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CONTRACTING FOR ENVIRONMENTAL PROPERTY RIGHTS: THE CASE OF VITTEL¹

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Abstract: Based on an authentic case of contracting for environmental property rights, our paper shows several implications of applying the Coase's propositions. The case study adds empirical content to basic transaction costs concepts by analyzing the design and implementation of a contractual arrangement between a pollutee –a bottler of mineral water Vittel– and several polluting farmers. We analyze the bargaining between land and water rights owners and the bottler Vittel to determine how transaction cost issues (valuation disputes, bi-lateral monopoly conditions, and third-party effects) were overcome and how they succeeded in contracting for environmental property rights. We provide several comparisons of the Vittel case with other similar cases, leading to generalizations and testable propositions for environmental rights negotiations.

Key-Words: Case Study, Contracting, Environmental Property Rights, Environmental-related transactions, Private arrangement, Vittel

JEL classification: H23; K32; Q15; Q25.

Contracting for Environmental Property Rights: The Case of Vittel

'Such studies would enable us to discover which factors are important and which are not in determining the outcome, and they would lead to generalizations which have a solid base. They are also likely to serve another purpose by showing us the richness of the social alternatives among which we can choose.' (Coase, 1974, p. 375)

'By analyzing the details of property rights negotiations, including the positions taken by the various parties, their characteristics, and the information available, one can determine why property rights emerge in the manner that they do.' (Libecap, 2002, p. 155)

1. Introduction

Established in 130 countries, Nestlé Waters² is the world leader in bottled water³. The bottler includes several famous brands such as Vittel and Perrier using one or a small number of very specific and geographically delineated springs. In the early 1970's, intensification of farming practices in the Vittel area, located in the French Vosges mountains, led to concerns about imbalances in the local ecosystem. More precisely, in 1988, the production unit of the bottler of mineral water Vittel⁴ noticed a quality deterioration in its mineral water, notably a slow but regular and significant increase in nitrates. The main cause was non-point source pollution from intensive farming practiced in the fields surrounding the Vittel springs, the so-called 'small Parisian basin' by analogy with the 'Parisian basin' well-known for its intensive agricultural practices. These upstream farmers (about 40 farmers for 3 500 ha) are mainly milk and cereals producers. In 1989, the whole turnover of agricultural activities in the catchment area was less than 2% of the turnover of Vittel, which is also a major employer in the area (1300 salaries) (INRA, 1997, p. 11). The dairy production is based on corn, which is considered as an important factor of nitrates increase (Deffontaines and Brossier; Perrot-Maître and Davis, 2001). The percolation of nitrogen runoff and intensive pesticides use affect the quality of the bottled water. Table 1 provides some technical data about this environmental problem.

Table 1. Some technical data about the environmental problem.

Catchment area	3500 ha
Number of concerned farmers in 1989-1990	37 farmers with a mean age of 40 years
Legal status of farms	70 % are individual familial farms

Vittel attempted several unsuccessful strategies to deal with this problem such as the use of regulatory pressures, meetings with officials of the Ministry of the Environment concerning significant changes in farming practices, collaboration with the Chamber of Agriculture⁵, purchase of fields and so forth. Therefore, Vittel turned its attention to research by contracting with the French National Agronomic

² Nestlé Waters was previously known as Perrier-Vittel, which was itself known before as the Société générale des eaux minérales de Vittel.

³ Vittel is one of the world's top ten best-selling brands and contributes highly to the reputation and financial results of Nestlé Waters. Key data of Nestlé Waters in 2004 includes: Sales: €5.2 billion; Estimated market share in value: 17%; Number of brands: 77 (Source: Nestlé Waters: <http://www.nestle-waters.com/en/>).

⁴ Hereafter, Vittel designates the Vittel Company, regardless of its formal name.

⁵ Established in 1924, the Chamber of Agriculture is a professional public institution representing farmers and rural interests.

Institute (INRA) for a specific research-action program, the so-called AGREV program⁶. Researchers from INRA were familiar with the local agriculture because of previous collaboration with farmers on agricultural extension issues (INRA). The question of Vittel was expressed as follows: "*What changes are required concerning farming activity, used on the site, and under what conditions in order to reduce the rate of nitrates found beneath the roots of cultivated plants and grassland, and to ensure that this rate remains below the limit of 10 mg per liter?*"⁷ (Deffontaines and Brossier, 2000). This question initiated a negotiated management program that led to a formal contractual arrangement between Vittel and farmers, in the way suggested by the Coase's seminal contribution (1960).

At first glance, the problem between Vittel and farmers was potentially very complex and likely to generate high transaction costs that could derail a Coasean solution. Nevertheless, these presumably high transaction costs were overcome and Vittel successfully contracted for environmental property rights⁸ with farmers. Our primary objective is to show how these two parties with conflictual interests and other stakeholders succeeded in contracting for environmental property rights. We show that a bargaining solution succeeded notably because (1) Vittel acted in innovative ways to reduce the transaction costs of bargaining, and (2) because the transaction costs were in fact sufficiently low compared to the overall gain resulting from the rearrangement. The case study adds empirical content to basic transaction costs concepts by analyzing the design and implementation of a contractual arrangement. We make use of detailed records –reports by INRA, academic papers, popular and technical press. These documents describe the bargaining history between Vittel and farmers as they negotiated over land use and property rights. Additionally, we did several interviews with key persons, i.e. some researchers (Marc Barbier, Eduardo Chia, Pierre Morlon and Philippe Pierre)⁹ from INRA who were actively involved in the process. These interviews make clear the bargaining positions, strategies and key issues of contention.

The originality of this paper is fourfold. (1) It considers the case of a non-point source pollution, i.e. intensive family farming practices in a well delimited area affecting the water quality of an industrial bottler. (2) It studies the whole process from the identification of the problem to the selection, design, implementation and running of a specific and partially self-enforcing solution, stressing the difficulties and costs encountered at each step. The contractual arrangement deals with environmental property rights but also attempts to 'lock' polluters into environmentally friendly practices. (3) It analyzes the precise nature of the compensation paid by the pollutee to polluters and subsequent implications. Indeed, the monetary transfers are found to mainly cover the short-term loss changes for which the contract is established. (4) The case of Vittel provides raw materials for confronting theoretical propositions and arguments with a real world situation. It makes also comparative evidence with other similar cases where there are potential contracting problems i.e. the Katell-Roc water bottler in Brittany experiencing water pollution and the Auxerre or Munich program to preserve its water quality. This comparison puts into relief which key transaction costs were sufficiently low to allow for successful contracting.

The remainder of the paper is organized as follows. Based on Coase's recommendations on the need to examine in detail the social alternatives to deal with an environmental externality, the next section answers the following question: why Vittel contracted with farmers? Section 3 analyzes the transaction cost issues, i.e. valuation disputes, bi-lateral monopoly and third party effects, that shaped

⁶ AGREV is the French acronym for 'Agriculture Environnement Vittel'.

⁷ While European regulation limits the maximum level of nitrates to 15 mg/l for mineral water for infant feeding, some countries impose a tough threshold nitrates level of 10 mg/l (INRA, 1997).

⁸ Property rights are social institutions that define or delimit the range of privileges that are granted to individuals or entities regarding specific assets. Such assets have multiple attributes and not all attributes are necessarily owned by the same person. The rights to attributes can be partitioned and reallocated on a temporary or permanent basis thanks to contracts (Libecap).

⁹ The views expressed do not implicate the interviewed individuals. Any error or misinterpretation is the sole responsibility of the authors.

the outcome. Section 4 shows how these transaction costs were overcome leading to the success of the Vittel bargaining. Section 5 exposes the Vittel bargaining and highlights the relevant features of this contractual arrangement. Section 6 provides an assessment of the arrangement. Section 7 considers the implications/generalizations for transaction cost economics that can be drawn from the case study. Section 8 concludes and highlights several exciting challenges for future research.

2. Why Vittel contracted with farmers?

According to the line of reasoning of Coase, we first identify the ‘richness of the social alternatives’ between which Vittel can *a priori* choose. Several factors stressed by Libecap (1989) – the great size of the anticipated aggregate benefits, the small number of implied farmers, their relative homogeneity and the relative balanced repartition of wealth under the considered property rights allocation – show that an institutional re-arrangement was very likely to occur. At first glance, five alternatives were at least considered by Vittel:

- (1) Vittel relocates its activity by choosing new and non-contaminated springs,
- (2) Vittel buys all the lands around the site (a kind of ‘quasi-integration’),
- (3) Vittel does nothing,
- (4) Vittel constrains farmers to change their practices by taking legal action,
- (5) Vittel achieves a contractual arrangement with farmers.

A closer analysis of the situation shows that the first four alternatives were prohibitively costly, making Vittel ‘prisoner’ to the last solution. (1) Relocation would cause Vittel to lose the worthy reputation asset tied with the location at Vittel and the right to label its water as a ‘natural mineral water’¹⁰ (Barbier, 2004). Note that in France mineral natural water must come from the same springs, while natural spring water can come from different springs, regardless of their respective locations.

(2) Because of the reluctance of several farmers and regulatory barriers aiming at preserving lands for agricultural activities, Vittel could not buy all the lands around its springs. One of the goals of these laws is to prevent the purchase of agricultural lands for non-agricultural uses. Moreover, even if it was possible to buy all the lands, Vittel does not have competences to manage the whole area and was not interested in making that. Nevertheless, such integration would have allowed Vittel to acquire at the same time the environmental property rights bundled with the land use. As developed below (section 4), the Vittel attempt to buy surrounded fields succeeded to some extent.

(3) The third alternative was also not suitable because the potential loss from doing nothing could be huge. Indeed, the market of bottled water is very sensitive to water quality. Indeed, in France and other European countries, one of the most powerful arguments of natural mineral water is their preservation from any pollution. Moreover, the main element, the nitrates rate is frequently discussed in popular press to denounce the quality of drinking water and constitutes in some cases, the most significant motive to switch to bottled water. Any presumption or doubt about the bottled water quality can make consumers switching to a rival product. Note that some rival brands e.g. Wattwiller, or Vernet label their bottled waters as ‘nitrates free’ or ‘zero nitrates’¹¹.

Let us assume that Vittel does nothing in order to prevent farming pollution. Consequently the nitrate rate increases continuously. Moreover, Vittel markets its water as high quality mineral water, beneficial for drinker health. Doing nothing and letting an increase in the nitrate rate will only be sanctioned within the terms of a certain probability. Thus, the opportunity cost of Vittel by doing nothing may be considered as the statistical expectation of a sanction $s = pL$, where p is the

¹⁰ In France, Vittel water is 50 % more expensive than the Aquarel water (i.e. the generic spring water of Nestlé that comes from different springs).

¹¹ LSA, 1998, De grands troubles dans l'eau, n° 1566, 59-69.

probability of being exposed and L the severity of the punishment. Because of the mandatory requirement to label the water composition including the nitrate rate per liter and the rivals' strategy publicizing their 'low nitrate rate' or 'nitrate free'¹², it is realistic to consider that p is close or equals to 1. The biggest difficulty is the estimation of the losses that Vittel may encounter if he does nothing. To provide a realistic approximation, we gathered anecdotal evidence on the 'Perrier affair'. The denunciation of an abnormal contamination of the Perrier mineral water by benzene led to the recall of several hundreds millions of bottles in all countries, a decrease of the firm value in the stock market and a costly advertising campaign. Eighteen months after the crisis, Perrier's share of the sparkling water market declined from 13 percent to 9 percent in the US and from 49 percent to less than 30 percent in the UK. The total cost of the global recall from 120 countries incurred by Perrier due to this one-shot problem has been estimated to \$ 263 millions¹³ (about € 217 millions). Noteworthy several industrial bottlers such as Katell-Roc or Divona, have been forced to close or abandon springs because of farming pollution, especially in Brittany well-known for its high nitrate rate in groundwater. Unlike the Perrier case, the Vittel problem was recurrent but likely to be perceived as potentially harmful for health, especially for babies¹⁴. Anecdotal evidence supports that the opportunity cost by doing nothing was considerable.

(4) The fourth alternative was explored, but the liability of farmers was somewhat unfunded and thus the problem cannot be solved by enforcement of existing laws and regulations, such as the Water Act of 1964 (INRA). But, even if it was, it could not be imposed and enforced without publicizing the Vittel problem. Such publicity was likely to generate negative spillovers on the image of Vittel with huge consequence on sales (Barbier, 2004; INRA). Vittel attempted in 1988 to impose 'ready to use' solutions, elaborated by the French Committee for the Reduction of Water Pollution by Nitrates (CORPEN). This solution was to transform all the fields of the catchment area in grasslands. The success of such a strategy was limited because it cannot be legally imposed to farmers who perceived it as not adapted to their production system.

(5) Therefore, only the fifth solution remained, which was considered as the solution with the lowest overall costs. According to Perrot-Maître and Davis, Vittel 'has come to realize that protection of water sources is more cost effective than building filtration plants or moving continuously to new sources.' This solution was feasible because the involved parties were well-identified, not too numerous and the definition of accurate property rights possible at a reasonable cost. Indeed property rights shaping the water quality like any other resource are subject to optimization, that is to say, they are defined to the extent that the benefits of definition exceed the costs of definition (Barzel, 1997).

Proposition 1: Under some circumstances, transacting parties may be somewhat 'prisoner' to a given social solution. This lock-in that can be caused by the institutional framework (North, 1990) can derail transaction cost economics predictions (Williamson, 1991) and lead to adjusting the transaction's dimensions to fit the available governance structure.

Indeed, transaction cost economics (Williamson, 1991) predicts that transactions, which differ in their attributes, are aligned with governance structures, which differ in their cost and competence, so as to effect a discriminating – mainly transaction costs-economizing – result. In the Vittel case, the suggested mechanism was to some extent reversed. This issue is analyzed more thoroughly in the following sections.

¹² See Ippolito and Matthis, 1990 for a theoretical justification of this rationale known under the name of unfolding theory.

¹³ At this time, the company did not have product recall and guarantee insurance.

¹⁴ High nitrate levels in water can cause methemoglobinemia or 'blue baby syndrome'. For instance, the Katell-roc bottler shut down its production unit in Brittany because of water pollution by nitrates, which was publicly known due to sickness of a child in the region close to the source (See section 4 and Table 5 for a larger description of this case).

3. Institutional arrangements and Transaction costs issues: Valuation Disputes, Bi-lateral Monopoly, and Third-Party Effects

Let us now consider precisely what transaction costs are implied by this contractual arrangement and their determinants. According to Coase 'in order to carry out a market transaction, it is necessary to discover who it is that one wishes to deal with, to inform people that one wishes to deal and on what terms, to conduct negotiations leading up to a bargain, to draw up the contract, to undertake the inspection needed to make sure that the terms of the contract are being observed, and so on'. Operational definitions of transaction costs usually refer to the successive phases of an exchange transaction (Dahlman 1979; Barzel, 1985; Williamson 1975; Furubotn and Ritzler, 2000). The notion of transaction costs used here includes the costs of discovering, negotiating, and completing the exchange of an asset, in this case, environmental rights tied to lands. Broadly speaking, exchange requires identifying the relevant parties; communicating information about the asset to be traded and terms of trade (offer and ask prices); inspection, verification, and measurement of the asset; negotiation to reach a sale price over mutually-accepted asset attributes and property rights; and finally, contract drafting and enforcement. The transaction costs literature emphasizes that each of these activities can be complex, affecting the timing, extent, and nature of trade (Libecap, 2004).

The data related to the Vittel case underscores the potential complexity involved in transactions, especially with respect to search, measurement, and negotiation. Two key points are useful for understanding subsequent bargaining disputes. (1) One is related to the precise definition of the asset upon which to contract. The water quality problem encountered by Vittel resulted from agricultural practices in a given area. The right to choose among a set of practices, that can be described as a continuum from harmless practices to very polluting ones (from the Vittel viewpoint) is bundled with the lands. This right is consequently owned by the land user, i.e. the farmer. Once the adequate area (including some farmers and excluding others) and practices are defined, the losses generated by the proposed changes have to be evaluated. (2) Farms were somewhat heterogeneous with respect to their surface share located in the catchment area, production process, economic performances and farmers' projects¹⁵. Consequently the valuation of practices changes was a particularly contentious issue for farms. The higher the surface in the catchment area, the farther the farmer project and production process from the changes desired by Vittel and the better the economic performances were, the more contentious the negotiation issues were.

In bargaining between farmers and Vittel between 1989 and 1999 there were three general classes of overlapping problems that impeded agreement: valuation disputes, bi-lateral monopoly conflicts, and third-party effects.

3.1. Valuation Disputes

There were two conflicts in determining compensations for the changes required by Vittel. One was the basis for general valuation of required changes -whether these changes should be valued as the sum of a loss in terms of reduced agricultural output, project re-orientation, transition effects and investments to apply new practices or as an input to the value increase of Vittel water, i.e. the opportunity cost of farmers versus the opportunity cost of Vittel if it does nothing. This was principally a negotiation issue. The second was the determination of the value of any particular changes when farms were somewhat heterogeneous. This was both a measurement and a negotiation issue.

In terms of the first problem, Vittel wanted to use the loss and investments subsequent to the required changes, i.e. adjustment costs in determining the compensations it offered farmers, whereas farmers wanted to use the opportunity cost of Vittel in order to get much more. If compensations were to be

¹⁵ Farm project can be positioned on a continuum from a project corresponding to the Vittel specifications to a very intensive and potentially polluting project. Farmers' projects were characterized and classified by sociologists and economists from the research team.

determined relative to Vittel gains, measurement costs (tied to performance) would be very high and uncertainty would add complexity to the problem. Rather, compensating farmers based (directly) on their revenues was a more visible and then credible strategy. Noteworthy, there can be economies of scale and learning by doing over time in a more precise delineation of property rights, leading certain parties that are likely to repeat similar transactions to incur *a priori* high initial transaction costs, e.g. Nestlé Waters in other locations. In terms of the second problem, the valuation of changes in a particular farm was a continuing and important source of contention because the value agreed determined the owners 'share' of the aggregate rents from the rights rearrangement. Several farmers typically held out for higher compensations or to get reliable data on the sustainability of Vittel propositions. In negotiations, each farm owner had the most complete information about the agricultural potential of his farm, personal project and the impacts of changes, but at the same time, had incentive to exaggerate their values.

Farmers challenged the estimated values of their characteristics. Challenges were based on disputes both regarding the relevant comparison basis, as well as assessment of individual farm characteristics. The disparities between the bid and ask prices due to measurement disputes could sometimes be very large. Agreement on changes valuation was also complicated by a lack of trust on both sides. Vittel viewed some farmers as making exorbitant compensation demands. Farmers, by contrast, viewed Vittel as attempting to undervalue the changes while the benefits for Vittel were huge in comparison. This limited trust meant that neither party held the other's pricing claims as credible or honest. This condition increased the transaction costs of negotiation and lengthened the time necessary for agreement.

32. *Bi-lateral Monopoly Disputes*

Disputes over valuation of critical changes took place within a bi-lateral monopoly context, and this condition increased the costs of negotiation apart from measurement issues. Vittel was the only 'purchaser' of environmental rights tied to land use in the Vittel area. The reputation asset and the plant located at Vittel were a large fixed, hardly redeployable investment. Their values and future profit flows depended upon the changes in farms. While Vittel could negotiate with each farmer in the targeted area, it could not walk away from the Vittel area as a whole. Each farmer located in the strategic area has also a kind of monopoly power to contract with Vittel, because lands they hold are not substitutable with other similar lands. In addition, the exploitations are not concerned the same way because the surface share per farm in the catchment area varies from 1 to 62% (INRA, 1996). Notice that at least two reasons can explain how the strategic location of farmland near the spring can lead to opportunistic behavior. First, if a close-to-the-spring farmer can, on his own, contaminate the groundwater to above 15 mg, then the farmer can obviously hold up the entire contracting process. Second, if the value of securing contracts with farmers within but near the perimeter of the sensitive area is conditional on also securing contracts with close-to-the-spring farmers, then hold-up rents are created for the close-to-the-spring farmers and they have incentives to act opportunistically. Because of the geographical configuration¹⁶, each farmer in the catchment area, regardless of his closeness to the spring can individually shape to some extent the nitrate rates. This partial hold-up from individual farmers obviously increases transaction costs¹⁷.

Bi-lateral monopolies have indeterminate pricing outcomes because they depend upon the relative bargaining power of the parties. Each party has incentive to misrepresent its position in order to extract a greater share of the gains of rearrangement in such negotiations, and there is little competitive pressure to force more accurate information revelation. Accordingly, negotiations often

¹⁶ Vittel spring can be considered as being located at the bottom of a basin, making it very likely to collect pollution regardless of the point in the catchment area from where the pollution discharge has been emitted.

¹⁷ Note that this is like comparing the holdup potential that upstream users of river water have on downstream users. In a similar way, the value of a downstream water right is conditional on upstream use.

break down and take a long time to complete (Williamson, 1975, 238-47). This was especially the case with farmers owning fields essential for the overall effectiveness of the Vittel arrangement.

33. Third-Party Effects

In the case of Vittel, the situation was somewhat surprising and differing from the cliché because the pollutee was a big industrial and the polluters, a group of small farms. On the one hand, there were complaints that the Vittel action was disturbing the local agricultural economy. The magnitudes of the effects were disputed by Vittel and farmers. Tensions and jealousy between farmers located within the critical area and the other ones located outside, and consequently excluded from the negotiations, were sometimes very high. The concerns raised in the farming community – especially on farmers unions and other agricultural organizations – about the impact of changes in farming were also significant, because the dominant, industrial agriculture model was substituted with a new and more stringent production process. The limited number of concerned farmers may have mitigated the negative third-party effects, making them quite small. The farmers involved in the Vittel arrangement were also over-publicized, making them very reluctant to further solicitations. Notice also that some farmers have been reluctant to accept the proposed contracts, e.g. because of union activism. On the other hand, because Vittel was a major employer and the water reputation was the determinant of many other activities, e.g. tourism, thermalism, the efforts required by Vittel from farmers were perceived as legitimate and necessary. For example, according to several participants of the research team, because each farmer has a member of his family working to Vittel, they are under pressure to find an arrangement to not threaten such jobs. Lastly, there was a strong political support to make the experience successful and at a certain extent, regardless of the overall costs (Barbier, 2004).

Proposition 2: Valuation disputes (+), bilateral monopoly (+), and third-party effects (+/-) shape transaction costs and may derail a Coasean bargaining alternative.

Given the difficulties highlighted above, it is a priori unlikely that a direct negotiation between the pollutee and polluters occurs. Nevertheless, Vittel and farmers succeeded to bargain. So, in the following we explain in detail how transaction (and production) costs were sufficiently low and somewhat reduced by innovative devices leading to the success of this contractual arrangement.

4. How transaction costs were overcome?

Although Vittel is a major employer in the small region, it had little knowledge of the farmers' realities and reasoning (Barbier). For example, the regulatory context was perceived differently by Vittel and farmers. Indeed, farmers were arguing that potable water requires 50 mg nitrates per liter, which was achieved, but mineral water must satisfy a 15 mg per liter threshold. Then, as mentioned in the introductory section, Vittel turned its attention to research by contracting with the French National Agronomic Institute (INRA). Whilst the desired outcome by Vittel was clear, the ways to achieve it needed to be defined. This intervention of researchers and other measures have allowed the reduction of transaction costs and deserve a development.

(1) The indirect governmental intervention through the research team has facilitated the development of the type of arrangement being described. Indeed, the research team has played a strong role in determining the base on which Vittel will negotiate with individual farmers the terms of each contract, especially the level of compensation. Vittel do not have competences in agriculture and do not know what changes are necessary to reach its nitrate rates objective. Note that farmers were also not competent to determine what changes must be achieved. Each party experiences a lack of reciprocal knowledge and trust. The research team played a strong role in defining precisely the rights which have to be included in the contracts to achieve the desired performance in terms of water quality. Moreover, the research team played a role of mediation and mutual comprehension between *a priori* divergent and dissymmetric interests of the two parties, i.e. an important industrial company trying to improve its water quality and farmers aware of public concerns but fearing the change of their production systems.

The competence of the research team and their mediatory role were essential to reach an agreement on these technical and economic questions. Moreover, the perception of the research team by farmers was better than the perception of Vittel Company, which was perceived as an industrial giant willing to end farming in the sensitive area. For instance, there were problems of agreeing on valuation of the impact on the farms. For farm property, the prices proposed by Vittel were very attractive and above the usual expected price for agricultural lands in the small region. The research team played a strong role by gathering raw data about each farm, classify them in homogeneous and representative classes and simulate several scenarios corresponding to the ‘loss’ that can be imputed to the required changes (INRA).

Notice that during the valuation process, researchers collected information¹⁸ about each farm — location, technical data, economic and financial results, farmer project, already done investments, etc. Nevertheless, some farmers challenged the researchers estimated values. However, because of status, previous relationships and social proximity between farmers and research teams, the research intervention – or ‘instrumentalization’ by Vittel according to some people – was likely to play a positive counter effect by economizing on transaction costs (Glaeser et al., 2000). More than ‘ready to use’ solutions, the research team, with the assistance of the farmers, progressively elaborated technical and economically feasible solutions compatible with farmers’ strategies. This collaborative process contributed to increase farmers’ acceptance because the clause of the proposed contracts was co-built and integrated farmers’ concerns (INRA; Gafsi).

The financial participation of the French Water Agency in the research program was also significant (INRA). At the same time, the Vittel area benefited from an OGAF¹⁹, facilitating the reorganization of the lands within defined boundaries thanks to a funding by public authorities at a national level. Of course, the public authorities played a fundamental role in providing a credible legal system to assure the enforceability of contracts and granting some limited financial aid (Perrot-Maître and Davis). The implication of the State was important for several reasons. First, the research team was interested in having a ‘real laboratory’ to test and apply an interdisciplinary approach. Second, some public actors were interested in designing a methodology that can be applied to other areas experiencing similar problems (INRA). By participating in the arrangement design, public actors remain key players. Third, the quality of Vittel waters has some public properties (employment in Vittel but also in many related activities such as thermalism and tourism, region reputation and so on). Lastly, there was a strong political willingness to make the project succeed.

Proposition 3: External intervention, notably governmental may lower costs of defining property rights because of specific skills and less conflictual relationships with transactors. Nevertheless, under some plausible circumstances, this external intervention may unduly ‘subsidy’ the private rent resulting from the rearrangement.

Noteworthy, the external intervention and the incurred costs may be considered as an investment which is to some extent redeployable. By participating indirectly in the Vittel arrangement, public authorities kept some intellectual rights on the approach which has served as a model in several other environmental related transactions on water quality in some French cities such as Lons Le Saunier, Pontivier and Auxerre.

(2) The subsequent quality of the groundwater was bundled with the land. Then, early, Vittel bought several fields (about 1500 ha), i.e. acquired property and tenant rights close to its springs at attractive prices (Chia and Raulet, 1994; Brossier and Gafsi, 1997) and became the owner of 45% of the sensitive area shaping the water quality. These lands come mainly from retiring farmers. Vittel seems to have benefited from a ‘special right’ or arrangement with the SAFER (the French Public Organization in charge of agricultural land transactions) to buy *in priority* all available lands in the

¹⁸ A major part of this information remains confidential.

¹⁹ OGAF (Opérations Groupées d’aménagement Foncier) is the French acronym for grouped operations for land planning.

defined area. This very particular arrangement, somewhat obscure, cannot be applied to all the lands because of the existing laws that restrain transactions on agricultural lands. At this time, the pressures from other stakeholders remain relatively limited. Nevertheless, these purchases were not enough to improve the water quality. Indeed, the impacts subsequent to the partial integration of some fields are ineffective unless the majority of concerned farmers become participants (Schmidtz, 1991)²⁰. Moreover, an attempt to buy all lands would lead Vittel to a 'jacquerie' (Barbier, 2004).

The purchase of some lands and their use in the bargaining process was very powerful to convince some more reluctant farmers. For some farmers, the lands previously purchased by Vittel and supplied after at very attractive conditions have enabled them to considerably increase the size of their farms. The main obligations under the individual private contracts are very easy to monitor and enforce, making the enforcement costs of the arrangement relatively low (Chia, 2004). Finally, several farmers of the Vittel perimeter switched to organic production, allowing a premium of their agricultural products (Reibel, 1999).

(3) To ensure its obligations and prove its sustainable implication in the radical change, Vittel has created an agricultural advisory firm, Agrivair. The mission of this firm is to advise, accompany, monitor and enforce contracts with farmers (Gafsi). Agrivair has recently introduced new technologies such as information geographic system to manage sewage spreads, which can increase the quality of its services. Several clauses of the contracts relate to the prevention of fraud, such as free access to accounting documents and visual inspection of farms. According to Chia (2004), 'visual inspection is sufficient and very easy for anyone well experimented in agriculture.' Notice also that Agrivair achieves itself (in other words 'has integrated') some tasks, e.g. composting that ensure the result and make monitoring operations less costly²¹. An interesting feature of the enforcement is the use of scientific research procedures that have been adapted for other purposes than their initial use (Chia and Raulet). During the process of applied research, an extension specialist was recruited to ensure constant communication between farmers, Vittel and the research team (Gafsi). It should be noted that the person in charge of Agrivair was the same agricultural extension specialist who worked previously for the research team (Deffontaines and Brossier; Chia and Raulet).

Proposition 4: Property rights will be defined to the extent that the costs of doing so equal the benefits of doing so. Rather than integrating the whole asset, more precise property rights may allow a transaction-cost-economizing by rearranging only the 'optimal' subset of property rights.

5. The contractual arrangement between Vittel and farmers

The organizational arrangement is a private contractual one. The contracts allow (1) the definition of property rights on production choice and agricultural practices, and, (2) the transfer of property rights from the formal owners or users of the fields, i.e. the farmers to the industrial company, Vittel. The research team helped to define the specifications and clauses of the contracts and the obligations of each party. To contract with targeted farmers, Vittel negotiated with each of them and proposed individual incentives and compensations. The incentives provided by Vittel to encourage farmers' acceptance were variable among farmers according to their individual situations. For example, the percentage of lands in the catchment area was a strategic variable in the bargaining phase. Farmers agreed to switch to less intensive dairy farming and pasture management. The property rights transfer lasts for a limited period²² and farmers are rewarded by several ways such as income support,

²⁰ The improvement of water quality requires that Vittel have the environmental rights over the most part of the concerned lands. If the quantity of purchased lands plus the quantity of lands under contract are insufficient, the water quality will not be noticeably improved and Vittel may consider that he squandered his resources.

²¹ It should be noticed that conflictual relations occurred at times between Agrivair and farmers (Reibel).

²² The duration of contracts is 18 or 30 years.

compensation for abandoning a farm project adopting a new trajectory, equipment subsidies, and free technical assistance. The main (and average) obligations of the farmers and Vittel are described in Table 2. Note that the specifications required by Vittel were on several points more stringent than organic farming requirements.

Table 2. Main obligations of farmers and Vittel.

Farmers	Vittel
Eliminate corn crop	€230 per ha and per year during 7 years
Ban pesticides	Equipment investment of about 150 000 euros per farm
Compost all animal waste	(haymaking materials, barn drying, buildings, etc.)
Nitrogen fertilization by composted manure (an additional nitrogen contribution less than 30 units per ha is tolerated)	Free supplying of manure treatments and use (composting, spreading, etc.)
Limit one livestock unit per ha of grazing area and balance livestock feed	Free technical assistance
Ensure farm buildings are up to Agrivair standards, exceeding legal obligations	Free usufruct of the previously bought fields and the quotas associated (about 25% more)

Notes:

1. Farmers have substituted corn by Lucerne and lost the Common Agricultural Policy (CAP) aid attributed to this crop.

2. The services supplied by Agrivair represent 23% of the overall seasonal works for each farm (Gafsi).

Main Sources: Gafsi.

The payment is not indexed on the improvement of water quality, but based on the switching costs and compensations resulting from the adoption of a less intensive farming system. First, there are significant measurement difficulties. Indeed, 'nitrates and pesticides take several years to reach the groundwater' (French Environment Ministry quoted by LSA). To assess the impact of the changes in practices on the nitrates rate, an important delay is necessary. Moreover, it is frequently difficult to impute the individual responsibility to the nitrate rate decrease and consequently to pay farmers according to this measure. Many other natural factors (rain, soil and so on) can hedge the degree of pollution (LSA). As mentioned before, reducing or maintaining a low nitrate rate was not really a gain for Vittel, but rather, avoiding a huge loss. Indeed, several water bottlers have been forced to close their business or delocate their operations because of pollution, e.g. Katell-Roc, Divona, Bagatz and Langoat²³. Second, farmers who own the rights of using their lands as they want will not engage in any bargaining if they do not have the guarantee that their adjustment costs (their revenue loss) will be clearly taken into account. Adjustment costs seem to constitute a kind of 'best available proxy' to economize on measurement and bargaining costs.

From the Vittel point of view, this arrangement can be considered as more cost-effective and sustainable than a permanent compensation. The expected effect is to 'lock' farmers in the required changes, making a flashback to previous polluting practices, unlikely to occur. A sample of surveyed farms shows they have increased their average usable agricultural surface by 34% (Gafsi).

Although the change in cultural systems has affected 11 % only of the whole farming area until 1994 (INRA, 1996) and despite the initial reluctance of some farmers, the number of farmers under contract has grown and reached a rate of 92% of targeted farmers (Barbier, 1997; Gafsi) and 96 % of the targeted lands are today under contracts. Note that the number of contracting farmers is evolving over time because of retirement, succession, operations on lands and so forth.

Between the initial question raised to the INRA team in June 1987 and the signature of the first individual contracts with farmers at the end of 1992, the period lasts about 4-5 years (INRA). The main quoted reason to explain the non-commitment of some farmers (3/36) is (1) their strong political commitment, notably in farmers unions, to champion their vision of a modern agriculture, (2) the

²³ Drévilion, Y., 2000, Les Bretons assoiffés d'eau en bouteille, Le télégramme, 16/02/2000, http://www.bretagne-online.tm.fr/telegram/htdocs/archive/2000/20000216/une/hm_article/eau.htm.

financial situation of some reluctant farmers (very high sunk costs invested in intensive farming and high debt ratio) making the obligations of the contract unachievable and (3) the issues related to land tenure and succession²⁴. According to INRA (1996), the farmers' decisions were clearly influenced by the perceived extent of practices changes, the offer of Vittel and its ability to address their specific concerns (size increase, financial compensations, succession problems, issues related to land tenure, overall sustainability), farmer's situation and the fit of the proposed change with each farmer's goals. Moreover, note that some farmers have left the area since the first negotiations, reducing the total number of target farmers from 40 to 36. In addition, there are differences in agricultural processes among farmers. For example, there are three kinds of breeding and thus, farmers' expectations regarding Vittel recommendations were different (INRA, 1996).

6. Assessment of the arrangement

In terms of performances, the records show that the overall nitrates rate in groundwater has decreased. Fifty per cent of monitored springs experienced a decrease of the nitrates rate and the other 50% have a constant nitrates rate (Gafsi).

Vittel has incurred different costs in getting the mechanism to work. We distinguish three kinds of costs: (1) the design costs including the contract with the INRA and other costs for defining the accurate area to buy or put under contract, the property rights to contract, the terms of contracts with farmers, (2) implementation costs notably including buying fields and investments in individual farms under contract, the costs associated with creating and running Agrivair, and economic compensations negotiated with farmers for changes in farming methods, and, (3) enforcement costs i.e. the costs of accompanying and monitoring farmers. Vittel spent more than €24,000,000²⁵ for 3500 ha over seven years and successfully converted the farming practices of most concerned farmers (INRA, 1997, p. 69). More data on the costs incurred by Vittel are provided in table 3.

Table 3. Costs incurred by Vittel for the contractual arrangement.

Land acquisition	€9.14 millions
Investments in farm equipment	€3.81 millions
Other expenditures, mainly financial compensations	€11.3 millions
Total costs for Vittel	€24.25 millions
Cost of protecting the resource per m ³ of bottled water	€1.52

(Source: <http://www.observatoire-environnement.org/OBSERVATOIRE>, 2005)

Compared to the potential loss, the overall cost of the contractual arrangement incurred by Vittel (around €24 millions) seem a very profitable investment. Moreover, the Vittel rent was partly financed by public funds including the research team, the *Agence de l'Eau* support and the grouped operations for land planning (*OGAF*) funds.

While the contracting may seem very costly, the evidence suggests that the arrangement was profitable for both parties and likely to be applied elsewhere. The approach has been applied to other companies of Nestlé Waters, i.e. Contrexeville and Perrier. The application of the same approach to the Contrexeville springs was more directly related because of its geographic proximity. 'The Perrier springs are located in southern France in an area of vineyards and intensive wheat cultivation where

²⁴ Again, the institutional framework may restrain the extent of the rearrangement. For instance, at the end of the farm tenancy period (or when the farmer retires), the land owner (the successor) may recover the lands and decide to use them as he wants. Moreover, each farmer leases from several owners. Vittel has to take into account such issues in contract duration or by proposing innovative contracts in the French legal context that can be enforced over time regardless of the land owner or user.

²⁵ This corresponds to an average of €980 per ha and per year, including initial investments. Note that in comparison with subsidies from the Common Agricultural Policy (CAP), €300 per ha and per year, the contractual arrangement was very attractive for farmers.

phosphates and herbicides are the main sources of water pollution. Perrier successfully introduced organic agriculture to 20 farms that cultivate approximately 350 hectares of cereals and 200 ha of vineyards and regularly monitors over 900 ha of land. The highly favorable market conditions for organic products made significant contributions to the rapid adoption of improved farming practices around the Perrier springs. Other French bottlers — Evian and Volvic — have considered using Vittel's experience as a model' (Perrot-Maître and Davis). The tools and approach developed by the research team have also been applied to other cases of water contamination by farming practices, e.g. in the Migennes and Plateau Lorrain (INRA)²⁶.

Proposition 5: If the contractual arrangement is redeployable to some extent, the initial transaction costs can be considered as spread over all the expected applications.

Nevertheless, a potential obstacle to the transposition of such a model relates to the technical and financial dependence of farms with regard to the other party involved in the contract (Brossier and Gafsi). Several other issues can affect the potential for transferability (Perrot-Maître and Davis):

Scale: The Vittel model may be difficult to use in larger geographic areas or in an area with a greater number of farmers. As noted elsewhere (Libecap; Ostrom, 1990), the greater the number of parties is, the higher the transaction costs associated with designing, implementing and enforcing an agreement are. If the transaction costs overcome a certain level, they can make other alternatives more cost-effective.

Timing: If quality drinking water was needed immediately, the approach adopted by Vittel may be too slow to achieve such a performance, making filtration plants unavoidable with the risk of losing the mineral water label. The timing includes the time needed to design solutions, solve valuation disputes and the lag between adoption and performances change. For example, between February 1993 and February 1996, the proportion of farmers under contract evolved from 3% to 65% and to 92% in 1998 (Barbier; Gafsi). Such a dimension stresses the need to consider pollution problems at early stages rather than when pollution thresholds are exceeded or in other words 'damage is done'.

Private sector profitability: Given the high level of investment required, imitating the Vittel approach seems limited to highly profitable industries (Gafsi). The purchase of property rights (land acquisition, practices changes) was possible because the value of the water quality was significantly higher for the bottler than the loss incurred by farmers. The opportunity cost of farmers to accept the contract was lower than the opportunity cost of the bottler. The creation of Agrivair was essential because it was perceived by farmers as a signal that Vittel was really investing for agriculture and that farming changes would really benefit from a long term support (Barbier). Despite the significant cost of the Vittel approach, it can be considered as a reasonable alternative by taking into account the unlikelihood of the other alternatives discussed in section 3. In addition, the switch of several farmers to organic production may have contributed to making the new system more sustainable and profitable.

Strong involvement of public research teams: The multidisciplinary research and extension team played an essential role in the success of the operation. 'The research program was finalized in 1996. Seven years of research enabled a preliminary conclusion to be drawn regarding three main aspects. Firstly, the objective regarding sustainable development on the Vittel plateau was achieved. The agrarian system used on the Vittel site has clearly made progress in terms of reducing nitrates levels in the water sources and in terms of farmers' incomes. Secondly, knowledge has been produced over a wider spectrum, such as in technical and socio-economic fields. The apparent high cost of the operation does not make this experience prohibitive. And, when drinking water becomes scarce, financial backing could easily be found. The third aspect concerns the positioning of the research

²⁶ A similar example can be found in the contractual arrangement between the city of Munich (Germany) and farmers in the Mangfall valley to maintain the city's high drinking water standards. Farmers have been encouraged to adopt organic agriculture and received, as an incentive, about €281,21 per hectare and per year, and technical assistance (Heid, 1997).

team faced with a complex question: the research team – placed in a highly uncertain context having accepted the challenge of a complex question – formulated, set up and implemented a wide range of technical and social tools which brought the various actors together on several levels. This is a good example of negotiated management’ (Brossier and Gafsi, 2000).

Table 4 provides some key elements that allow comparisons between Vittel and three other cases of successful (Munich or Auxerre programs) and unsuccessful (Katell-Roc) negotiations with farmers for environmental property rights.

Table 4. Some comparisons between Vittel and other cases of contracting with farmers to preserve water quality.

Case	Vittel	Auxerre	Katell-Roc	Munich
Place	Vosges	Plaine du Saulce	Lizio (Brittany)	Mangfall valley
Perimeter size	4360 ha (of which 3500 ha are farmed)	9000 ha		6000 ha (of which 2250 are farmed)
Externality	Water pollution by nitrates	Water pollution by nitrates	Water pollution by nitrates	Water pollution by nitrates and pesticides
Polluters	Who	Farmers	Farmers	Farmers
	Number	40	40	Unknown
Pollutees	Who	Mineral water bottler	Association de la Plaine de la Saulce	Katell-Roc bottler
	Number	1	1 (60 000 inhabitants)	1
	Status	Private actor	Non lucrative private actor	Private actor
Transaction structure	‘Collective bilateral monopoly’	‘Collective bilateral monopoly’	‘Collective bilateral monopoly’	‘Collective bilateral monopoly’
Required change	Eco-friendly farming (+++)	Eco-friendly production (+)	-	Organic farming (++)
Contracting farmers	37	24	-	107 (2004)
Surface under contract	About 3350 ha	?	-	2650 ha
Compensation	€230 /ha/year during 7 years Initial equipment	€69 /ha/year	-	€281,21 /ha/year during 6 years coupled with €152 /ha/year during 5 years (AES) €230,08 /ha/year during 12 years
Whole costs incurred by the pollutees	About €24 M€	About €1,9 M€	Closing the unit	About 14.5 M €
Opportunity cost estimation compared to production and transaction costs	>	>	<	>
Measurement difficulty	Very high (+++)	High (++)	High (++)	High (++)
Third parties	Farmers’ unions, Vittel employees, tourism	Citizens	Employees, local social and economic life	Munich citizens, ecological unions
Government intervention	INRA, Water agency Rhin Meuse and SAFER	Water agency Seine-Normandie, territorial collectivities (Financing Farming Territorial Contracts)	DDASS	The city of Munich (bought bioproducts for its institutions (schools) to enhance demand and finances farmers for AES).

In the Vittel case, the opportunity cost of Vittel doing nothing was huge, especially compared with the opportunity cost of farmers changing practices. Such a situation makes the rearrangement very likely. The switching costs to move to more environmentally friendly farming practices were not well estimated. Consequently, Vittel had to give up a part of the informational rent, growing the gains of the farmers. Farmers may tend to adopt an opportunistic behavior, increasing the monitoring costs of Vittel. The strategy adopted by Vittel seems able to generate a kind of self ‘lock-in’ of farmers to the environmentally friendly changes. Rather than permanent funding for the quasi-integration of the relevant subset of rights, Vittel causes the changes and finances them, but once these changes are

achieved, they are supposed to be self-enforcing²⁷. Indeed, farmers are supposed to acquire specific knowledge and abilities about environmentally friendly farming and price premiums for environmentally differentiated products, such as organic products. Once this is done, it is expected that the opportunity costs –including notably switching costs – will be sufficiently high, making the return to the traditional polluting process not profitable.

Proposition 6: The higher the expected gain from rearranging property rights, the higher the likelihood of a successful rearrangement of property rights.

In addition, Table 5 summarizes the main characteristics of this institutional arrangement in a comparative approach, i.e. in comparison with the three other similar arrangements. Noteworthy, voluntary contractual arrangements can be effective devices to deal with non-point-source pollution in comparison with more traditional command-and-control or market-based instruments. Another interesting point from this comparison is the fact the repartition of transaction costs (design, implementation, and enforcement) varies among these similar contractual arrangements. For instance, Vittel has incurred important *ex ante* transaction costs to design draft a specific contract while the Munich program has used a standardized contract, i.e. organic farming. *Ex post* enforcement costs are reduced in the Vittel case because most contractual clauses can be visually monitored by Agrivair employees while Munich program relies mainly on conventional inspections for organic farming that are achieved by third party certifiers paid by the Munich program²⁸.

²⁷ While moral hazard may constitute a real issue in temporary rearrangement of environmental rights, it may be mitigated to some extent by the need for producers to make significant initial investments in knowledge, skills, materials, and time to become operational. Indeed, acquiring and assimilating environmental abilities implies initial sunk costs and can be considered as a choice made once and for all (see Rogerson, 1983 for a similar rationale). Once acquired these abilities may generate a kind of “self lock-in” reinforced by the threat of losing price premiums.

²⁸ There can be a degree of substitutability between the different categories of transaction costs that arise at different times of the transaction. Indeed, Williamson (1985) emphasizes the distinction between *ex ante* and *ex post* transaction costs whereas Dahlman (1979) distinguishes different types of transaction costs according to the stage of the transaction. This substitutability is analogous to the substitutability between inputs in production functions. Measuring the degree of substitutability between any pair of categories of transaction costs can be done similarly to the estimation of the elasticity of substitution. More formally, the elasticity of substitution measures the percentage change in transaction costs proportions due to a change in marginal rate of ‘technical’ substitution. Substitution effects can allow minimizing overall transaction costs in order to achieve a specific transaction. Because of asymmetric information and unequal allocation of power, some parties may have a vested interest in making other parties support their transaction costs, exploiting the substitutability described above, in order to minimize their own transaction costs, regardless of whether or not this results in overall minimization of overall transaction costs. Such ‘substitution effects’ between categories of transactions have to be taken into account in order to minimize the overall transaction costs.

Table 5: Characteristics of arrangements that deal with water pollution problems

Case	Vittel	Auxerre	Katell-Roc	Munich
Buy	X			X
Contract	X	X		X
Leave			X	
			“There was no means of diminishing nitrates rate at a reasonable cost “(CEO)”	
Collective/individual	I	C	-	I
Contract duration	18 years and 30 years	5 years	-	18 years
Design	Very costly because of very specific requirements Use of the public funded research team	Not very costly because of generic requirements Use of the environmentalist association	“We have not the Perrier financial willingness, thus it is deadly for a firm like our” (CEO)	Selecting a unique alternative: organic conversion. “A part from the ecological farming model no other improvement measures are at hand which would lead to lower administrative costs” (Schuchardt, 2004)
Implementation	Adversarial relations with professional unions +++	++	-	++
Enforcement	Partially self-enforcing (organic farming) and Agrivair enforcement (++)	2 agents were hired to control the application of the required measures	-	Relies on conventional enforcement of organic farming
Overall assessment	Significant decrease in the nitrate rate (see in full text) Cost for Vittel: 1,52€m ³	Not yet evaluated	Closing the source	Nitrate rate down from 14 µg/litre to 8-10 µg/l Cost for Munich: 0,001 €m ³ while dropping nitrates would cost 0,3 €m ³

In conclusion, this rearrangement of rights, based on individual contracts, constitutes a private solution for externality problems where clear property rights and easy identification of stakeholders played a key role. The applied principle was not ‘the polluter pays’, but the counterintuitive ‘pollutee pays’. This arrangement constitutes an original application of Coase’s recommendations in a real world context with high transaction costs. The high transaction costs threatening to derail a Coasean bargain were overcome, notably by indirect public intervention, through research team and other informal arrangement; the main roles devoted to the public authorities in a Coasean solution including notably the definition and enforcement of property rights were evident in the Vittel success (Van Zandt, 1993). Several lessons can be drawn from this case study that can be useful, especially for other applications by carefully taking into account other institutional environments.

7. Policy considerations

The Vittel case study points several challenging issues for researchers and policymakers. Without purporting to be exhaustive, let us consider some of them.

First, it seems obvious that a clear definition and non-contestable allocation of property rights may economize on transaction costs. In the Vittel case, the intervention of public authorities, notably through research teams, to delineate property rights played a strong role in the success of the private arrangement. The accurate identification of a subset of sufficient property rights tied with land property – i.e. farming practices over a well-defined area – allowed agents to engage in a coasean

bargaining process. Research teams also contributed to the identification of key technological variables that play a role in the level of water nitrate rate and proxies used to monitor them (Barzel, 1982)²⁹. Let us stress again the strong uncertainties faced by Vittel about the technical path that the farmers ought to follow in order to reduce their harmful effects. Indeed, the causalities between the modification of farming practices and the results in terms of nitrate rate reduction were not well established before the intervention of the research teams. Indeed, the relation between the two variables is complex and non-linear and results are observable at middle or long-term horizons.

Therefore, in the case of externalities, a major role of the state is to provide the basis –i.e. defining and assigning property rights – for a bargaining solution. This investment including learning costs, skills, savoir-faire, can be very costly and prevent private stakeholders from bargaining. If this investment can be redeployed to other situations, the initial costs appear as less dissuasive and likely to generate economies of scale. In general, public authorities or multinationals because of their operations scale are more likely to benefit from such economies of scale. The more the arrangement is likely to be applied elsewhere, the more the initial high costs are likely to be overcome. Consequently, the intervention costs have to be considered by taking into account the potential redeployability of the outcomes. Closely related to this, in order to ensure the redeployability, intellectual property rights on the arrangement have to be carefully managed.

Second, the status of the intervening party, e.g. public research teams, may play a strong role in generating trust and consequently reducing transaction costs of reaching an agreement (Glaeser et al.). While technical skills may constitute a core ‘input’ to find ‘technical solutions’ to the problem, the status of the chosen intermediate party has to be carefully considered, if this is to decrease transaction costs. At first glance, we may consider that minimal technical abilities are necessary, but not sufficient. Technical abilities are likely to generate *technical trust*, trust in the competences, but not *ethical trust*, in the sense that implied parties trust the ethical values of the facilitator.

Third, the co-construction of the contractual arrangement is likely to reduce barriers and to induce a greater formal acceptability. In the Vittel case, several points of the contractual arrangement were designed in close collaboration with farmers (Deffontaines and Brossier). Unlike ‘external or imposed institutions’ where rules are defined independently of agents and where they have only a ‘binary choice’ to follow them or not, the co-construction increases the overall effectiveness by mitigating several potential barriers. Agents are not ‘rules takers’ but ‘rules makers’ and their early and voluntary participation would increase formal acceptance. Such a co-construction shares several similar features with ‘internal or induced institutions’ and their articulation with legal rules or regulator power (Dulbecco, 2003).

Fourth, the in-depth study of the Vittel case suggests that the Williamson’s analysis of governance structures could be usefully applied to environmental-related transactions³⁰. Although such an issue is out of the scope of this paper, we may consider several promising points. Formally, a subset of the property rights shaping the nitrates rate in groundwater belongs to the French public authorities. These property rights are defined and delineated by the regulatory threshold (‘command and control’ performance standards) on nitrate rate. The governance structure has a quasi-hierarchical form (Richards, 2000) but the enforcement appears very difficult and costly mainly because of measurement problems. In order to secure the nitrate rate at a level stricter than the regulatory threshold, an additional governance structure is necessary. As suggested by neo-institutionalists (Coase; Demsetz, 1969; Williamson, 1996) agents implied in the environmental-related transaction

²⁹ Note that efficient measurement would be undertaken by the party who has easy access to information and lower costs of measurement, provided that incentives to cheat are curbed and trust is established. ‘The survival hypothesis also suggests that, other things being equal, quality must be measured at points in the process of production, exchange and consumption where it can be done with the least expenditure of resources’ (Eggertsson, 1999, p. 201).

³⁰ The problem faced by Vittel shares several features with the paradigmatic question of transaction cost economics ‘make or buy’ in industrial organization.

have explored and attempted several alternatives before selecting the contractual arrangement that appeared as the most efficient at the decision time. Because the property rights shaping the water quality were tied to the land, Vittel established long term contracts with farmers to ‘quasi-integrate’ such rights, to exercise a kind of hierarchical discretion on the use of these rights. Indeed, Vittel was the one who valued these rights the most, compared to the farmers who held the second highest values, making the bargaining solution potentially profitable for the both transacting parties. The Vittel situation, presents a high degree of asset specificity and bilateral dependency notably because of reputation and the label ‘natural mineral water’, both being tied to the location. Such bilateral dependency makes each party very vulnerable to opportunistic behavior by the other transacting party.

The identification of the relevant subset of property rights on which to contract shows that precise definition of rights can avoid too much integration in favor of a more efficient solution where only some property rights (as indicated in the contracts between Vittel and farmers) are transacted. Moreover, other barriers were preventing a full integration of all lands around the Vittel springs. Note that Vittel attempted a full integration but faced strong opposition of several targeted farmers who were very tied to their lands and jobs. Nevertheless, a significant fraction of sensitive lands were purchased by Vittel and re-used to get a higher level of adhesion from resistant farmers. So, the definition of rights on which to contract was a socially more acceptable solution rather than a whole land acquisition (INRA). Thus, high specific assets do not automatically lead to full integration of the other transacting party, but may be mediated through long term contracts that allow the quasi-integration of the relevant subset of rights.

The Vittel strategy to minimize organization costs –costs of setting up and running the hybrid organization – needs to be explained. A large part of the cost was indirectly incurred by the public authorities through the research teams and the so-called ‘Agence de l’Eau Rhin Meuse’. Vittel has benefited from the pre-existing non-adversarial and non-lucrative relationship of researchers with farmers and has consequently economized on a kind of ‘learning costs’. Moreover, as mentioned before, an extension specialist was employed by the research team to manage the relations between farmers and the research teams. This specialist has acquired very specific competencies, such as precise knowledge of local farms and proxies used by the research teams and so on. These core competencies were redeployed at relatively low cost to the Agrivair structure. Interestingly, this person became the director of Agrivair at the end of his collaboration with the research teams. Agrivair may be considered as a micro-institution that improves the enforceability and enforcement of arrangements (Ménard 2003, Ménard and Shirley, 2002). Such micro-institutions may explain why similar arrangements in similar institutional contexts perform differently.

Fifth, the financial compensation paid by Vittel and the other expenditures implied in this contractual arrangement may be used to estimate the value of an environmental (and health-related) good, e.g. the decrease of the quantity of nitrates per liter. The case study may provide raw data to apply the averting behavior methods. The rationale of such a method is that the cost a pollutee, incurred in order to avert the negative effects of polluted water, can be considered as an indicator of the pollutee’s willingness to pay for the improvement of water quality. Such method is likely to provide an underestimated value of the asset and to allow for comparison with second most valuable possible asset use.

8. Conclusion

The in depth case study of the environment-related transaction between Vittel and farmers provides raw materials for confronting theoretical propositions and arguments with a real world situation. Several policy implications and theoretical insights have been drawn from the Vittel case, showing that the ‘problem is one of choosing the appropriate social arrangement for dealing with harmful effects (...). Satisfactory views on policies can only come from a patient study of how, in practice, the market, firms and governments handle the problem of harmful effects’ (Coase). The confrontation has put into relief several exciting and challenging issues. Indeed, the Vittel case shows that even in the

presence of a priori high transaction costs, a Coasean bargaining solution may be designed and implemented successfully if these transaction costs are sufficiently low.

The degree of subdivision of rights can improve the efficiency of transactions, because agents can contract on the necessary rights only. Consequently, they make the Coasean bargaining process more efficient. However, such precise delineation and definition is not costless and must be considered in context with the expected benefits, over a comprehensive horizon, including the possibility of other similar applications. The role played by public authorities was also decisive and obviously reduced the overall transaction costs, as well as reducing the transaction costs incurred by each party. The success and the transposition of the approach in other places must not hide the risk that public authorities may be 'instrumentalized' by private parties.

One of the most promising issues resides in the possible extension of the Williamson's framework to environmental economics; in the dimensionalization of environmental-related transactions and governance structures and in their alignment, especially in the policy instruments chosen for supporting environmental-related transactions. The contractual arrangement with an *ad hoc* structure –between a pollutee and several polluters generating non-point source pollution – provides an original experience that can be transposed and applied in similar situations.

References

- Barbier, M., 1997. Quand le pollué et les pollueurs se découvrent conventionnalistes. *Revue Française de Gestion* 112, 100-107.
- Barbier, M., 2004. Personal communications.
- Barzel, Y., 1982. Measurement costs and the organization of markets. *Journal of Law and Economics* 25 (1), 27-48.
- Barzel, Y., 1985. Transaction Costs: Are They Just Costs? *Journal of Institutional and Theoretical Economics*, 141 (1), 4-16.
- Barzel, Y., 1997. *Economic Analysis of Property Rights*, 2nd ed., Cambridge: Cambridge University Press.
- Brossier, J., Gafsi, M., 1997. Farm management and protection of natural resources: analysis of adaptation process and dependence relationships. *Agricultural Systems* 55 (1), 71-97.
- Brossier, J., Gafsi, M., 2000. Une gestion négociée d'un problème de pollution : pratiques agricoles et qualité de l'eau, l'exemple de Vittel. *Comptes rendus de l'Académie d'Agriculture de France* 86 (2), 57-72.
- Chia, E., 2004. Personal communications.
- Chia E., Raulet, N., 1994. Agriculture et qualité de l'eau : négociation et rôle de la recherche - Le cas du programme AGRE. *Etudes et recherches Systèmes Agraires et Développement* 28, 177-193
- Coase, R. H., 1960. The problem of social cost. *Journal of Law and Economics* 3, 1-43.
- Coase, R. H., 1974. The lighthouse in economics. *Journal of Law and Economics* 17 (2), 357-376.
- Dahlman, C. J., 1979. The problem of externality. *Journal of Law and Economics* 22, 141-62.
- Deffontaines, J. P., Brossier, J., 2000. Système agraire et qualité de l'eau. Efficacité d'un concept et construction négociée d'une recherche. *Nature Science Société* 8 (1), 14-25.
- Demsetz, H., 1969. Information and efficiency: another viewpoint. *Journal of Law and Economics* 12, 1-22.
- Dulbecco, P., 2003. The dynamics of institutional change and the market economy: Understanding contemporaneous market development process. *Review of Austrian Economics* 16(2-3), 231-251.

- Eggertsson, Thráinn, 1999, *Economic behavior and institutions*, Cambridge Surveys of Economic Literature, Cambridge, UK.
- Furubotn, Eirik G., Richter, Rudolph, 2000, *Institutions and economic theory: the contribution of the new institutional economics*, Ann Arbor, University of Michigan Press.
- Gafsi, M., 1999. Aider les agriculteurs à modifier leurs pratiques – Eléments pour une ingénierie du changement, INRA SAD, Façade 3, 1-4.
- Glaeser, E. L., Laibson, D. I., Scheinkman, J. A., Soutter, C. L., 2000. Measuring trust. *Quarterly Journal of Economics* 115 (3), 811-46.
- Heid, P., 1997. Organic agriculture protects drinking water around Munich, Germany. *Ecology and Farming* (14), 24.
- Höllein, K., 1996. Clean water through organic farming in Germany. *Pesticides News* (32), 18.
- INRA (National Institute for Agronomic Research), 1996. Programme de recherche AGRiculture-Environnement-Vittel. Documents de base. INRA SAD, Unité Versailles-Dijon-Mirecourt.
- INRA, 1997. Vittel. Les Dossiers de l'environnement de l'Inra 14.
- Ippolito, P.M., Matthios, A.D., 1990. The Regulation of science-based claims in advertising. *Journal of Consumer Policy* 13, 413-445.
- Jung, C., Krutilla, K., Viscusi, W. K. Boyd, R., 1995. The Coase theorem in a rent seeking society. *International Review of Law and Economics* 15, 259-268.
- Libecap, Gary, 1989, *Contracting for property rights*, New York, Cambridge University Press.
- Libecap, G., 2002. A transaction costs approach to the analysis of property rights, In: E. Brousseau and J.M. Glachant (Ed.), *Economics of Contracts, Theory and Applications*, Cambridge: Cambridge University Press, 140-157.
- Libecap, G. D., 2004. Chinatown: transaction costs in water rights exchanges—The Owens valley transfer to Los Angeles. Working Paper, Eller College of Management.
- Ménard, C., 2003. L'approche néo-institutionnelle: des concepts, une méthode, des résultats. *Cahiers d'économie politique* 44, L'Harmattan, 103-118.
- Ménard, C., Shirley M., 2002. Reforming public utilities: lessons from urban water system in six developing countries. Mimeo. Washington, DC, World Bank.
- Ostrom, Elinor, 1990, *Governing the commons: The evolution of institutions for collective action*, Cambridge University Press.
- North, D.C., 1990, *Institutions, institutional change and economic performance*, Cambridge, Cambridge University Press.
- Perrot-Maître D., Davis P., 2001, Case studies of markets and innovative financial mechanisms for water services from forests, *Forest Trends*, Washington.
- Richards, K. R., 2000. Framing environmental policy instrument choice. *Duke Environmental Law and Policy Forum* 10 (2), 221-285.
- Reibel, C., 1999. Dans le périmètre de captage d'eau, 24 agriculteurs sous contrat avec Vittel. *Réussir Lait Elevage* 117, 80-81.
- Rogerson, W.P., 1983. Reputation and product quality. *Bell Journal of Economics*, 14(2), 508-516.
- Schmidtz, David, 1991, *The limits of government*, Boulder, Colorado, Westview Press.
- Schuchardt, J., 2004. Water resources engineering and experiences in voluntary approaches, *Lednice, CZ* i 30.6.
- Van Zandt, D. E., 1993. The Lessons of the lighthouse: Government or private provision of goods. *Journal of Legal Studies* 22 (1), 47-72

Williamson, Oliver E., 1975, *Markets and hierarchies: analysis and antitrust implications*, New York, Free Press.

Williamson, Oliver E., 1985, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, The Free Press, New York.

Williamson, O.E., 1991. Comparative economic organization: the Analysis of Discrete Structural Alternatives, *Administrative Science Quarterly*, 36: 269-296.

Williamson, Oliver E., 1996, *The mechanisms of governance*, Oxford University Press, New York.