop their economic activity and start a radically different one.
So, both collectives' activities are characterised by a site and a time specificity, and by a brand name specificity in the case of shellfish farmers. For this reason, the agents are in a situation of strong dependence to the resource.

We have just revealed, through the analysis of the various attributes of environmental transactions in the case of the quantitative water resource management issue in Poitou-Charentes, the origins of the transaction costs. We are now able to draw conclusions with regard to the management methods at our disposal in our case study.

Application to the case of water in Poitou-Charentes

Structuring attributes of environmental transactions	***Application to the case of the water resource in Poitou-Charentes***
Property Rights Systems	No property rights on the water resource owing to its communal nature. Rights of use granted to irrigating farmers, but temporary rights - non-exchangeable and not guaranteed. SDW use and environmental use are priority uses.
Uncertainty : Measurement Problems and Imperfect Information	- Different types of simultaneous uses, distributed over the territory, and several impacts. - Recurrent negative externalities with peaks concomitant with low-water period. - Negative externalities distributed over the territory with localised peaks depending on the resource vulnerability and the localised significance of the abstractions. - Geographical discrepancy potentially significant between "causes" and "consequences". - Some effects can hardly be remedied, if at all. - Nuisance and user responsibility measurement problems. - Uncertainty linked to lack of scientific knowledge about the aquatic ecosystem, the

	economic value of the resource and about the link between the water level and the shellfish production.
Transaction structure	- High transaction frequency due to recurrent quantitative difficulties. - Many agents involved, but some organised as collectives (farmers, shellfish farmers,environmental organisations). - Heterogeneity between the collectives due to different legal statuses and consumption profiles. - Increasing heterogeneity within the two main collectives involved (farmers, shellfish farmers) : diversity in the production configurations and consequently diversity of pressures on the resource and situations of vulnerability towards the resource.
Asset specificity	Specificity of SDW investments Site and time specificity for the agricultural and shellfish farming collectives Brand name specificity for the shellfish farmers ⇨ Strong dependence on the water resource

5. First results and implications

The analysis of the characteristics of the environmental problem concerning the water resource in Poitou-Charentes enables us to understand the relative efficiency of the various management methods potentially available.

Let us first of all remember that Coase states that a negotiation between the involved parties is only to be considered if information is perfect, transaction costs non-existent, and the property rights are established. On the contrary, if the property rights are incomplete or the transaction costs high, another solution should be preferred to a Coasian negotiation. Coase identifies several potentially available "management methods", and promotes the analysis of cases individually for the identification of the adequate management method.

The Poitou-Charentes situation is characterised by an absence of property rights on the water resource. Though the activities involved in the negative externalities are easy to identify, measuring the nuisance and the exact responsibility of users is complex to achieve owing to measurement problems and a lack of scientific knowledge. These uncertainties are sometimes exploited by agents for their own ends. The recurrence of environmental problems leads to a high frequency of transactions for the improvement of the state of the water resource. There is a high number of agents involved and they are distributed over a vast geographical area. They have different legal statuses, consumption profiles and abstraction modes. Several users made the choice to group together with the aim of better defending their interests, which means a reduction in the number of potential transactants. We can also observe a strong heterogeneity within the collectives involved, which leads to a diversity of production configurations and consequently a diversity of relationships with the water resource. Finally, the asset specificity entails a strong dependence of the activities with regard to the water resource. As we can understand, the complexity of the water resource environmental problem in Poitou-Charentes generates important transaction costs that prevent direct negotiations. All these elements add up to speak in favour of a management by the authority, such as state intervention, in order to better control the contractual risks implied by the externalities in question, and as a result minimise governance costs.

The State is considered as appropriate for the management of situations involving a high number of heterogeneous agents. Moreover, its high degree of administrative control enables to thwart opportunist behaviours, contrary to Coasian-bargaining-type, decentralised solutions. It is appropriate for transactions affected by uncertainty and involving specific assets. Finally, it allows to reduce the costs generated when looking for agreement, as compared with a decentralised solution.

This "conclusion" regarding the way of managing the environmental problem studied corresponds to what has been implemented in Poitou-Charentes. The water resource is now mainly managed through the implementation of volumetric monitoring[12], with strong state intervention and control. According to Richards (2000), "Where transaction costs are high because of asset specificity, uncertainty, and obstacles to measurement, the government may choose to use one of the instrument under which it retains discretion".

This management mode consists in granting a general volume (maximum authorised volume) to each irrigating farmer for the whole duration of the irrigation season (in most cases, from mid-June to mid-September). This volume is established by taking into account the farms' characteristics : the irrigated land area declared and the reference volume (volume per hectare needed to meet the needs of cultivated plants). The irrigation season can be divided into several periods, and with the aim of respecting the MALWL for the different nodal points, the general volume is distributed over the periods depending on the maize growth stages. Threshold values are determined for each nodal point and allow to monitor the state of the water resource. When the thresholds are reached, the authorised volume of water is reduced, or even cancelled. The irrigating agents have to report the abstracted volumes and the water police can control them during the irrigating season.

Though the question of volumetric monitoring efficiency in Poitou-Charentes would require further investigations, this management method seems to be efficient at first sight : first, the volumes abstracted by farmers stabilised to some extent between 2000 and 2004, and decreased by more than 18% from 2004 to 2006, and second, the irrigated areas decreased by 9% between 2004 and 2005, and by 20% between 2005 and 2006. Farmers have turned to less water-dependent crops (wheat, and in smaller proportions oil seeds as well as temporary meadows) and are questioning their irrigation practices. However, the question of the role of volumetric monitoring on the evolution of agricultural behaviours deserves an in-depth study through an analysis of other variables that could be an influence on agricultural behaviours, and in order to predict the future trends in the evolution of agricultural water abstractions. This is important, because though the reduction in the abstractions is already visible, the effects on the environment have no yet been observed (for example, no convincing evidence of a reduction in number of nodal points to have crossed the MALWL and CLWL since 2000), so it relevant to try and predict the evolutions in the agricultural behaviours (the decrease in agricultural water abstractions observed may continue or only be temporary).

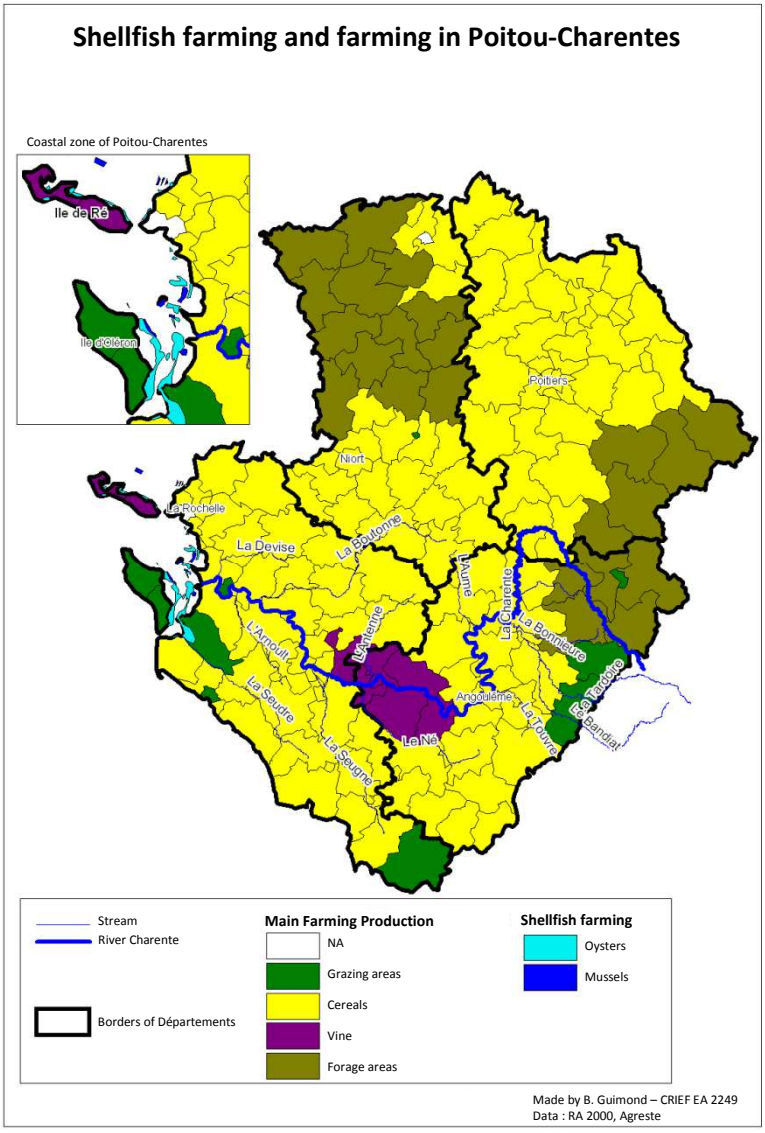
So, even though volumetric monitoring seems to have acted as an incentive in the reduction of irrigated areas and abstracted volumes, the threshold values for water resource management are reached every year, requiring crisis management to be deployed every year, when it should be exceptional. This situation does not allow to meet the quantitative balance target introduced by the Water Framework Directive and the 2006 Water and Aquatic Ecosystems Bill. To reach this target, a Common Organisation will be created in the relevant zones. The abstractable amounts will then be

[12] Implemented for a few catchment basins in the mid 1990's, but structuring character since the 2000's.

determined according to the ecosystems' needs and not according to the users' needs as used to be the case. Moreover, these abstractable volumes, called "ecological volumes", will be estimated for each basin, and the common organisation will be in charge of the distribution between users for each basin.
The measurement of the efficiency in the state management of externalities regarding the water resource in Poitou-Charentes deserves to be continued and further researched, all the more so if we consider that the problem lies not so much in the elaboration of rules as in the enforcement of these rules.

These first results lead to two other avenues of research. First, we can concentrate on the options available for the agents facing problems of externalities, with the aim of identifying more precisely what courses of action are available for the State. For this, we emphasise the necessity to take the context into account, that is to say understand the agents' positions in the physical space, in the space of resources, and in the space of coordination schemes. We show the importance of carrying out an in-depth analysis of the logics at work within and between the collectives of agents, of the systems of interdependence in which they are placed, and of the conflicts that divide them. Second, it appears relevant to analyse the evolution and the modes of evolution in the agricultural practices in the wake of the implementation of water management rules by the State, rules that have a restricting effect on the production activity. This allows us to analyse and compare the relative efficiency of the measures potentially available in a given territory. By doing so, we question the economic efficiency of the adopted behaviours, for the professionals on the one hand, and for the territory on the other. An in-depth analysis of the agricultural system in the Poitou-Charentes coastal zone would also allow us to demonstrate the importance of heterogeneity in the practices and in the farmers' behaviours.

Appendix



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