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Douadia Bougherara, Gilles Grolleau, Naoufel Mzoughi

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Douadia Bougherara

Gilles Grolleau

Naoufel Mzoughi

Abstract: A theoretical framework combining the two branches of TCE, *i.e.*, the governance branch (Williamson, 2005) and the measurement branch (Barzel, 2005) may explain the choice of the governance structure for private environmental transactions. Four case studies, *i.e.*, the market for pure air in polluted cities, the contractual arrangement between *La Esperanza* and the *Monteverde Conservation League*, the case of the French mineral water bottler *Vittel* and the case of land ownership by land trusts are briefly developed in order to support the theoretical framework. Special attention is devoted to the presence (or not) of a 3-D (defined, defended and divestible) property rights system and its influence on the way environmental property rights are likely (or not) to be re-arranged. Lessons and policy implications are drawn in order to foster research on these challenging issues.

Key words: property rights; environmental transactions; measurement; transaction-cost economics.

JEL Classification Numbers: D23; K32; Q58.

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1. Introductory remarks

Several theoretical contributions have recently attempted to build a theoretical bridge between transaction cost economics (TCE) and environmental economics (Richards, 2000; Hagedorn, 2002; Delmas and Marcus, 2004; Bougherara et al., 2006). Other studies, such as Paavola and Adger (2005) and McCann et al. (2005), have focused more broadly on the links between environmental economics and new institutional economics. They argue that the conceptual framework of new institutional economics has potentially attractive features for environmental research but has mainly focused on other domains such as industrial organization or public utility regulation.

The limited application of TCE in environmental economics may result from an important difference in the basic unit of analysis. Indeed, the *externality* is the basic unit of analysis in environmental economics (Baumol and Oates, 1988; Cropper and Oates, 1992) while the *transaction* is the basic unit of analysis in transaction cost economics (Coase, 1960; Williamson, 1998). Coasean economists have heavily criticized the externality concept and its usefulness (Coase, 1960, 1988; Cheung, 1970; Dahlman, 1979; Randall, 1993; Zerbe and McCurdy, 2000; Anderson and Libecap, 2005), some of them calling for expunging it from the analytical toolbox (Cheung, 1970; Anderson, 2004). We contend that shifting from the externality to the transaction as the basic unit of analysis is not only quibbles over words, but may generate fruitful theoretical advances. Coase (1992) contends that he "explained in "The Problem of Social Cost" that what are traded on the market are not, as is often supposed by economists, physical entities but the rights to perform certain actions, and the rights which individuals possess are established by the legal system" (Coase, 1992, p. 717). For example, a

river may be used in different ways such as fishing, recreation, transportation, electricity production, dump waste from paper mill and irrigation. It is obvious that some of these uses are conflicting, *e.g.*, power production and transportation or swimming and waste dumping. Water pollution by a factory is simply a use of the river that conflicts with others' enjoyment of that scarce resource. In a different context, Coase (1960) emphasized that the main "question faced by the courts [to solve this conflict] is not what shall be done by whom but who has the legal right to do what". Indeed, a way to resolve such conflicts is through competition. A property right system in a society defines the allowable forms of competition by giving to individuals the exclusive rights to use their resources and to voluntarily transfer them. Consequently, environmental problems are viewed as a competition over conflicting uses for scarce resources and the main question in the preceding example is: who has the right(s) to use the river and therein derive value from it? While every one takes property rights for granted for normal items like cars or houses, their use in some domains like natural resources can be challenging, notably because of tremendous legal, cultural and technological barriers.

Basically, a transaction refers to an elementary coordination problem between at least two parties in conflict over resource use and potentially involves a transfer of property rights. Such a definition is more inclusive than the definition of commercial transactions by Williamson and closer to the definition of Commons upon which Williamson bases his own definition (Ramstad, 1996). Esty (2004, p. 142) concedes that "because Williamson's analysis centers on corporate organization, his transaction cost-based categorization of institutional structures requires some translation to make sense in the environmental realm. The relevant "transaction" is not that of a firm but the effort to protect (or exchange) environmental property rights." Coase showed that the common assumption that there are no costs involved

in carrying out market transactions is completely unrealistic (Coase, 1960). Consequently, transaction costs are the resources used to define, establish, maintain and transfer environmental property rights (McCann et al., 2005, p. 530; Barzel, 1989), even if in some cases the transaction *sensu stricto* does not arise.

Simply put, the externality framework has legitimized governmental intervention while the transaction framework focuses the attention on how the marketplace may resolve conflicts over the use of an environmental resource (Coase, 1960; Anderson, 2004; Anderson and Libecap, 2005). The transaction framework does not eliminate any role for government, but rather advocates a significant role to develop an effective system of 3-D (*i.e.*, defined, defendable and divestible) economic property rights[2, 3] (Hill, 1997; Yandle, 1999a).

In the Coasean tradition (Coase, 1960; 1974), we contend that detailed empirical studies of real world environmental transactions may generate insightful theoretical advances. The originality of this paper is threefold. First, it reformulates environmental issues as environmental transactions between private parties that can be achieved through different social arrangements. The environmental transaction is the basic unit of analysis and its particular attributes call for particular institutions in order to achieve a transaction cost economizing result. Second, unlike the traditional viewpoint that considers environmental problems as a 'market failure' requiring quasi automatically a 'state intervention', several real world examples of private arrangements in the environmental realm are developed. They

[2] To avoid any confusion, we distinguish legal property rights from abilities to make choices, *i.e.*, economic property rights. The legal property rights are the property rights that are recognized and enforced by the government. The economic property rights of an individual over an asset are the individual's ability, in expected terms, to consume the good or the services of the asset directly or to consume it indirectly through exchange. Agents may capture economic property rights, even if legal property rights are absent, and such initiatives can be supported by other formal or informal institutions (Barzel, 1989).

[3] In the real world process, evolution and development of property rights are very complex. In many cases, government does not create property rights as a policy decision, *ex nihilo*. The rights somehow develop through spontaneous evolution or other unauthorized processes, sometimes including coercive measures (Nelson, 1986).

support the Coasean seminal propositions that private arrangements may solve environmental issues in an efficient way. Third, we attempt to operationalize in the environmental realm a transaction cost analysis inspired by the economics of governance *à la* Williamson-Barzel.

The remainder of this paper is presented as follows. In the next section, we provide a theoretical sketch of TCE applied to environmental transactions between private agents in a given institutional setting. Section 3 explores four illustrative case studies through the lens of TCE. Section 4 draws lessons and conclusions.

2. Applying TCE to private environmental transactions

This section provides a theoretical sketch of TCE applied to private environmental transactions. Our reasoning follows the three steps suggested by Williamson (1991): characterizing the transactions, dimensionalizing the governance structures and aligning the transactions to governance structures in a discriminating way.

2.1. Characterizing environmental transactions

"That which is common to the greatest number has the least care bestowed upon it" (Aristotle).

Environmental problems are fundamentally problems of poorly defined property rights (Coase, 1960; Hardin, 1968; Anderson and Libecap, 2005). In addition to the three attributes proposed by Williamson (1991) to characterize a commercial transaction, *i.e.*, asset specificity, uncertainty and frequency, we contend that the *extent to which property rights over environmental resources are 3-D* is a major attribute of environmental transactions. Interestingly, Williamson himself conceded that his list including 3 attributes was not exhaustive (1991, p. 281) and recently suggested (Williamson, 2005, p. 33-34, 43) that weak property rights may play a similar role to that of asset specificity (see also McCann et al.,

2005, p. 529). Drawing on previous work (Yandle, 1999a; Anderson and Leal, 1991), we describe below the three dimensions or three characteristics shared by effective property rights. Sometimes, it can be useful to consider a bundle of rights including an environmental property right rather than a stand alone right. For example, the right to modify the underground water is frequently tied to the right on surface activities.

Well *defined* property rights means that the physical attributes of the resources are clearly specified and measurable. A system of well defined property rights can be described as the set of economic and social relations specifying the position of each individual with respect to the utilization of resources (Furubotn and Pejovitch, 1972). For example, land is often surveyed and the boundaries of property are recorded so that any disputes over land ownership can be easily settled. The rectangular survey system may also help define ownership to the airspace over land or to underground resources, but more questions arise here because of the fluidity of air, the infinite vertical third dimension above ground and when a part of common oil pool is located under the owned surface. For non-point source pollution, attributing individual responsibilities may be extremely difficult. In the preceding cases, delineation of property rights becomes obviously more difficult (Libecap, 2005).

Defendable and *enforceable* property rights are needed. If for any reason, rights to a resource cannot be defended against theft, harm, and use by others or trespass, the value of this resource diminishes. Without defence and enforcement, the holder of well defined surface rights to land cannot prevent other incompatible uses. Conflicts are inevitable if there is no way to defend and enforce the boundaries. The development of barbed wire in the 1870s provided an inexpensive way to defend property rights on the U.S. western frontier (Anderson and Hill, 1975). But enforcing one's rights to peace and quiet by "fencing out" sound waves

may be more difficult, as will keeping other people's hazardous wastes out of a groundwater supply. Whenever the use of property cannot be monitored or enforced, property rights become worthless and trade is impossible.

To solve interpersonal conflicts over environmental resources, transferable or freely *divestible* property rights are needed. In other words, the owner is free to sell or rent the resource to any willing buyer. Gains from trade can be realized and potential wealth can be created. While the costs of defining and enforcing resource uses are mainly shaped by the physical nature of the property and technology, the ability to exchange is largely determined by the legal and institutional environment (Anderson and Libecap, 2005). Suppose that an environmentalist values a wildlife habitat more than the farmers value the same habitat for farming certain crops. In France, for example, such an environmentalist was legally prevented from contracting with the farmer to impose environmental restrictions and the potential for gains from trade was precluded[4].

3-D property rights are fully consistent with the measurement issues raised by Barzel (1989; 2005; Bougherara et al., 2006). As frequently asserted, 'what gets measured gets managed' (*e.g.*, McCann et al., 2005). Indeed, measurement issues are frequently (but not exclusively) the core problem, preventing the emergence of 3-D property rights[5]. Perfect 3-D property rights mean that measurement issues are not problematic. It can be helpful to visualize the characteristics of 3-D property rights as measured along the axes in a three dimensional space

[4] At common law, downstrean parties hold the right not to be harmed without permission. Public nuisance law handles the collective harm problem. Private nuisance law handles the individual harm cases. Parties upstream that wish to use the environment in ways detrimental to those downstream can contract around the common law rule. In other words, common law established 3-D rights early on, especially for water pollution.

[5] Measurement difficulty may arise both in terms of the sources and the consequences of pollution, similarly to asset specificity (see Bougherara et al., 2006 for more details). Husted (2004, p. 252) illustrates this difficulty of measurement when "a factory's output is, in and of itself, not noxious; however, in combination with the by-products of other production processes, it can be toxic."

(Arnason, 1999[6]). A given property right exhibits the three characteristics to a greater or lesser extent that can be conveniently scaled from 0 (the characteristic is lacking) to 1 (the characteristic is fully present). For each property right studied, a footprint can be depicted by comparison with a perfect 3-D property right (figure 1). Noteworthy, the definition and defense characteristics are essential and must be both positive, at least to some extent. Indeed, with nil values for these two characteristics, the whole property right can be considered as worthless.

[Insert Figure 1]

A perfect 3-D property right means that carrying out a transaction generally involves a minimal transaction cost[7]. The extent to which property rights are defined, enforced and transferable evolves over time. While the establishment of a system of property rights has many advantages, Eggertson (1990; chapter 8; see also Yandle, 1999b) points two reasons for why governments do not always work for this goal: the cost of doing so and political opposition. When resources become scarce, and sufficiently valuable to overcome the burden of cost, competition among potential claimants provides incentives to invest in defining, enforcing and transferring property rights (Anderson, 2004). Several real-world examples show that technological and institutional innovations may increase the extent to which property rights reach higher 3-D levels. (Demsetz, 1967). The attributes of environmental transactions exposed above give rise to different contractual hazards that governance structures could mitigate.

[6] Arnason (1999) suggested a methodology to measure the quality of property rights that may be useful to extend our analysis.

[7] Even in the case of 3-D property rights, certain properties of environmental assets may increase transaction costs. For example, some environmental amenities may require contiguous acres and landowners may exploit spatial opportunism by holding out.

2.2. Dimensionalizing the governance structures

Williamson lists three discrete governance structures, including neoclassical markets (the textbook ideal), hybrid modes (into which private ordering credible commitments have been crafted) and hierarchy (unified ownership) (Williamson, 2005; Ménard, 2004 for recent progress in the understanding of hybrid forms). These governance structures can be extended to address environmental transactions between private parties. For example, we can consider that spot markets exist for some environmental goods, *e.g.*, selling and delivering canned pure air in some polluted cities. Spot markets rely on price signals and decentralized decision making by agents pursuing their own self interest. Hybrid approaches, sometimes correspond to agreements or conventions between 'polluters' and 'pollutees' under which agents commit voluntarily to undertake some actions in order to provide (or abate) an environmental good (harm) (Coase, 1960). Lastly, hierarchy corresponds to coordinated adaptation among economic actors working through administration. For instance, in some cases, a firm may acquire (or integrate) certain environmental rights, or in other words the rights to perform certain actions that affect environmental quality, which is the central object of the transaction. The environmental governance structures are distinguished on the basis of three characteristics: instruments (incentive intensity, administrative controls), performance attributes (adaptability) and contract law (dispute settling). At the one extreme, the spot market combines high powered incentives with weak administrative controls and dispute settling by courts that together generate a strong autonomous adaptability. At the other extreme, the hierarchy is characterized by low-powered incentives and internal dispute settling (forbearance), which together lead to a strong cooperative adaptability. Hybrid forms are located between spot market and hierarchy with respect to incentives, administrative controls, contract law and costs (Williamson, 1991, 2005; Ménard, 2004). Beyond the private sphere, the public authorities may intervene and modify the system of private property rights

by regulating some environmental issues (Coase, 1960; Williamson, 1999; Bougherara et al., 2006). Regulation attempts to modify market outcomes with outcomes mandated by government (McGee and Block, 1994; Hill, 1997). Despite its obvious importance and the voluminous literature on it, this issue is beyond the scope of this paper.

2.3. Aligning the transactions to the appropriate governance structures

Transaction costs economies are achieved by assigning environmental transactions that differ in their attributes to environmental governance structures in a discriminating way. The general argument is as follows: more complex modes of governance are reserved for more hazardous transactions. For Williamson (2005), much of the explanatory power of the theory rests on asset specificity which is largely corroborated by empirical studies (Shelansky and Klein 1995). Bougherara et al. (2006) suggest that the difficulty of measurement may play the role of asset specificity in environmental transactions. Here, we refine the analysis by contending that given the institutional context, the extent to which property rights are 3-D determine what governance structures generate a transaction costs economizing result. The hazard that is posed by imperfect property rights (r) is that of maladaptation: as r increases, the maladaptation hazard both changes and grows and the need for added governance appears. r is a measure of the extent to which property rights are 3-D. The individual's make-or-buy decisions reflect a series of decisions about property rights hazards illustrated in figure 2.

[Insert Figure 2]

As property rights are perfectly 3-D ($r=1$), faceless interactions in spot markets may solve the environmental problem (node A). If property rights are imperfectly 3-D ($r<1$), parties have incentives to promote continuity and safeguard (s) their investments. s denotes the level of

any such safeguards. In other words, if *s=0*, the option is to live with the hazard without any safeguards (node B). Node B poses unrelieved contractual hazard in that weak property rights (*r<1*) are not compensated by the use of safeguards. If *s>0*, safeguards are provided to mitigate contractual hazard. This last splits into two options at nodes C and D. At node C, dependant parties use hybrid contracts to support cooperative adaptations across a wider range of disturbances. At note D, the transaction may be taken out of the market and organized under hierarchy, through unified ownership (Demsetz, 2003). Because added bureaucratic cost accrue upon taking a transaction out of the market and organizing it internally, internal organization is usefully thought of as the organization form of last resort: try markets, try hybrids and have recourse to the firm only when all else fails[8].

As the property rights are very weak, (*r<<1*) and the measurement difficulty extremely crucial, the state may intervene by imposing regulations, which can be described as a new system of property rights. "Instead of instituting a legal system of rights which can be modified by transactions on market, the government may impose regulations which state what people must or must not do and which have to be obeyed" (Coase, 1960). Nevertheless, the rights established by regulation must be distinguished from private property rights and may violate them (McGee and Block, 1994; Goodin, 1994; Hill, 1997). Two sublevels not depicted in figure 2 can be conceptually distinguished. At the first sublevel, the goal is politically determined but the methods to achieve it are left to regulated entities. The state designs market incentives such as taxes or marketable permits that push regulated entities to reduce pollution (market-based instruments)[9]. Conceptually, at the second sublevel, the state fixes both the overall goal and the way to reach it, *e.g.*, by imposing technological devices

[8] We do not mean that hierarchy has higher total transaction costs than hybrid forms under all circumstances. Indeed, in some circumstances, hierarchy may constitute the most economizing transaction cost way to organize the transaction.

[9] On the difference between market-based instruments and free market environmentalism, see McGee and Block (1994), Cortado (1997), Hill (1997).

(command-and-control instruments) (Bougherara et al., 2006). Interestingly, public authorities rely more and more on contracting for the provision of certain environmental services. In such cases, public authorities may sometimes be considered as a stand-in for individuals[10].

3. Some case studies of environmental transactions through the lens of TCE

In the following, we briefly present four insightful case studies that illustrate how environmental transactions may be mediated through the governance structures suggested by Williamson. The cases illustrate how various governance structures were chosen to economize on the specific transaction costs present in each instance. We expose the spot market devoted to the selling of pure air in polluted cities, the contractual arrangement between a hydropower producer and a conservation NGO, the quasi integration of farmers' rights by a mineral water bottler and the choice of land trusts to own land or to contract with farmers for the provision of amenities.

3.1. A case of environmental spot market: the selling of pure air in polluted cities

The air of most major cities is polluted, *e.g.*, Mexico and Tokyo. By breathing this contaminated air, the health of residents is harmed. Some people willing to respire an uncontaminated air constitute a demand side for entrepreneurs able to sell pure air. In some cities, one may enjoy the coin-operated oxygen booths in public areas, regardless of its objective efficacy. For instance, in Beijing there is a flourishing business in selling oxygen. There are booths where you can breathe 50% oxygen for $6 an hour. In Mexico, the price of one minute of fresh air from a sidewalk oxygen booth is about $1.15[11].

[10] Nevertheless, the governmental contracting for environmental services differs from private contract, notably in the sense that they are frequently achieved under the threat of a stricter regulation.

[11] http://www.doorbell.net/tlr/87_93.htm.

In addition, several entrepreneurs have manufactured canned oxygen (http://www.thebigox.com/) and take bottled water as an inspiring model. Pure air, *i.e.*, oxygen is commoditized[12]. Such transactions are supported by something similar to classical contract law (costless dispute settling by courts) in which the identity of transacting parties is irrelevant and dependence weak. Interestingly, the rights are well-defined, enforceable (canned oxygen or oxygen booths allow exclusive use unlike atmospheric air) and transferable at low transaction costs. Consequently, the role of governments remains limited.

3.2. The contractual arrangement between La Esperanza and the Monteverde Conservation League[13]

The private Costa Rican firm *Inversiones La Manguera S.A.* has a project to build a 6 MW run-of-river power plant called *La Esperanza* in northern Costa Rica. Most of the watershed (3000 ha) used by the project is located within the Children's Eternal Rainforest, owned by a not-for-profit non-governmental organization, the Monteverde Conservation League (MCL). MCL was created in 1986 by a group of scientists, activists, and community members with the goal of purchasing sections of the remaining forestland in the surroundings of Monteverde for conservation purposes. MCL currently owns over 22,000 ha of forestland in the Tilarán Cordillera. The forests located in the upper watershed of the hydropower plant La Esperanza provide a range of downstream hydrological services for which the hydropower producer is willing to pay.

Under a private agreement signed in October 1998, *La Esperanza* pays the Monteverde Conservation League for environmental services obtained through the protection of about

[12] http://www.columbiatribune.com/2006/Jul/20060718Busi014.asp.

[13] The data for this case study comes mainly from the contract itself (Janzen, 1999), Rojas and Aylward (2002), Rojas and Aylward (2003), and personal investigations.

3000 ha of forests located in the basin of the hydropower producer but owned by the environmental NGO. The agreement allowed the settling of a dispute over a small parcel of land (0,5 ha) where the hydroelectric plant was to be built, granting the right to the company to build and use the water during 99 years, after which infrastructure and land will become the property of MCL. The conflict over the use of this parcel of land arose because two different official land titles stated that both parties owned the considered parcel. The contract stipulates different amounts to be paid according to the different stages of the project. It starts out with a payment of $3/ha/year during the construction phase of the hydro project. The amount paid is gradually raised to $10/ha/year on the third and fourth years of operations. All payments up to the fifth year are to be made in advance, at the beginning of every year. After that, payment is made retroactively every six months. Interestingly, the contract between La Esperanza and MCL is based on the model established in a previous governmental sponsored scheme. The payment is also indexed on the standard compensations specified in the scheme that is $10 per year per hectare per environmental service[14]. After the five first years, the amount of payment is variable and depends on the production and sale price (Rojas and Aylward, 2002), using the following formula:

$$\textit{Payment for environmental service} = \$10 * (G_r/G_f) * (T_{avg}/T_{beg})$$

where $10 is the reference value of the services per hectare per year, Gr is the real energy (GWh) generated during the time period, G_f is the forecasted energy (GWh) production for the time period, T_{avg} is the average power tariff (US$) paid throughout the time period and T_{beg} is the tariff (US$) paid for the energy generated on the first day of the time period. The innovative aspect of the compensation scheme is that it links the payment to power production

[14] For example, FONAFIFO (Fondo Nacional de Financiamiento Forestal or National Forestry Financing Fund) set US$ 40/ha/yr as the standard payment for a bundle of four environmental services: mitigation of greenhouse gas emissions, watershed protection, biodiversity protection, and natural scenic beauty.

and inflation (Rojas and Aylward, 2002). Interestingly, the payment scheme is not indexed on the value of environmental service provided, but on the profitability of the infrastructure according the real-world circumstances. The parties do not precisely measure the value of environmental services provided. Such a measurement would mean a more tailored contract, but this benefit was probably estimated to be (more than) offset by high measurement costs. Estimations made by Rojas and Aylward (2002) indicate that the payment for environmental services causes a 21 percent increase in operation and management costs of the hydropower producer. Correspondingly, such payments contribute for 10 to 25% to the annual budget of Monteverde Conservation League.

The contract gives surface rights to La Esperanza, while the MCL retains full ownership of the land. Despite the fact that the contract states that the payment for environmental services is independent of the surface right, it is a by-product of the negotiations initiated because of the land dispute. In fact, the contract stipulates that the surface rights granted to La Esperanza remains contingent on the payment of environmental services. If La Esperanza delays the payment of environmental services by more than one month after it is due, the MCL would immediately recover the full surface right to the land and all infrastructure on it.

3.3. A quasi integration strategy: Protecting the Vittel catchment area from polluting activities through the purchase of lands and contract

Vittel is one of the most famous brands of Nestlé Waters[15], the world leader in bottled water distributing to 130 countries. In 1988, the Vittel production unit noticed a quality deterioration in its mineral water, notably a slow but regular and significant increase in nitrates. The problem was crucial because Vittel may lose its famous reputation and its right to label its water as 'a mineral water'. According to French regulation, mineral water is usually declared "originally pure", characterized by a constant level of minerals and trace elements, that is, "not under the threat of any pollution" (Barbier and Chia, 2001). Moreover, many bottlers emphasize their low nitrate concentration to attract consumers and to disadvantage rivals that have higher nitrate concentration. Indeed, it is mandatory that the nitrate concentration be labeled on each bottle. Interestingly, several bottlers of natural mineral water and spring water in France, *e.g.*, Katell-Roc, Divona, Bagatz shut down their production units because of water pollution by nitrates. The main cause of Vittel pollution was identified as non-point source pollution from intensive farming practiced in the fields surrounding the Vittel springs. These upstream farmers (about 40 farmers on 3500 ha) were mainly milk and grain producers. In 1988, the sales and profits of Vittel were respectively estimated at about 206 and 6 millions euros while the total sales of concerned farmers were less than 2% of the sales of Vittel (Brossier et Deffontaines, 1997).

Vittel initially purchased several fields (about 1500 ha), *i.e.*, acquired property and tenant rights close to its springs by offering attractive prices to retiring farmers (Chia and Raulet, 1994; Brossier and Gafsi, 1997) and became the owner of 45 % of the area in question, in the

[15] Nestlé Waters was previously known as Perrier-Vittel. Hereafter, Vittel refers to the Vittel Company, regardless of its formal name. 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; Market share in value (estimated): 17%; Number of brands of bottled water: 77. (Source: Nestlé Waters: http://www.nestle-waters.com/en/)

process reshaping the water quality. The average purchase price was twice the usual price for lands in this area (≈ € 6000/ha). Such transactions disturbed the local market for agricultural lands (Jechoux, 1990). After, Vittel negotiated with farmers (farm-by-farm) on some environmental rights tied to fields surrounding its springs. To achieve successfully such a bargaining in a conflict context, Vittel contracted with a public research team to produce key information. The research group undoubtedly provided a strategic 'input' for Vittel's negotiation and increased the level of contract completeness, especially on the Vittel side. The research team played a strong role in reducing behavioral uncertainty and measurement problems. Its intervention facilitated the enforcement stage, and consequently reduced *ex post* transaction costs. The research team provided guidance in at least three domains *i.e.*, by (1) delineating the rights on which to contract (delineation of the catchment area, identifying the harmful practices and the technical path to follow in order to improve Vittel's water quality), (2) providing key data about farms allowing Vittel to propose compensations based on the losses due to the adoption of environmentally friendly practices desired by Vittel rather than on the benefits extracted by Vittel from pure water and (3) partly deciphering complex interactions and producing key proxies, sometimes involuntarily[16], to mitigate measurement issues (Déprés et al., 2005).

Later in the bargaining process, farmers become more aware that the environmental rights they possess may allow them to capture more of the rent resulting from the re-arrangement by getting higher compensation (Barbier and Chia, 2001). Some farmers typically held out by delaying their participation or by changing some key variables (*e.g.*, corn surface) that play a strong role in determining the amount of compensation. There is anecdotal evidence regarding strategic action taken by farmers to raise the damage caused to Vittel and expected

[16] For example, the Vittel enforcement uses some scientific research procedures that have been adapted from their initial use (Chia and Raulet, 1994).

compensation, *e.g.*, rumors about farmers who were deliberately putting contaminants into rock faults (Schmid, 1990). The fields and tied dairy quotas previously acquired by the company were also used as powerful incentives to encourage farmers to accept the contractual arrangement by making these fields available to farmers under contract. Indeed these additional lands provided absolute benefits in terms of size increase, but also *positional benefits* because the beneficiaries had bigger farms compared to other farms located outside the catchment area. According to the study achieved by Gafsi (1999) on a sample of farms, these farms have increased their average agricultural area by 34%. Vittel strategically offered the rights-to-use these fields for free as a means to avoid tenant farming status, which does not allow (in France) the owner the opportunity to control the way lands will be farmed. Interestingly, Vittel offered most of these fields in 1994, the principal year of negotiation, in order to reinforce its bargaining power. At the same time, these lands and dairy quotas were also a formidable enforcement device. Indeed, Vittel may punish any deviation from the contract terms by recuperating its lands and quotas.

Despite initial reluctance, the number of farmers under contract has grown and reached a rate of 92% of targeted farmers (Barbier, 1997; Gafsi, 1999). The contract duration is 18 or 30 years and farmers are rewarded in several ways including income support, compensation for abandoning a farm project and adopting a new trajectory, equipment subsidies, and free technical assistance. In terms of performance, the records show that the overall nitrate concentration in groundwater has decreased. Fifty per cent of monitored springs experienced a decrease in nitrate concentration and the other fifty per cent have been constant (Gafsi, 1999).

In sum, despite the exploration of several alternative strategies, Vittel understood that the most economizing and suitable way to solve the pollution issue was through contracting with

farmers. Rather than selecting a governance structure that fits the transaction attributes, Vittel has adjusted the transaction attributes in order to fit the only available arrangement, thanks to the research team input.

3.4. An integration strategy: the purchase of land by land trusts[17]

Environmental degradation is often due to private activities that require the pollutee or parties acting on its behalf to deal with a polluter for conservation on its private land. Agriculture is particularly concerned by conservation policies. First, agricultural land represents a significant share of EU and US land. Second, environmental output and agricultural output are jointly produced by farmers. Farming has negative impacts on the environment but also positive impacts with underprovided goods like biodiversity through hedgerow maintenance or late mowing for example. Policies such as the EU agri-environmental schemes or the US Fish and Wildlife Service and not-for-profit land trusts give private landowner or land-operators the opportunity to enrol in a conservation program. Governmental as well as private parties acting on behalf of environmental sensitive people may offer to contract with private landowners to enhance conservation.

On the private side, land trusts in the US and in UK are not-for-profit organisations whose aim is to preserve wildlife habitat and scenic views on private land on behalf of the general public. There are various ways by which land trusts can conserve land. They can own it outright, they can hold conservation easements, they can lease land, or they can engage in land management contracts with landowners. Probably because of privileged tax treatment towards conservation easements, easements are much more prevalent than leases and management agreements. However, land trusts do not always use conservation easements.

[17] The discussion is mainly based on the work of Parker (2004, 2005).

They sometimes own land outright. Outright ownership corresponds to a model of vertical integration whereas easements correspond to a hybrid approach. Parker (2004, 2005) argue that this choice to own land outright typically reflects transaction-cost economizing behaviour. In particular, the transaction costs of specifying and enforcing easements can be high when the trust wants to intensively manage land or when it wants to coordinate conservation over a landscape of separately owned parcels. As Parker (2005, p.26) notes "the dynamic uncertainty of natural resource management, the costs of specifying easements and verifying compliance, and exposure to spatial holdups[18] provide trusts with incentives to own land." One of the determinants of the choice of outright ownership over easement is property rights being 3-D imperfect. The transaction is then carried out of the market under hierarchy.

4. Lessons and concluding remarks

Several lessons can be drawn from the previous analysis. First, economists have to be cautious not to automatically fall into the trap that nearly all environmental analysis falls into, namely the trap that there is something called the environment that is a good unto itself. Drawing on Coase, economists need to recognize that there are conflicting uses of natural resources such as air and water and that the degree to which voluntary transactions can resolve conflicting uses will be a function of property rights and transaction costs. In this context, “pollution” is not something that is bad in and of itself; it is simply the use of air or water for waste disposal. Whether bargains take place to increase or decrease the use of various disposal media for waste disposal will depend on property rights and transaction costs. Starting from this basic tenet of economics, transaction cost analysis can provide a refreshing way to evaluate alternative methods of resolving conflicting uses.

[18] This problem relates to asset specificity. Trusts contracting easements for the provision of trails and greenways will be more exposed to spatial holdups because of economies of scale across parcels for these amenities.

Second, the marketplace is able to play a stronger role in solving conflicts over environmental assets. To play this role, attention must be devoted to the implementation of 3-D property rights and innovative strategies to economize on transaction costs. Indeed, in some cases, the rules of the game prevent the market from playing its role by restricting property rights on one or several of these three dimensions. Path dependency and institutional lock-in, *e.g.*, in France, farmers were legally prevented until recently from contracting over agricultural practices with private parties. So, decision-makers must prefer institutions with built-in flexibility capable of taking into account unanticipated developments. Government intervention in private business is both part of the problem and the solution. Indeed, governments may take advantage of economies of scale and learning by doing effects in performing many of the tasks associated with the definition and defence of property rights. Nevertheless, establishing 3-D property rights may be so costly that it "may preclude whatever gains might have been realized by the establishment of [property] rights (Anderson and Hill, 1983)". Therefore, a challenging issue that deserves more attention is to systematically assess the transaction costs of such a privatization in comparison with the costs of more traditional governmental intervention (Cole, 1999). Moreover, transactions over environmental assets are sometimes achieved by considering a bundle of rights rather than an isolated environmental right. This strategy is well illustrated by the cases of *Vittel* and *La Esperanza*, where the contract includes more than the alone environmental rights. Indeed, such a strategy may economize on transaction costs. The increase in the payment due to a transaction over a bundle of rights rather than a stand-alone right may be (more than) offset by the economies on transaction costs associated with a more precise delineation and enforcement of environmental rights.

Removing legal impediments to environmental related transactions between private agents is a necessary step but an adequate legal framework does not all the work. Innovative strategies may help to reduce transaction costs. In more concrete words, reaching voluntary agreements between sellers and buyers of environmental services frequently requires trust that can be achieved through the use of intermediaries that diminish transaction costs (Glaeser et al., 2000). In the Vittel case, the research team plays this crucial role between the concerned parties. In addition, the *Vittel* and *La Esperanza* cases show that the financial compensation does not necessarily require to be based on the value of the ecosystem services provided. Contracts may sidestep the measurement problem by specifying the actions to be undertaken by service suppliers in terms of means to the end rather than the end itself. Even if the exact result remains unverifiable at the individual level, the contract becomes verifiable. Anecdotically, by basing the contract on the means rather than the end performance itself, the beneficiary may both lower measurement and enforcement costs and reinforce its willingness to compensate for a switch in practices rather than fairly divide the 'pie'.

Interestingly, while economists generally encourage perfect competition by assuming a great number of sellers and buyers, a TCE analysis may encourage more concentrated market structures in order to economize on transaction costs. Anecdotal evidence shows that private bargaining outcome were more successful in situations involving a small number of transactors. According to Salzman (2005, p. 131), "most successful service markets to date operate as *monopsonies*, with only one buyer for multiple service provider sellers." In the Vittel case, negotiating with a unique 'seller', *i.e.,* a farmer pool was likely to reduce transaction costs on the one hand while serving to increase the monopoly power problem on the other. The analysis on how a system of private property rights may solve environmental problems does not mean any role for public authorities. The line is not so sharp. For example,

the efforts of public authorities (as a stand-in for individuals[19]) to contract with polluters may sometimes constitute a transaction cost economizing strategy to create artificially a quasi-monopsony.

In some cases, the large number of people and the subsequent alleged high transaction costs is not an insurmountable impediment to private deals. Basing his rationale on the Buchanan and Stubblebine's seminal paper (1962), Haddock (2003) contends that all parties involved in an environmental issue on either side are not necessarily identical. Consequently, a few parties on either side may privately interact and bargain to solve the environmental issue with benefits for the entire population. In sum, more is needed to provide clear cut conclusions on the effect of the number of involved parties on the efficiency of environmental transactions.

An unexplored aspect relates to transition effects. Indeed, what is the best path to implement 3-D property rights according to the initial situation? The initial situation that is the temporal point from which deciders, either state or individuals, decide to design and implement an effective system of property rights differs among countries. It reflects an accumulation of customs, norms and formal institutions that opens more or less the door for an effective system of 3-D property rights. For example, market-based instruments such as marketable permits may not constitute an end in themselves, but an intelligent step to reach later a 3-D property rights system. While private solutions to environmental problems may be well suited and easily implemented in countries benefiting from adequate formal and informal institutions, the path to reach the same level in other countries may have a too high opportunity cost, at least, initially. In other words, can we advocate contractual approaches in different institutional environments (e.g., developing countries)? A comparative institutional

[19] In this case, the optimal scale at which public authorities (e.g., local, regional, national and so forth) intervene is a crucial issue that deserves more attention.

analysis is clearly needed before prescribing a timely design and implementation of a 3-D property rights system.

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Figure 1: The quality map of property rights

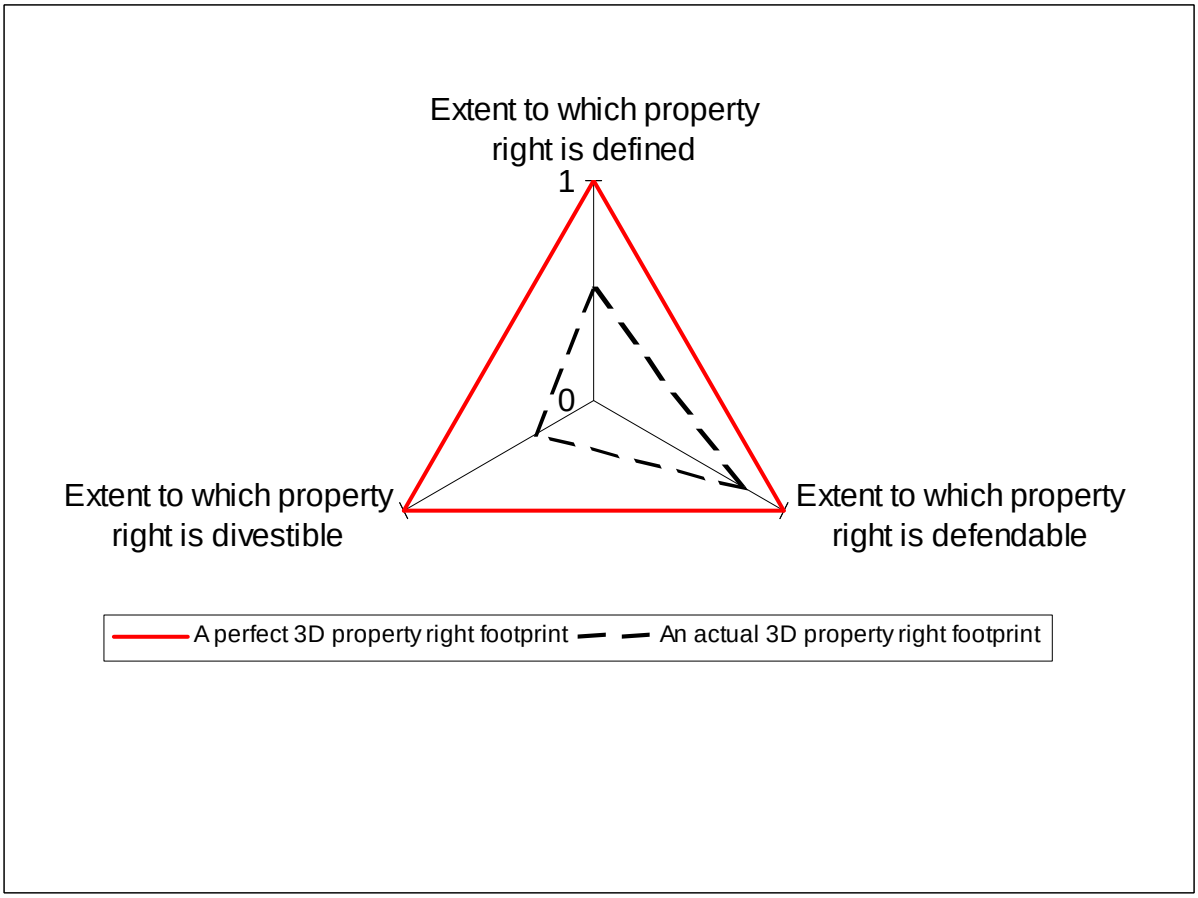

Figure 2: The simple contracting schema in the environmental realm