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Analysis

Designing watershed programs to pay farmers for water quality services: Case studies of Munich and New York City ☆

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ABSTRACT

While preserving water quality by contracting with farmers has been examined previously, we analyze these arrangements from a different perspective. This study uses a transaction cost framework, in conjunction with detailed case studies of two water quality payment schemes, to examine factors that increase and decrease transaction costs in order to improve policy choice as well as policy design and implementation. In both the Munich and New York City cases, agreements with farmers to change land management practices resolved the water quality problems. In Munich, factors including lack of rural/urban antipathy, homogeneous land use, utilization of well-developed organic standards, and strong demand for organic products decreased transaction costs. Using existing organic institutions addressed a range of environmental issues simultaneously. Factors that decreased transaction costs in both cases included: highly sensitive land was purchased outright and the existence of one large "buyer". Adequate lead time and flexibility of water quality regulations allowed negotiation and development of the watershed programs. Tourism and eco-labels allow urban residents to become aware of the agricultural production practices that affect their water supply. We conclude with recommendations based on the experiences of these cities, both of which have been proposed as models for other schemes.

1. Introduction

Preserving and restoring water quality is a major concern in numerous countries. The success of regulations in reducing pollution from point sources[1] has led to an increased focus on nonpoint, unregulated, sources of pollution such as agriculture, which may have lower abatement costs. Point–nonpoint source trading has been enabled by legislation in several places in the U.S. as a way to reduce abatement costs but there has been less trading than expected due to issues such as transaction costs (Fang et al., 2005). Contractual arrangements and payments for water quality services from municipal water organizations to nonpoint sources represent a similar policy instrument. The current study uses a transaction cost framework in conjunction with detailed case studies of two water quality payment schemes (i.e., Munich and New York City) to examine the factors that increase and decrease transaction costs in order to improve policy choice as well as policy design and implementation. Rather than just admitting that high transaction costs can prevent contractual arrangements as emphasized by Coase (1960), we devote attention to factors explaining the level of transaction costs and strategies employed to shape them (Anderson and Libecap, 2005; Déprés et al., 2008; Libecap, 1989).

The water supply of Munich, Germany, with a population of 1.2 million, is mainly from the Mangfall Valley. The water supply for New York City, with a population of over 9 million people, comes from the Catskill Mountains and the headwaters of the Delaware River. In both cities, decreasing water quality in the 1980s meant that expensive water filtration systems would need to be installed ($6 billion in the case of New York City), or that land management changes would need to occur in the watersheds. In both cases, agreements with farmers to change land management practices resolved the water quality problems, however the two cases differed in a number of ways. Using these two detailed cases, we examine the factors

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[1] According to an OECD report (2003, 43), point-source pollution reduction has been successful in most OECD countries, given that 'industrial discharges of heavy metals and persistent chemicals have been reduced (…) by 70–90% (or more) in most cases'. Nevertheless, the same report indicates these successes are not enough to meet water quality standards.

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that influenced the level of transaction costs, the nature of the transaction costs that are likely to affect the potential for exchange, and the opportunities for greater reliance on voluntary contractual solutions.[2] Transaction costs arise throughout the process of an exchange transaction, even if it ultimately does not occur. From an operational viewpoint, these costs notably include the costs of defining, enforcing and exchanging property rights (Dahlman, 1979; McCann et al., 2005). Under some circumstances, they may be high enough to prevent voluntary exchanges (Coase, 1960).

The contributions of this paper are at least threefold. First, it adds empirical content to basic transaction cost concepts by analyzing the design and implementation of real contractual arrangements for nonpoint source pollution in a multi-player setting. Second, our comparative analysis of Munich and New York indicates how specific transaction costs were modified to enable efficiency gains and successful arrangements. Third, it uses the case studies to develop recommendations regarding the design of similar contractual solutions to water quality issues. While our analysis is focused on water quality, it has applicability to other complex environmental and natural resource issues where both physical location and the specific institutional environment are important.

The remainder of the paper is organized as follows. Sections 2 and 3 provide historical background and context, analyze the transaction cost issues in each city, and show how various issues were overcome leading to satisfactory arrangements.[3] The final section provides an overall assessment of arrangements, draws some generalizable lessons and policy implications, and then concludes.

2. Transaction Cost Issues in Munich

Munich is the third largest city in Germany with about 1.2 million inhabitants. For more than 125 years, Munich drinking water was extracted mainly from springs in the foothills of the Bavarian Alps, namely the Mangfall Valley. This valley, located 40 km from the city of Munich, supplies around 80% of the tap water consumed in Munich, that is, about 90 million m^3 per year (SVM, 2008). The land in the catchment areas is mainly used for farming or forestry. Interestingly, since the end of the nineteenth century, the city purchased lands surrounding the Mangfall springs and devoted them to forestry activities. Despite this, in the 1980s, the Munich water organization noticed a slow but significant increase in nitrates (15 mg/l) and pesticides (0.065 µg/l) in groundwater supplying the city. Between 1974 and 1992, the nitrate level increased 250%, from 6 mg/l to 15 mg/l, and there was also deterioration in the taste of the water. Although this increased nitrate level was lower than regulatory requirements for tap water, the city decided in 1991 to behave proactively and encouraged farmers in the catchment areas to adopt organic farming (Table 1).

First, the Stadtwerke München (SVM or Munich City Utilities) delimited the target area (6000 ha) by using hydro-geological data and defined the desirable changes in farming practices that were needed to ensure water quality. While half of the area is covered by forest, around 2250 ha are used for agriculture and 120 farmers (mainly dairy farmers) were in the target area. Then, SVM organized a public information campaign for local farmers in order to encourage them to switch to more environmentally friendly practices. Farmers were initially very reluctant because the suggested changes would have profoundly modified their production practices. To overcome the initial reluctance of most farmers, SVM organized meetings to discuss the issue and provided in-depth guidance to individual farmers by ecological/sustainable farming experts (SVM, 2005). In addition to persuading farmers at meetings, SVM considered the possibility of offering financial incentives tailored to each practice change such as limitations in nitrogen use or manure discharge, or transition to pasture.

The practice by practice approach was abandoned because to be effective, it required extensive monitoring and verification, which would have been very costly and time-consuming. Rather than following its initial plan, SVM switched to a comprehensive approach by encouraging farmers to switch to organic farming, as defined by existing regulations (SVM, 2005). Moreover, the SVM selected 3 reputable associations of organic producers already operating in the targeted areas, namely Bioland, Naturland and Demeter. The SVM paid for the first evaluation by producers' unions of potential candidates for organic conversion, reducing their fear regarding the extent of practice changes and their consequences. SVM recognized that the extensive involvement of the unions helped to overcome farmers' fears (SVM, 2005).

Contractual arrangements were proposed to farmers who had land located in the catchment area. In the Munich case, it is clear that by basing the contractual arrangements on organic farming requirements, SVM economized on several types of transaction costs. Indeed, referring to organic standards in Germany facilitated several phases of the transaction. For example, rather than defining and explaining each practice change, negotiating the value of a specific mix of changes according to a particular situation (e.g., the portion of the farm located in the targeted area) or acquiring skills to effectively monitor and enforce the contractual requirements, SVM benefited from synergies offered by existing organic standards. In Germany, disputes over appropriate payments were seemingly less intense compared to the Vittel case[4] thanks to baselines regarding technical aspects of organic farming and potential losses due to conversion. Rather than starting from scratch, SVM used the experience accumulated by producers' unions to convince farmers. Relationships with farmers were also facilitated to some extent by the unions. In some areas, producers' unions requested stricter requirements than official organic requirements such as only 1.5 cows per ha and banning the use of manure from another farm (Naturland). The monitoring is conducted by conventional certification bodies and violations range from admonition to immediate contract termination. This enforcement strategy is very cost-effective since it uses existing procedures.

Using available knowledge, the payments offered took into account expected lost income and the investments required to switch to organic farming. As a financial incentive, the city offered farmers an annual payment of 280€/ha/year for agricultural land during the first 6 years, regardless of whether the land was owned or leased. For the next 12 years, farmers received compensation of 230 €/ha/year. Interestingly, farmers also benefited from European and national subsidies to switch to (and remain in) organic farming. According to Simonet (2005), farmers received European subsidies of 250€/ha/year for a 5-year period, corresponding to the Bavarian agri-environmental program, the so-called “Kulturlandschaftsprogramm' (KULAP). At the end of the 5-year period, these contracts can be renewed. Given the average farm size of 24 ha in the Mangfall watershed, overall compensation per farmer amounted to more than 10,000€ per year (SVM, 2005). In sum, the financial investment

[2] In our analysis we do not use the externality as the basic unit of analysis but the transaction. Like other authors (e.g., Cheung, 1970; Coase, 1992; Bougherara et al., 2009), we suggest shifting the basic unit of analysis from the traditional externality to the transaction. The transaction framework emphasizes conflicting uses of natural resources by humans and the potential of various institutional arrangements as ways to resolve this conflict.

[3] Multiple sources of case evidence were gathered and analyzed, e.g., reports by various institutions, academic papers, websites of key organizations, internal documents, interview transcripts, and the popular and technical press. These documents describe the history of each case. Of course, any error or misinterpretation is the sole responsibility of the authors.

[4] Vittel is a French bottler of mineral water which developed contractual arrangements with farmers located in their firm's catchment area to change some agricultural practices and preserve its water quality. The case is detailed in Déprés et al. (2008).

required from the city to make the switch profitable for farmers was less than expected because of financial synergies. SVM was also able to leverage consumer market payments for organic produce. Although organic products command a significant price premium that can exceed 30% compared to conventional products, organic farming is less profitable than conventional farming during the initial conversion phase and becomes more profitable than conventional farming about seven or eight years after the switch.[5]

Time is usually required to develop the skills to master organic farming (learning by doing). Moreover, the relatively high homogeneity of farms (in terms of products and methods of production) in the targeted area reduced transaction costs to identify and assist farmers. It also facilitated the process of convincing farmers since results from the early adopters were available. Despite the willingness to prescribe organic farming in the whole targeted area, the arrangement was somewhat flexible since it allowed farms that could not comply with all requirements of organic farming to adopt practice changes favorable to water quality and receive compensation of 200 €/ha/year and have the status of 'supporting members' (SVM, 2005). Given that these supporting members benefit from municipal and state (CAP) financial incentives they are monitored by independent examining teams and spot checks are made by the Department of Agriculture (SVM, 2005). In addition to financial incentives and efficient organizational design, personal characteristics of the farmers involved also played a strong role as admitted by SVM. SVM states that it "has some very conscientious farmers (…) who are practicing ecological farming not only for the sake of financial remuneration but with enormous personal conviction and enthusiasm" (SVM, 2005).

Another noteworthy point is the involvement of Munich and the producers' unions in the processing and retailing of the organic products. For instance, the city is an important purchaser of products from the targeted area to supply its schools and municipal restaurants. The city also funded advertising campaigns to promote the purchase of organic products from the catchment area by Munich inhabitants. These ads frequently emphasized the relationship between purchases of locally produced organic products and water quality. A special promotion involving children's milk indicated "One liter of Bio milk contributes to the protection of 4000 liters of Munich's drinking water" (Höllein, 1996). Interestingly, some broader marketing initiatives aim at creating a link between regional origin and Munich inhabitants. For instance, the 'UnserLand' (Our Land) umbrella organization promotes the marketing of regional products (including organic products) from the counties surrounding Munich (Schafer, 2006). The city involvement was also perceived by farmers as a real and sustainable commitment reinforcing the strategy's credibility.

It is very likely that the initiative benefited from the institutional environment (Dietz et al., 2003; Libecap, 1989; North, 1990; Ostrom, 1990; Williamson, 2000) due to a strong and historically rooted trend in favor of organic farming. For instance, Germany is considered as "one of the founders of organic farming" and as the "largest market for organic food in Europe" and Munich as the "largest market for natural food and organic products in Germany" (Schafer, 2006, p. 3). The city of Munich itself owns 11 farms covering 2800 ha, not necessarily in the catchment area, and offers tours of these farms to promote its citizens' interest in organic farming (Schafer, 2006). Moreover, the city of Munich organizes bicycling tours from Munich to the Mangfall Valley, at the heart of the catchment area, and some tours have included picnics and explanations of the city's initiatives (Simonet, 2005).

In sum, the switch to organic farming was self-enforcing thanks to at least two mechanisms, namely, a mix of financial incentives until organic farming became more profitable than conventional farming, and strong involvement of the city in purchasing and promoting organic products from the targeted area as well as acquisition of specific skills and reputation. If a farmer is largely known as having pro-environmental values by adopting organic farming, this reputational asset (and desire for consistency) can make a return to conventional farming less likely. It is expected that, for established organic farms, the opportunity costs of returning to conventional farming will be so high that it will not be profitable to do so. Another factor in Munich's favor was that the strong existing demand for organic agricultural products in Germany, as well as German farmers' acceptance of sustainable and organic production mentioned earlier (Schafer, 2006), meant that existing institutions, such as well-developed organic production standards, extension organizations, and marketing channels for organic produce could be used, thus decreasing transaction costs. Use of the existing organic institutions also meant that a range of environmental issues related to conventional farming were addressed simultaneously. The farming systems near Munich were also quite suitable to organic production (Ministère de l'Ecologie et du Développement Durable, 2005).

The results are inspiring. Most of the targeted area (110 farmers and 80% of agricultural area) is now under contract and is considered to be the largest contiguous area of organic farming in Germany (Schafer, 2006). There has been a significant increase in water quality with levels of nitrates down to 7 mg/l and some pesticides containing terbuthylazin down to 0.02 μg/l (Simonet, 2005, see also Höllein, 1996). The price increase for water consumers due to the whole water protection scheme is estimated to be 0.005€/m^3 (SVM, 2005) whereas the avoided cost of water treatment equipment was estimated at 0.23/m^3 (Simonet, 2005). Good advance planning and sufficient time were clearly necessary to reach this mutually beneficial arrangement. If the city had not acted early, before they were required to, time considerations may have prevented the use of contractual approaches and forced the water utility to consider engineering solutions (e.g., building a filtration plant). The Munich case has also served as a model and inspired similar arrangements in other German cities (e.g., Stuttgart, Leipzig). Unfortunately, since the New York City

Table 1
Main events regarding the protection of water quality in Munich.

Main dates	Main events
1873–1878	First use of the Mangfall valley (Mangfalltal) to supply drinking water to Munich
Late 1800s	First outright purchase of forest and agricultural fields in the catchment area
1930	Purchase of 30 properties (500 ha) and plantation with spruces and larches
1950s	Seeking of new catchments
1950–1970	Plantation of 100 ha with conifers
1980s	Slow but regular increase of NO_3 and pesticides in groundwater
1991	SVM's decision to encourage farmers to switch to organic farming
1992	Public information campaign for farmers located in the center of the targeted area and initial reluctance of farmers
From 1992	Several meetings, individual and collective discussions between the city, farmers and unions
1993	First 23 farms (800 ha) under contract
1994	50 farms under contract
1998	Updating of contract length after the pilot phase: from 6 years (conversion period) to 18 years (maintenance period)
1999	92 farms (2200 ha)
2005	110 farms (2500 ha) i.e., over 80% of agricultural areas in the conversion area were under contract; only about 10 farms refused to contract

Various sources as indicated in the text.

[5] Burkhard Schaer, Expert in economic analysis of organic farming in France and Germany Ecozept, Personal communication, January 2010. Organic farming is frequently perceived as less profitable than organic farming, but several studies (e.g., Delate et al., 2003; Badgley et al., 2007) comparing organic and conventional farming find that organic farms are often more profitable per acre, even if the time by which organic farming becomes more profitable varies across systems (see Nieberg and Offermann, 2003).

case was unfolding concurrently with the Munich one, they were not able to benefit from the Munich experience.

3. Transaction Cost Issues in New York City

New York City is the largest city in the United States, with about 9 million inhabitants, and consumes almost 5 million m^3 of water per day.[6] The New York City watershed consists of 518,000 ha in the Catskill Mountains and Hudson Valley regions. The portion west of the Hudson River is located 120–200 km north of New York City (Appleton, 2002). It is the largest unfiltered water supply in the U.S. and provides drinking water for the residents of New York City and some other locations, or almost half of the population of the state of New York (Catskill Center for Conservation and Development). Land acquisition and construction of the 18 reservoirs and associated infrastructure began in 1905 and continued through the 1960s and now supplies 90% of the City's water (Table 2). Land was taken by eminent domain and entire towns were relocated or disappeared which contributed to resentments that continue to the present (Gold, 1990; Hoffman, 2008; Porter, 2006). The Croton Watershed, east of the Hudson River, supplies 10% of the City's water but due to the severity of the problems, water from this reservoir will be filtered (Appleton, 2002), therefore this watershed is not part of the discussion below.

Relative to New York City, the Catskill Mountains area is economically depressed, relying on tourism, farming (especially dairy), and construction (Gold, 1990). Three quarters of the watershed is forested, and 85% is in the hands of individuals (Nickens, 1998); half of that is owned by people from the New York City area who have purchased land for vacation or retirement homes. Changes in these local industries eventually jeopardized the natural filtering abilities of the ecosystem, thus compromising drinking water quality in the 1980s (Appleton, 2002; Porter, 2006). More intensive agricultural practices, due to economic pressures, led to more pollutants in the runoff from farms. Forestry practices became less sustainable since forests were not actively managed. There were also increased discharges from wastewater treatment plants and faulty septic systems. Increased development contributed to runoff from impervious surfaces and there was increased building on hills and near attractive streams, which increased erosion (Appleton, 2002).

In the early 1990s, because of the deteriorating water quality, coupled with changes in federal regulation and potential compliance costs, New York City reexamined its water supply strategy. Under the Safe Drinking Water Act Amendments of 1986, the City would normally have been required to filter its surface water supplies unless it could demonstrate that it had taken other actions to protect its customers from harmful water contamination. For instance, a filtration avoidance determination or waiver can be granted to water suppliers if they have a comprehensive watershed protection program ensuring natural filtration and compliance with water quality standards (Murphy et al., 1995). The alternative was to spend $4–6 billion to install a filtration plant (plus ¼ billion per year operating costs) (Appleton, 2002). The filtration plant would have doubled the cost of water to residents and worsened water taste as well. Presented with a choice between provision of clean water through a major investment in a new treatment facility or managing the watershed, New York City decided that using natural filtration through watershed management was more cost effective. A state law dating from the beginning of the reservoir projects gives the City the right to take what measures are necessary to preserve the quality of its drinking water (Gold, 1990). In 1990, the NYC Department of Environmental Protection Agency, headed by Commissioner Albert Appleton, developed a set of regulations, the first since 1954, which restricted development and farming activities in the watershed. This was seen as unfair by farmers and other property owners who would be affected; they thought that New York City residents should pay for what the farmers perceived as changes in property rights (Gold, 1990). Years of what was described as "open warfare" ensued (Nickens, 1998).

Table 2
Main events regarding the protection of water quality in New York City.

Main dates	Main events
1905	Construction on reservoirs and other infrastructure in the Catskill Mountain and Hudson Valley watersheds.
1905	City obtains legal authorization to take land in the watersheds by eminent domain and begins to do so.
1954	Regulations to preserve drinking water quality enacted.
1986	U.S. Environmental Protection Agency promulgates new rules to reduce microbial contamination under the Safe Drinking Water Act.
1980s	Water quality deteriorates
1990	Regulations to preserve drinking water quality to comply with the Safe Drinking Water Act are drafted by the City's Department of Environmental Protection. Conflict ensues.
Early 1990s	The New York State Department of Agriculture works with farmers and the City to facilitate dialogue and problem-solving.
1997	The City and about 30 watershed communities sign the New York City Watershed Agreement.
1998	500 farmers were signed up for the Whole Farm Program.
2002	93% of farmers had chosen to participate in the program, well above the 85% that was stipulated in the Agreement.
2003	1800 acres are in conservation easements and 1375 acres are in agricultural easements.
2009	Over 200 business listings are in the Pure Catskills Guide to Farm Fresh Products

Various sources as indicated in text.

Appleton's office worked to diffuse the confrontation. The City approached the New York State Department of Agriculture to ask them to help (Appleton, 2002). High level administrators of the Department made helpful suggestions for creating a dialogue with farmers such as mutual education on the problems faced by the City and by farmers in the Catskills. Ultimately, Appleton agreed to let the farmers themselves design and run a program to reduce pollution from farms.

In 1997, the City and about 30 watershed communities signed the New York City Watershed Agreement which paid farmers and others to implement changes to preserve water quality. The agreement was estimated to cost $1.4 billion, a significant saving over the new water treatment facility (Nickens, 1998). Activities included upgrading sewage treatment plants and septic systems, acquiring conservation easements, buying land from willing sellers, and developing innovative agriculture and forestry programs (Nickens, 1998). The latter included having farmers sign up for a Whole Farm Planning Program to reduce pollution by implementing best management practices and upgrading manure handling facilities. Technical teams worked to find combinations that improved water quality and also addressed the business and labor needs of farmers. The City also paid for technical assistance, research, and monitoring support that the new Watershed Agricultural Council (consisting of both farmers and government staff) contracted for. Appleton (2002) indicated that it was an ecosystem approach, not a pollutant by pollutant approach, although less comprehensive than the Munich case. In exchange for a voluntary program, the farmers committed to obtaining participation by 85% of the relevant farmers within five years. Farmers were also involved with recruiting and training farmers in the Munich case, but in a less formal way. If the program didn't work, the City had the right to impose restrictive regulations. This represented a credible threat to underpin the search for mutually beneficial programs and policies.

By 1998, almost 500 dairy and livestock farms had signed up for the program, including one who had threatened physical violence (Nickens, 1998). Within five years after the Whole Farm Program was created, 93% of farmers had chosen to participate and there are

[6] The New York Metropolitan Statistical Area has almost 19 million inhabitants, including some in New Jersey and Connecticut, but we focus on those on New York City water.

reports of farmers wondering how they can become part of the watershed (Appleton, 2002). Similar to the Munich case, there is an eco-label for agricultural products from the region, "Catskill Family Farms", now "Catskills Pure" that is managed by the Watershed Agricultural Program (Lydon, 1999). It represents farmers who are participating in the program to improve water quality but the products are not organic. Increasingly, the program seems to be benefiting from the "buy local" movement in the U.S.; they have a Farm to Market Program that helps to connect communities to farmers (Watershed Agricultural Program, 2010).

Land acquisition, as in the Munich case, was another important strategy to improve water quality. This corresponds to the well-known strategy for dealing with pollution, internalizing the externality by the agent being negatively affected purchasing the polluting firm, i.e. integrating the two activities in a single decision unit (Castle, 1965). Demsetz (1967) indicates that both contracting and purchase are options to internalize externalities. However, "…if there are several externalities, so that several such contracts will need to be negotiated, or if the contractual agreements should be difficult to police, then outright purchase will be the preferred course of action" (p. 357–358). This was certainly the case for the Munich and NYC watersheds. Land acquisition was voluntary (willing seller, full market value) but the City also needed to prioritize its acquisitions to efficiently meet water quality objectives (Pires, 2004). The property owned by New York City in 2001 was located closest to the reservoirs. High priority areas for further land acquisition are located in the lower portions of the watersheds, near the reservoirs (Catskill Center for Conservation and Development, 2001). However, the Watershed Agreement stipulated that the City solicit purchase of (not necessarily actually purchase) 143,745 ha of land in the watershed between 1997 and 2007 and this has gone more slowly than expected (Pires, 2004). Another strategy was conservation easements. By 2003, the agency had acquired over 1800 ha in conservation easements (Pires, 2004). There were also 1375 ha under agricultural easements. The parties were able to take advantage of the existing Conservation Reserve Enhancement Program from the United States Department of Agriculture. Munich was also able to benefit from existing programs, as previously mentioned.

The long-standing animosity between people living in the watershed and the governmental agencies from New York City represented an obstacle to this agreement. Pires (2004) and other authors put these relationships in a more general category of critical water resource conflict narratives where a powerful place dominates and extracts resources from a subordinate place. In addition, there was a lack of understanding of the situation of each party. The complexity of the changes required was also an issue. There were two other major parties in addition to the farmers, residents of towns and owners of forested areas. Diversity of the farms as well as the diversity of the stakeholders would tend to increase transaction costs compared to a more homogeneous landscape and population as was the case in Munich. While various organic standards have existed in the United States, national legislation was only passed in 1990 and the regulations were implemented in 2001. Also, until the 2008 farm bill, there was not specific funding available in the United States to facilitate the switch to organic farming. The institutional environment in the U.S. thus did not enable the City to use the same institutional infrastructure that existed in Germany.[7] In addition, organic production alone would not have addressed one of the main water quality issues in the New York case, pathogens from human and animal waste.

A factor that facilitated this agreement was that the Commissioner of the New York City Department of Environmental Protection, Albert Appleton, was open to new ways of thinking about the problem and new solutions (Appleton, 2002). He had a background in management and environmental policy, not engineering, so was more willing to consider non-engineering solutions to the problem. At the level of institutional environment, the 1989 USEPA rule that precipitated the need for filtration to address pathogens allowed the agency to issue a filtration avoidance determination for facilities that had not previously filtered their water. This regulatory flexibility allowed them to consider non-engineering solutions. Appleton found people in the Department of Agriculture that were willing to help address the rural/urban impasse. He thus made use of existing institutions and the trust that the farmers had in that Department. The fact that the farmers in the Catskills had a high level of social capital also helped them to use collective action to design and run the program themselves and recruit the farmers. The City was also willing to purchase land outright and obtain conservation easements rather than use its eminent domain rights. This was a major concession (Pires, 2004).

It is also the case that there were large potential gains available since the cost of the filtration plant was so high. The City could be fairly generous with farmers and still save billions of dollars over time. The City paid the staff costs of the Whole Farm Program, and also the capital costs for some pollution abatement investments (Appleton, 2002). Hoffman (2008; see also Sabatier et al., 2005; Lubell et al., 2002) indicates that sufficient resources make watershed collaborations more likely to succeed.[8] As indicated by the high participation rates and desire of those not in the watershed to participate, the program did more than make the farmers whole, it enabled them to improve their farms and their economic situation.

Hoffman (2008) using federal, state, regional and rural controls found that the collaboration in the New York City case generally had positive or neutral effects on population, incomes, unemployment, wages and agricultural employment but negative effects on the construction industry. From the point of view of the environment, EPA issued filtration avoidance determinations in 1993, 1997, 2002 and 2007, indicating that water quality was satisfactory. Thus, while likely having higher transaction costs than the Munich case, the agreement solved the problem satisfactorily.

4. Some Lessons from the Munich and New York City Strategies to Cope with Non-point Source Pollution

The previous two sections on the historical background of water supplies in Munich and New York City show that the two cities were benefiting for free from natural filtration services for many years. They eventually noticed a deterioration in their water quality and made the connection to watershed activities, notably intensive farming, and were forced to act. Previously, these two groups of agents, farmers and water suppliers, were using the same environmental assets for different purposes (farming, filtration services) but in a compatible way. Then, because of increased use of chemical inputs in farming, more intensive livestock production, and stricter regulatory requirements applied to water supplies, the previous balance was disturbed. These two competing groups were now using the same scarce resources in an incompatible way (Anderson, 2004). In the case of NYC, the formal or legal allocation of rights to the provision of water quality (dating from the early 1900s) was now in conflict with the perceived rights of individuals in the watershed to use the land as they wished for farming or development. The differences in wealth between the Catskills and the City, and the knowledge that in the U.S. environmental practices for farmers are usually

[7] As pointed by one of the referees, even if the U.S. has had federal standards for organic certification since 2002, there is a history of conflict regarding issues such as GMO use and sewage sludge. It is not as well-accepted as the organic standard in Germany. There is evidence showing how consumer preferences have shifted in response to that (e.g., Ward et al., 2004; see also Rosenthal, 2011).

[8] Using a comprehensive survey of empirical literature devoted to watershed partnership, Leach and Pelkey (2001) proposes a comprehensive list of factors contributing to their success including several quoted in our study.

voluntary, may also have contributed to the strong initial reaction against regulation of farming practices in the New York case.

This history also showed that several conditions are likely to influence the level of transaction costs, affecting whether a voluntary contractual agreement is feasible and at what cost it can be implemented. In cases where large gains from trade exist (e.g. NYC case), transaction cost issues may become secondary to win–win opportunities as far as whether an agreement is reached, but are still important as far as the overall cost of the program. Without purporting to be exhaustive, we elucidate several factors that played a significant role in the Munich and New York City arrangements. We then draw some lessons and recommendations based on the experiences of these cities, both of which have been proposed as models for other schemes in their respective countries. Interestingly, the lessons drawn from our case studies are consistent with factors identified in other streams of literature about watershed collaborations (Leach and Pelkey, 2001; Lubell et al., 2002; Sabatier et al., 2005).

4.1. The Importance of the Institutional Environment at Different Levels

The two cases show that the institutional environment (Dietz et al., 2003; Libecap, 1989; Lubell et al., 2002; North, 1990; Ostrom, 1990; Williamson, 2000), including norms, legal frameworks and policy, matters. These deeper levels of institutional environment also shape, to some extent, the level of transaction costs in reaching a quasi-Coasean solution. For instance, it is clear that contractual arrangements were considered, at least partly, because of looming regulatory pressures regarding water quality and the high cost of engineering solutions (i.e. filtration plants). Voluntary strategies may require the existence of conventional regulatory threats with significant economic consequences to be seriously considered. Several contributions have already stressed the role of regulatory threat (and associated costs and loss of flexibility) as a significant driver of voluntary approaches to environmental management (e.g., Alberini and Segerson, 2002; Khanna and Anton, 2002).

As a second example, economically efficient rearrangements of property rights can seem unfair, regardless of their formal validity, if they contradict the perceived existing allocation of rights. Also, loss aversion can make beneficiaries very reluctant to become payers - that is, to pay for environmental services which were previously free. Interestingly, in the New York case, both parties (i.e., farmers and the municipality) thought they had, to some extent, the property rights regarding water quality, which created conflict and increased transaction costs. Property rights affect the direction of compensation. While 'polluter pays' is an official OECD policy, in practice, it has been the case in the U.S. and E.U. that public authorities do subsidize farmers to improve environmental outcomes (Baylis et al., 2008). Both NYC and Munich water authorities wanted to avoid paying for high-cost engineering solutions, so a compromise with farmers had to be reached.

The historical and strong trend towards organic farming in Germany benefited Munich in comparison to New York City. European and German (formal and informal) incentives in favor of organic farming allowed the city to take advantage of pre-existing policies, while this dimension was less important in the New York City case. Moreover, the historically rooted urban–rural antipathy in New York City obviously increased transaction costs and generated the need for intermediaries (e.g. representatives of the Department of Agriculture) and costly and time-consuming efforts to develop less contentious relationships while Munich benefited from better pre-existing relationships with the farming community.

It is obvious that history matters and policy instruments rarely start from scratch. In short, transaction costs of reaching a contractual agreement are impacted by path-dependence (Arthur, 1989; see Rammel and van den Bergh, 2002 for an application to environmental policies). Choices made previously (e.g. imposing statutory regulations) can determine, at least partly, reactions towards a potential win–win contractual arrangement (see also Lubell et al., 2002). A clear implication is that decision-makers have to consider both short and longer term time horizons since short term benefits can be more than offset by additional costs generated later.[9] Once precedents are set, either formally or informally, transaction costs are incurred to reverse them (Challen, 2000). We do not contend that voluntary approaches are always better but suggest asking under what circumstances would contracting/negotiating for improved water quality be better than regulations or a tax? For example, in places that already have a well-developed organic system, requiring organic methods could be an efficient way to address multiple environmental issues simultaneously. However, in a country without such standards and markets, more conventional input restrictions might be better. These considerations of time and path dependency are in addition to the problems of sustainability, intergenerational equity, choice of discount rates, etc. that are addressed by several authors in Bromley (1995).

Lesson 1: Stricter regulations about water quality (with flexibility about how to reach the regulatory targets) may be needed as an impetus to seriously consider voluntary arrangements. Nevertheless, policies rarely start from scratch and overall transaction costs can be increased or decreased according to the weight of history and the institutional environment (Challen, 2000; Libecap, 1989).

4.2. Homogeneity and Number Issues

In water quality issues, there is a fairly strong location specificity[10] (watershed services are not fungible like carbon markets), making a case-by-case approach necessary and limiting the scale and scope of the market structure. Watershed services must be exchanged at the watershed level which makes the local context, physical and institutional, very important. The two case studies show that homogeneity (heterogeneity) among farmers and other stakeholders can lead to lower (higher) transaction costs of reaching and enforcing a contractual arrangement (Ostrom, 1990). For instance, the homogeneity of farms in the Munich catchment area contributed to standardized definitions of requirements and allowed mutual exchange of information among farmers. The fact that requirements were standardized in accordance with organic farming rules facilitated enforcement by using pre-existing institutions that are expert in organic farming monitoring. Adopting a whole farm approach rather than a practice-by-practice approach in the two cases increased some costs (by acquiring rights on actions that are not directly tied to water quality issues), but decreased other costs, notably monitoring costs, and probably increased efficiency since synergies among practices could be exploited. A recent USDA report from long-term research programs shows that suites of practices work better than individual practices (USDA, 2010). Contracts may sidestep the measurement problem by specifying the actions in terms of means to an end rather than the end itself, sometimes at the price of sacrificing some allocative efficiency (Bougherara et al., 2009). Interestingly, in the two cases, the arrangement was an interesting mix of one-size-fits-all or shared requirements, but with some flexibility. For instance, Munich enabled some farmers who were not able to meet all organic requirements to participate in the program at a less stringent level with reduced financial incentives. In the New York City case, whole farm plans were developed that incorporated both environmental and

[9] These time horizon considerations can be inconsistent with other time horizons such as political elections which can create additional complications.

[10] Cities need selected farmers located on the catchment areas and these farmers can propose and get significant payments for their ecosystem services mainly/only from these cities.

business criteria. Since these were developed on an individual basis, this probably increased transaction costs compared to the Munich case.

In addition, the 'monopsony' market structure with a municipality as buyer and a limited number of farmers (in comparison with other situations such as the Mississippi River Basin) has seemingly reduced some transaction costs.[11] In a recent paper, Kemkes et al. (2009) suggested that creating a 'monopsony' can provide an effective way of delivering ecosystem services, because it is relatively easy to calculate the willingness of the purchasing organization to pay by measuring the benefit of the ecosystem service to the organization's objective function. Indeed, city size and location (developed versus developing countries) can very roughly determine the money available to address water quality issues. Part of the solution can be found in transforming 'large number cases into smaller numbers when the large numbers form associations, clubs or firms, such as river basin associations' (Yandle, 1998, p.148; see also Libecap, 1989; Mailath and Postlewaite, 1990; Ostrom, 1990; Paavola and Adger, 2005). Similarly, the efforts of some organizations (e.g. SVM), as a stand-in for individual citizens to contract with farmers, may sometimes constitute a transaction cost economizing strategy to artificially create a quasi-monopsony. In the two cases, the arrangement was also facilitated by producers' unions but in different ways. For instance, in Munich the unions of organic producers were effective at promoting organic farming in targeted farms, while in New York City, representatives of farmers were responsible for helping to design the program and getting a minimum percentage of farmers to participate in the program.[12]

Lesson 2: Voluntary contractual arrangements are more likely when contractors are homogeneous on each side, embedded in a monopsony-like market structure and not too numerous on the supply side. To some extent, the market structure can be modified in order to reduce overall transaction costs.

4.3. Time and Good Science

It is obvious from the two cases that adequate lead time and good science were necessary to reach mutually beneficial agreements. Reaching agreements between two very different groups (i.e., urban water users and farmers) required time to create mutual knowledge and understanding, especially in the New York City case. There are also lag times with management approaches since there is a stock of pollutants in the environment, while changing practices affects the flow. However, timing of regulatory requirements may not allow time for considering contractual approaches as a possible solution and may inadvertently favor engineering solutions, which can clean up drinking water more quickly. Interestingly good science, from neutral and reputable sources, can increase scientific consensus on causes and strategies to fix the problems, which lead to lower transaction costs. Better knowledge and understanding of multidimensional interactions between surface activities and watershed services, especially at the local level, is likely to decrease transaction costs of designing mutually acceptable contractual arrangements. Conversely, lack of such a shared understanding, based on good science, can make the bargaining very contentious where each party suspects the other one of exploiting the situation to his advantage (e.g., Déprés et al., 2008). Scientific findings may not be automatically accepted by all involved groups (Michaels, 2008).

Lesson 3: Advance planning and good science can decrease transaction costs of reaching mutually beneficial agreements. Without ignoring other parameters, regulators have to take into account how time flexibility can restrain or enlarge the opportunity set of parties. Given the public nature of good science, this situation can legitimize investments in acquiring better knowledge of relationships between land use and watershed services.

4.4. Visibility Issues

Increasing visibility (direct and indirect) of ecosystem services can increase support of citizens for the proposed arrangement.[13] Indeed, being close and visible allows the development of a mutual understanding that reduces transaction costs. This effect was stronger in Munich because of physical proximity and the city's initiatives in terms of sourcing food products from local areas, preserving water quality, and organizing bicycling tours in the catchment. New York City is also much more limited in using natural visibility than is the case in Quito, Ecuador, where residents can see the snowcapped peaks that provide their water, which facilitates transforming beneficiaries into supporters and payers (Hahn, 2006.). As described by Hawn, "walking out of Penn Station onto 34th Street, any New Yorker who looks up will see concrete and neon, taxi-lines and donut shops. The forested slopes of the Catskills, some of the city's main watersheds, lie roughly eighty miles to the north; they are very much out of sight and, usually, out of mind". Tourism in the Catskills allows some urban residents to observe the agricultural production practices that affect their water supply, and natural visibility has been substituted to some extent with education campaigns. On the marketing dimension, New York City also supported an ecolabel initiative Pure Catskills which was adapted in 2004 to "emphasize the connection between our region's good food and the famously pure water that flows to New York City taps" (Watershed Agricultural Council, 2010). So, increasing visibility can also provide suppliers with additional (and not necessarily monetary) benefits (e.g. social image, access to new markets).

Lesson 4: Visibility matters. It can decrease overall transaction costs by facilitating mutual knowledge and appreciation among potential transactors or their representatives. Increasing visibility can be a strategy to decrease the costs of reaching and maintaining an agreement over time.

In sum, the design of watershed protection programs needs to begin with an understanding of the unique institutional and physical environment which facilitates some options and constrains others. For instance, building on existing policies and institutions (as in the Munich case) can decrease transaction costs. Nevertheless, lessons can be learned from the successes (and failures) in other situations.

[11] At the same time, a monopsony structure can make the transaction very specific (just one buyer). This effect has been avoided to some extent in the Munich strategy, where the city reduced the asset specificity of the transaction (by prescribing organic), making farmers less dependent on the city of Munich (European incentives under the CAP, market development of organic products in Germany, etc.). Another issue is that creating a new monopsony buyer would incur transaction costs.

[12] In some cases, too high a level of concentration on each side of the market can lead to bilateral monopoly issues with uncertain outcomes. Indeed, while negotiating with a unique 'seller', e.g., a farmer pool in the Vittel case, was likely to reduce transaction costs on the one hand, it can also serve to increase the monopoly power problem on the other (Déprés et al., 2008).

[13] This recommendation is consistent with recent research in behavioral economics (Sunstein and Thaler, 2008). Moreover, Pedersen (2000) provided empirical support to show that environmental concerns are likely to be accentuated in areas where the environmental impact is visible and tangible.

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