Environmental Turning Points, Institutions, and the Race to the Top

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The phrase *environmental turning point* took on a new meaning in 1991 when Gene Grossman and Alan Krueger (1991, 1995) unveiled the first empirical Environmental Kuznets Curves (EKCs). As shown in figure 1, a hypothetical EKC for sulfur dioxide, the peak of the curve is a turning point that separates two distinct income-environment relationships: to the left of the peak, air quality deteriorates with rising income; to the right, air quality improves with rising income. The first portion of the EKC represents a "race to the bottom" in which rising income hastens environmental decay. The portion to the right of the peak describes a "race to the top" in which higher income is associated with better environmental quality.

As might have been expected in a world where no silver bullets exist to remedy every imaginable problem, not every environmental dimension examined by Grossman and Krueger conformed to this happy turning-point model. Still, their 1991 EKC identification established a baseline argument that somehow the route to higher income may also be a path to improved environmental quality.

Since the publication of Grossman and Krueger's 1991 article, more than a hundred empirical EKC studies have been added to the professional literature (Yandle, Vijayaraghavan, and Bhattarai 2004 forthcoming).[1] EKC estimates now exist for numerous elements of water pollution, including levels of dissolved oxygen, fecal col-

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1. Although there are dissenters among EKC scholars about the turning points, there is compelling evidence that some important environmental conditions, such as the extent to which the air is pervaded by sulfur dioxide or the rivers depleted of dissolved oxygen, first worsen when income begins to rise from low levels, but later reach a turning point after which growth in income per capita becomes associated with improved environmental quality.

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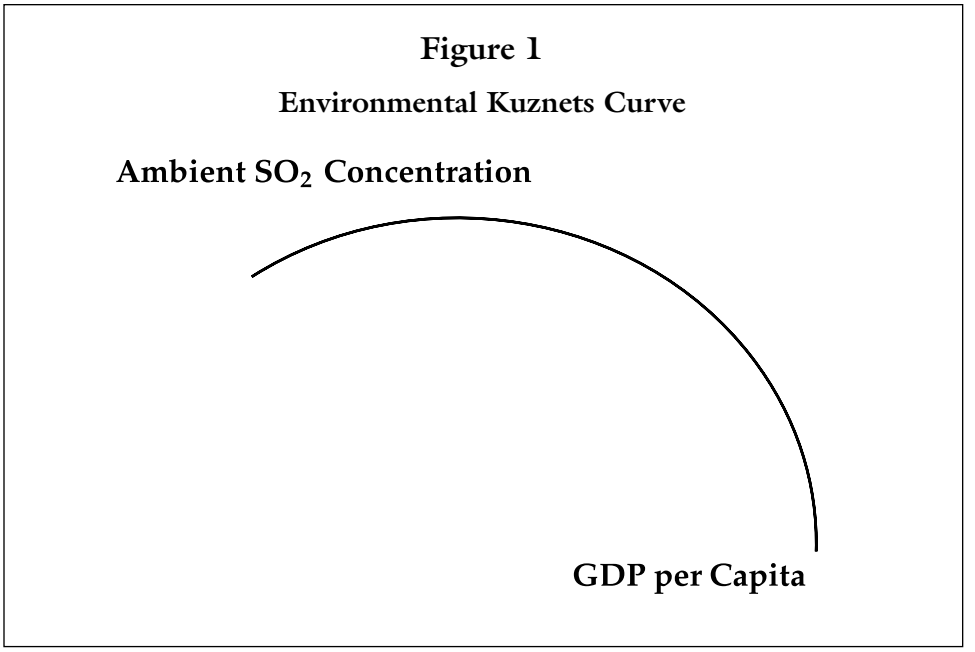
Figure 1

Environmental Kuznets Curve



iform, nitrates, and arsenic; for hazardous materials; and for forestation/deforestation, among other things (Yandle, Vijayaraghavan, and Bhattarai 2002).

The studies, which are primarily cross-sectional, include some time-series estimates. In some cases, the research replicates and supports the Grossman-Krueger findings. In other cases, the turning points are not observed. As comforting as turning points may be to those who prize both environmental quality and the other benefits that come with higher income, however, EKCs themselves do not tell us how the crucial turning points emerge—that is, how a race to the bottom becomes a race to the top. Stories of human action lie hidden within the data. We know that property rights, market forces, and political actions that specify how the environment is used make a difference in outcomes (Coase 1960; Becker 1983; Libecap 1989; Anderson and Leal 1997). We do not understand fully how the advent of a race to the top is associated with changes in the rules for managing environmental quality.

To illustrate, consider the case of water quality. Every point on a statistical EKC marks a level of income and, let us say, the amount of dissolved oxygen in the water at a specific location on a river. Each of these points is associated with a state of scientific understanding and an institutional framework that affects environmental use; for each point, some form of property rights and regulations (including no property rights and regulation at all) may constrain or allow environmental use. For example, at one income level a community may allow unregulated fishing, swimming, and drinking from a river that passes through the community. These uses may be based on custom, tradition, and tribal rights (Ostrom 1990). The effectiveness of the rules and the forbearance that community members exercise determine the resulting water quality. At

another EKC point for the same community, where higher income and new knowledge generate new demands and make more costly institutions affordable, a system of common-law rules enforced by government-operated courts may control use of the same river segment. Ownership of riparian land gives rightholders access to the courts when other parties violate their environmental rights without having gained the owners' permission to do so. At yet another, higher income point on an EKC, a system of government command-and-control regulation may have either supplanted or augmented the earlier common-law system.

All across a given community EKC, different levels of water quality become associated with different levels of income and the accompanying rules for managing the river. In other words, a third dimension, an institutional dimension, needs to be taken into account. In some cases, the rules for use remain unchanged as incomes rises, but higher income enables increased monitoring and enforcement of the rules. In other cases, new rules, statutes, and regulations for managing water quality are put into effect.

Given that the different rules generate different outcomes, we need to understand how changes in rules come about. Can we find actual stories of successful efforts to alter property rights? Which set of rules can the community sustain most successfully? Knowing more about how changes in environmental rules occur and about the traits that cause rules to survive, we may be better able to identify institutions that accelerate the race to the top.

In this article, I discuss environmental turning points, the agents of change that contribute to the turn, the rules that accompany a race to the top, and the rule characteristics that sustain the race. In the next section, I review EKCs, focusing on turning points and the race to the top. Then, I develop a set of characteristics associated with self-sustaining environmental-management institutions. Stories about institutional change and human action come next, and rule sustainability is discussed at the end of each story.

EKCs and the Race to the Top

EKCs gained prominence in 1995 when the North American Free Trade Agreement (NAFTA) became the focus of national debate. NAFTA opponents marshaled arguments that included concerns about environmental quality. Indeed, American steelworkers put on "Bootlegger and Baptists" clothing to argue not about job losses that might occur with open borders but about water quality and air quality in Mexico (Yandle 1993). Exhibiting profound concern about Mother Earth, the union and others, notably the Sierra Club, argued that lax Mexican environmental standards would generate a sucking sound as U.S. industry was siphoned off to attractive pollution havens. NAFTA's result, from these critics' point of view, would be environmental decay as well as diminished American industrial prosperity.

Although some parties argued passionately about these matters, Grossman and Krueger decided to "count the teeth." Gathering World Bank data on several com-

mon measures of environmental quality for a large sample of countries, they related the pollution measures to gross domestic product (GDP) per capita and reported the first EKC. When data for sulfur dioxide and total suspended particulates were considered, their results showed an income turning point after which pollution diminished with growing income. In 1985 dollars, the GDP per capita turning point lay in the $4,000–5,000 range, depending on the pollutant considered. It so happened that the turning point was close to Mexico's GDP per capita. Their results offered a bit of empirical support of NAFTA's relative merits and launched a veritable cottage industry of academics crunching numbers in an effort to identify the strengths and weaknesses of the EKC concept.

Figure 1 describes the general EKC form. When GDP per capita is low, human communities apparently trade off certain forms of environmental quality for income. Arguably, increased life expectancy, the advent of leisure time, and the desire to consume environmental quality, instead of transforming it, lead to the turning point, after which further income increases become associated with increased environmental quality. In the benign part of the curve, the environment shifts from being treated as a sink for disposing of wastes to becoming a source of greater direct consumption value (enjoyment) to the community.

Figure 2 presents an EKC for sulfur dioxide estimated by Xiang Dong Qin (1998). This estimate used balanced panel data for fourteen countries over three time periods. The estimating equation that generated the EKC in figure 2 contains an adjustment for property-rights protection (Knack and Keefer 1995). When protection is stronger, as shown by the dashed curve, the EKC's peak is not as high: communities with stricter property-rights protection do not allow as much environmental degradation. To say that the environment is less degraded where property rights are more secure is not to say that environmental property rights exist. In fact, where individuals can own and transfer real property and gain the profits from doing so, those same individuals do more to see that air quality, water quality, and other environmental assets are maintained or improved. Environmental improvements become capitalized in the value of land when secure property rights in land can be sold.

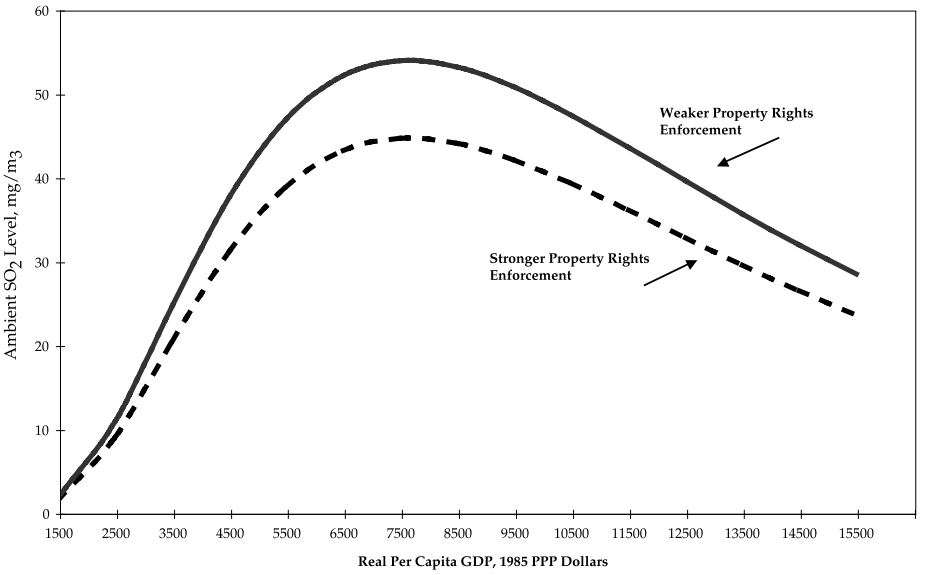
Qin (1998) also estimated EKCs for water quality. With data on the level of dissolved oxygen for the cleanest river in each of a panel of countries, the estimate generated an income turning point much lower than that for air-quality data: evidently, the communities examined assigned more importance to cleaner water than to reduced levels of sulfur dioxide when incomes were low.

Sustainable Rules

Often, it seems, some pending or actual environmental catastrophe generates an institutional response that inspires human action that in turn gives rise to the turning point. Smog over Los Angeles in 1943, typhoid epidemics in the Ruhr basin at the beginning of the twentieth century, and massive fish kills in North Carolina's Tar

Figure 2

Environmental Kuznets Curve for Sulfur Dioxide



River in the 1980s exemplify environmental catastrophes that seem to have inspired the creation of new institutions. Institutions, however, are costly to operate, and to survive they must possess traits that combine to yield what I call resource-conserving sustainable environmental protection (see also Dales 1968).

Sustainable environmental protection requires that (1) the boundaries of the environmental-management institution match the boundaries of the asset being managed. Boundary matching implies that (2) the community defined by the boundaries will bear the costs and receive the benefits from managing the environmental asset, and people in a nonbenefiting community will not bear the cost of providing environmental protection elsewhere. Sustainable environmental management then requires (3) getting the incentives right for key environmental players who form the foundation of sustainable environmental improvement. Private as well as public entrepreneurship will then be encouraged. This is not to suggest that the institution-building process is somehow immune to pork-barrel politics, rent seeking, and other political actions that constitutional and other constraints may allow. In the real world, the turning-point institutions most likely will result from a combination of private (Coase 1960) and public (Becker 1983; Libecap 1989) contracting. In any event, the resulting institution must have key resource-conserving constraints in order to survive. It must be understood that the deadweight losses from political favor seeking or

the pure and simple demolition of a groups' institutions by a politically more powerful group or coalition can destroy sustainable institutions (Higgs 1982).

If environmental protection is to be sustained, (4) real environmental benefits that ordinary people can recognize must be produced. Finally, for long-run sustainability, (5) the total benefits produced, somehow perceived and measured, must exceed the total cost borne both directly and indirectly by those who receive the benefits. When the foregoing traits are lacking, improvements may still occur, but the system will be vulnerable to change and abuse: environmental management will become a growing sinkhole for resources, and ineffective institutions will not be modified or eliminated.

Stories about Turning Points

England's Anglers' Cooperative Association

In the mid-1940s, John Eastwood, an English angler and lawyer, was disgusted with the condition of waters in England's rivers, lakes, and streams (Bate 2000). He examined the sixteen acts of Parliament that purported to protect those waters and decided that none of them was any good. At the time, rivers were classified by use, and little effort was made to reduce pollution in streams classified as receptacles of industrial waste. Fish, the aquatic environment, and the joy of fishing all suffered. Something had to give. Eastwood almost single-handedly generated a turning point.

Eastwood understood the common law. He knew that owners and occupiers of land along streams held environmental rights that their property not to be harmed without their approval. He knew that fisheries were considered riparian assets subject to protection by common law. He also understood the problem of small benefit/large cost that any single landowner faces when contemplating a decision to bring suit, as well as the related free-rider problem. Hardly ever did a single landowner incur the cost of bringing suit against a polluter. Eastwood reasoned that if he could persuade landowners to join an association of anglers, then he and the association could use the association dues to bring common-law suits against polluters who harmed the property rights of any single landowner. In a word, the cooperative would consolidate benefits for all angler members as well as for nonmembers. Transaction costs would be reduced. Eastwood's was a Coasean solution. He was undertaking to solve another "lighthouse problem" (Coase 1974).

Sitting in his kitchen, Eastwood wrote three thousand letters by hand to drum up support for his idea. About a year later, he formed the Anglers' Cooperative Association, known today as the Angler's Conservation Association (ACA). He appealed to the anglers' self-interest, and by doing so he led a movement that has been instrumental in producing cleaner waters throughout England and beyond. Eastwood and his associates generated an environmental-quality turning point.

The ACA has brought more than two thousand actions against polluters. It has lost three cases. The cases include actions against city governments, electrical utilities, chemical plants, and even trout farms. When it sues, the ACA does not ask for fines;

it does not fish for money. Instead, it seeks court injunctions to stop the pollution. The ACA sponsors the formation of regional angling societies and has extended its programs to include ocean property.

The association's actions rest on common-law bedrock, but in an institutional environment that includes national statutes and environmental regulation. Membership is voluntary. Actions are financed by private funds. Polluters who receive a telephone call from the ACA inquiring about their water-degrading activities move quickly to remedy the situation. Improved fisheries provide cleaner water for all. The so-called free-rider problem, which in mainstream economic theory precludes such resolutions, is resolved in part by organized private action.

The ACA's success in bringing about improvements in water quality and fisheries rests on a foundation of court-enforced common-law rules that operate within and beyond national statutes. The rules provide incentives for holders of environmental rights to bring legal actions against those who harm their property rights. Although the outcome depends on the protection of private-property rights, this legal condition is often not enough to prompt action. As Coase reminds us, transaction costs must be borne. The ACA story tells us how entrepreneurial efforts have reduced transaction costs and how those who benefit from improved environmental quality bear the cost of protecting their assets.

Is the ACA sustainable? One might respond by saying that apparently it is. The organization has flourished for almost sixty years. The sustainability question, however, pertains to more than survival. Recall that the sustainability test asks about the boundaries that define who bears costs and who receives benefits. It relates to the incentives, benefits, and costs and to the extent to which real benefits accrue to those who pay. The ACA passes the test of sustainability on all scores. As a voluntary, member-supported organization, it would disappear quietly if its members ceased to find its beneficial outcomes worthy of their support. Perhaps not directly but certainly indirectly, statutes lent strength to the overall turning point at which the ACA made its contribution. In turn, the organization probably has caused the statutes to be reformed so that they are more effective.

Early-Twentieth-Century Water-Quality Management by River Basin Associations

In the late nineteenth century in Westphalia and Rhineland, industrial development associated with expanding coal, steel, and chemical production led to the emergence of one of Europe's most populous and polluted regions (Bower et al. 1981; Kneese and Bower 1968; Riggs and Yandle 1997). For example, by 1912 the Krupp Steel Works at Essen employed 70,000 workers. Essen's population grew from approximately 10,000 in 1852 to some 130,000 in 1900 (Essen 2003). The region's rivers that fed into the Rhine suffered from wide variations in flow, ranging from droughts that produced dry riverbeds to floods that washed away low-lying homes

and businesses. Flooding caused serious problems described as a series of crises. The combination of flow variation, human waste, and industrial pollution eventually gave rise to deadly outbreaks of typhoid and cholera, but the combination of floods, droughts, and disease also generated a turning point.

Following one of the more serious floods, some of Essen's business and civic leaders met for dinner to discuss the problem and how they might effect change. We do not know their names. We do know that they decided to incorporate Ruhr River management activities under private law. The Essen-based Ruhr Reservoir Association was organized in 1899.

The Ruhr association first focused on the construction of dams and reservoirs for the purpose of smoothing the variation in water flow. Water-using firms and industries bore the cost of operating the association. The charges were based on water withdrawals and discharge. With the budding understanding of the causes of typhoid and cholera just entering the public's awareness, the actions taken to avoid low flows improved public health (Meeker 1972).[2]

Impressed with what the Ruhr community had accomplished, the king of Prussia determined that more river basin associations should be incorporated. Laws were enacted that expanded the responsibilities of these first associations. The political economy now complemented the private economy. The statutes required decentralized management by quasi-private corporations *(Genossenshaften)* managed by local stakeholders and their elected board of trustees. Each of the (eventually twelve) associations was separately organized and managed, and each paid its own way by imposing charges on waste dischargers and water withdrawers. Dues from municipalities and industry, based on water usage, covered any shortfalls in revenues from discharge and withdrawal fees.

Until the 1980s, the associations competed in the provision of drinking water and sites for industrial development. They charged different prices for their services. Association managers had a definite incentive to get the price right. They and their neighbors received the benefits of improved water quality along with the bills to pay for it. The association managers eventually charged fees to all dischargers based on the concentration and volume of acceptable waste discharged. Cities and drinking-water providers paid for the water they took from the rivers.

Under the *Genossenshaften* system, expanding industrial firms had a choice: they could treat their own waste, pay to discharge it, or mix the two options. They could shop among the various associations to find which was most economic. As might be expected, competition among water-quality managers led to innovation. Instead of always building and operating advanced treatment facilities, associations adopted

2. Edward Meeker's studies (1972, 1974) of the public-health aspects of water-quality improvements in the United States at the turn of the century are relevant here. Meeker illustrates how new scientific knowledge linking water quality to typhoid and cholera epidemics gave rise to an early environmental movement that focused on the construction of water-treatment works. He reports a dramatic decline in these water-borne diseases for a sample of major U.S. cities. Institutional changes that provided the public the means for building treatment works contributed to this environmental turning point.

other innovations to counter seasonal sags in water quality. For example, levels of dissolved oxygen could be augmented by placing large boulders in rivers to churn and aerate the water as it passed. If even more oxygen were needed, the associations sometimes injected oxygen directly into the streams. The new river basin associations ushered in a turning point. Water use declined; water quality increased. Scarcity became a prelude to plenty.

Decentralized water-quality management with management based on private-property and then public-property rights and ecological boundaries, not the usual political boundaries, emerged as the solution. National statutes fortified actions taken within the boundaries of biologically defined areas. A combination of private and public contracting led to the formation of the water-quality institutions. Prices based on the cost imposed on the water-quality-management unit were charged users in ways that yielded environmental progress. Competition among water-resource communities spurred innovation and the discovery of lower-cost methods. Ordinary people became innovative when the costs and benefits of environmental quality were linked.

The so-called Ruhr system exhibits most of the traits required for sustainability—or, to bring the story up to date, it did exhibit them. Unfortunately, much of the learning was lost when Germany harmonized its laws with the European Union's, at least in Briscoe's (1994) view. Today, the boundaries of the problem no longer correspond with those of the solution. Linkages between benefits and costs have been broken. All dischargers in Germany now pay a uniform fee that has little to do with costs and benefits. Uniform command-and-control regulation sets the standard. The stakeholders in river basins no long manage water quality directly. The decentralized river basin–management systems no longer exist in Germany.

Once the cost of achieving water-quality improvements had been uncoupled from the associated benefits, unrealistic standards began to emerge. European Union funds were appropriated almost without limit until tough economic times arrived. Now the German water-quality-management system is burdened with standards that cannot be achieved, but the funds for trying to do so no longer come rushing in from Brussels. The race to the top and sustainability may have been stymied. The famous Ruhr system was lost when state recontracting altered the political boundaries and rules.

Los Angeles Smog and the Air-Quality Turning Point

On July 26, 1943, Los Angeles suffered a serious smog attack (South Coast Air Quality Management District 1997). Downtown shoppers and workers experienced eye-stinging, throat-burning sensations; visibility diminished to three blocks. Anxious to find a culprit and to show that they were "doing something," city officials put the finger on a large local butadiene plant and shut it down. The smog continued. Although smog seemed to be a new phenomenon, smoke and fumes were not. Indeed, in 1903

air pollution had been so thick that residents thought they were experiencing an eclipse of the sun. Nonetheless, the 1943 episode represented a low point. The situation was so serious that the airport considered relocating to escape the smog—pilots were having difficulty with visibility.

Although city officials expressed concern and committees were appointed to get to the bottom of the problem, nothing systematic was done until an unexpected message arrived from London. Insurance companies holding Los Angeles municipal bonds sent word that they would call for premature payment unless something was done to clean the air. The market had spoken.

But who would take the initiative? What organization or individual could capture the benefits of doing something to clean the air? Would goodwill and good intentions alone get the job done? Because no one could identify the culprit responsible for causing the smog, no common-law suits could be organized. Los Angeles smog had the classic traits of the economist's public-good problem. According to mainstream economic theory, private actors cannot solve the problem; only the state can do so. Though dirty in nature, the smog problem presents a pure case in theory.

The *Los Angeles Times* took the lead. The city's major newspaper had a long-term stake in the region's economic success; it became, in effect, a Coasean "lighthouse" firm. In 1946, the newspaper hired Raymond R. Tucker, an air-pollution specialist from St. Louis, to make recommendations for eliminating the smog (South Coast Air Quality Management District 1997). Tucker identified a number of sources as culprits and recommended that a countywide air-pollution agency, the first in the United States, be formed and given broad powers to adopt and enforce air-pollution regulations. A bill setting up a county air-pollution board, drafted by the county board of supervisors, sailed through the California legislature and became law in June 1947. Even then, however, no one really knew how smog developed; the true culprit had not yet been recognized. Nevertheless, a decentralized approach to the problem had been established.

It took Professor Arie Haagen-Smit of Cal Tech three years to identify ozone as the source of the problem. He showed that ozone was not produced directly but developed in the atmosphere when hydrocarbons and nitrogen oxide, primarily from automobile exhausts, interacted with sunlight. Meanwhile, Los Angeles took steps to shut down three hundred thousand backyard incinerators used for burning trash, pushed for the elimination of oil-burning smudge pots used in the orange groves, and developed other rules that reduced atmospheric dust and smoke substantially. These actions were followed by a panoply of rules related to hydrocarbon emissions. In short, Los Angeles generated a turning point and a set of local institutions for managing air quality. To a high degree, the citizens in the region bore the cost and monitored the benefits.

In 1959, the boundaries of the solution migrated to the state legislature, which created a board to control mobile-source emissions. The nation's first air-pollution

regulations for automobiles came from California in 1963. Then, in 1970, the boundaries became national with enactment of the Clean Air Act. The Los Angeles problem continued to be a local one, but the Los Angeles solution became a national one.

Long before any federal air-pollution regulations existed, Los Angeles and every other major U.S. city had adopted a variety of approaches for dealing with air-pollution problems. Dramatic air-quality improvements were made prior to 1970 (Goklany 1999). The various turning points had occurred much earlier.

Was California's approach sustainable? Apparently not. The requisite traits were not satisfied. A severe boundary problem exists. Incentives for appropriate asset management are missing, and there is no simple way to reckon benefits and costs. Once management goes national, it becomes quite costly for people to register their preferences by voting with their feet. Will the institution now in place continue to operate? Most likely it will, but for rent-seeking, not competitive, reasons.

The Ohio River, ORSANCO, and Regional Compacts

On June 30, 1948, Congress approved an eight-state compact establishing the Ohio River Valley Water Sanitation Commission (ORSANCO). Headquartered in Cincinnati, the compact brought together Ohio, West Virginia, Indiana, New York, Illinois, Kentucky, Pennsylvania, and Virginia for the purpose of dealing with water pollution in the Ohio River drainage basin.

From Cincinnati's standpoint, the problem was simple. Located at the end of the line, so to speak, this city received a load of waterborne waste discharged by upstream cities, Pittsburgh being the major contributor. Having little in the way of legal leverage over cities outside the state, Cincinnati built larger treatment works so that it could provide drinking water to its growing population. Finally, gastroenteritis communicated the problem upstream, affecting populations throughout the drainage basin. After an especially serious outbreak, the Cincinnati Chamber of Commerce took the initiative to do something about the Ohio River. Because chamber members were bearing the brunt of the cost of providing clean water, they would receive the benefits of any improvements. In short, the pursuit of profits inspired a pursuit of environmental quality. Just as in the Ruhr basin fifty years earlier, a turning point had been reached.

With Ohio taking the lead, governors of the river basin states joined to form ORSANCO. Soon the newly activated commission established water-quality standards to be met by the compact members, set up continuous monitoring stations along the river, and moved on to coordinate other river basin improvements.

The 1948 compact approved by Congress stated that "no single standard for the treatment of sewage or industrial wastes is applicable in all parts of the district due to such variable factors as size, flow, location, character, self-purification, and usage of waters with the District. The guiding principle of this Compact shall be that pollution

by sewage or industrial wastes originating within a signatory state shall not injuriously affect the various uses of the interstate waters as hereinbefore defined" (ORSANCO 2003). Thus, Congress required a decentralized approach, avoided the imposition of a one-suit-fits-all solution, and basically codified the traditional common-law rule. Upstream parties were denied the right to impose costs downstream without the agreement of the downstream parties. The compact added a requirement that no state allow discharge to the river that reduced water quality below the level of the water entering the state's jurisdiction, also a feature of the common law.

Does ORSANCO meet the sustainability test? First, the boundary issue was satisfied, as was the payment for benefits received. Monitoring provided hard evidence that the multistate institution generated benefits. The member states were given incentives to discover less costly ways to improve water quality; no universal rule was imposed on all parties. Finally, ORSANCO received no federal funds. If the institution itself did not produce sufficient revenue to cover costs, ORSANCO would disappear. Thanks to all the foregoing conditions, ORSANCO proved to be sustainable, at least until 1972.

In that year, the Federal Water Pollution Control Act established uniform methods of pollution control throughout the nation. Command and control replaced ORSANCO's decentralized performance standard. Like the river basin associations in Germany, ORSANCO lost its independence but gained a new source of revenue. The boundary of the solution was stretched to the four corners of the nation. Incentives for discovering lower-cost approaches were thereby removed. Institutional sustainability now depended on politics and redistribution, not on resource conservation and environmental outcomes. ORSANCO is still in business, but it is now a branch office of the Environmental Protection Agency (EPA).

Allen Kneese and Charles Schultze early on identified the 1972 statute's fatal institutional flaw: "In the longer perspective—especially in light of the relationship between management of water quality on the one hand and the need to develop programs for the control of residuals from nonpoint sources on the other—the failure to build institutions that could undertake efficient region-wide management was perhaps the most profound deficiency of the entire approach" (1975, 45). The flaw that Kneese, Schultze, and others observed had to be recognized in 1989, when nonpoint-source pollution became so bad that it forced a turning point in U.S. water-quality management. The action occurred in North Carolina's Tar-Pamlico River region.

Tar-Pamlico River Association

In 1989, following a series of severe fish kills that caused North Carolina to declare the Tar-Pamlico River and Pamlico Sound nutrient-sensitive waters and to set a binding constraint on discharges, leaders and key citizens in eastern North Carolina knew they had a serious problem. It had to do with the amount of nitrogen and phospho-

rous entering the Tar River, which then becomes the Tar-Pamlico as the waters approach the Atlantic. These nutrients feed algae, which die and oxidize; oxidization consumes oxygen; and, lacking oxygen, fish suffocate.

At the time of the fish kills, twenty-four publicly owned treatment works and one industrial plant discharged into the river. All of the dischargers were operating within the limits of their EPA permits. Still, the fish were dying. Unregulated nonpoint-source discharge of the sort mentioned by Kneese and Schultze was the source of the problem.

The North Carolina regulators and the EPA had little choice but to follow the federal statutory blueprint. The statute allows no flexibility. When there is a problem, the law calls for more command-and-control, technology-based regulation. For Tar-Pamlico, however, putting more capital in the plants and ratcheting up the level of control would have no effect on the problem. The farmers and other nonpoint-source dischargers were creating 80 percent of the problem. Nonetheless, the law was the law. The EPA estimated that the cost of meeting advanced treatment requirements might reach as much as $100 million, and the fish would still be dying.

Community leaders in the region were given ninety days to devise a solution (Riggs 1999). Perhaps realizing that local citizens would have difficulty in finding $100 million, community leaders, with the backing of the Environmental Defense Fund, a respected organization among environmentalists, proposed to decentralize Tar-Pamlico management. Probably unwittingly, members of the Tar-Pamlico community took a leaf from the Ruhr River story. They proposed that the EPA grant a waiver and allow an association to take responsibility for achieving and managing water-quality improvement. The emerging association managers asked for permission to establish a water-quality pricing and trading system that would include farmers and other producers of nonpoint-source discharge. Permission was granted, and the first water-quality trading association in the United States went to work.

The Tar-Pamlico Association invited all direct dischargers to join. Members would pay to discharge on the basis of the nutrient content of waste. Members also would engage in trades with other members; thus, one treatment plant could expand its treatment so that another, higher-cost plant could reduce treatment. Not every direct discharger joined. Those who did not join had to satisfy the EPA's standard requirements.

Water-quality outcomes, not machinery inputs, became the criterion that mattered. The association built a computer model of the entire basin so that water-quality changes could be monitored. Using funds obtained from dischargers, the association supplemented the state's payments to farmers to reduce nutrient-rich runoff. The association's actions served to close the water-quality loop. Water quality improved: the nutrient-concentration goal was achieved in one year at an estimated cost of $11 million. Once again, an environmental tragedy had spawned an institutional change, this time within the friendly environs of a legal exemption.

Is the Tar-Pamlico Association sustainable? It has the necessary traits—boundaries, incentives, private action, and sufficient revenues to operate. As an institution, however, it is an endangered species because it exists in breech of the law. A series of lawsuits brought by any unhappy party might bring it down. It is endangered even more by a large inflow of federal funding. The association has become such a model for improved policy that it has attracted increased federal grants. Now, it seems, people who are not receiving the benefits of the region's water-quality improvements are bearing part of the cost, and so the link between benefits and cost has been broken. Considerable discipline by association managers will be required to stay focused on cost-effective management.

In growing recognition that centralized command-and-control regulation cannot deal with emerging water-quality challenges posed mainly by nonpoint-source problems, the Tar-Pamlico experiment became a model for the EPA's evolving water-quality-management regulations. On January 13, 2002, the EPA announced a new watershed-based water-quality trading policy (U.S. EPA 2002). This policy, along with the related *Watershed-Based National Pollutant Discharge Elimination Permitting Policy Statement* (U.S. EPA 2003), illustrates how institutions can be modified, perhaps beneficially, within the limits of the law. At the same time, however, the fact that the policies are percolating through the federal bureaucracy after bubbling up from communities carries a high risk of the development of one-suit-fits-all regulation and the loss of sustainability traits. Barring the muffling or loss of community creativity and accountability, the new EPA initiatives might mark the beginning of another race to the top, but this outcome is by no means guaranteed.

Final Thoughts

History teaches us that human communities find ways to build institutions that conserve environmental assets. A close look at this history allows us to draw inferences about the turning points at which a physical entity becomes a resource, an asset to be conserved. EKCs are statistical artifacts that describe these turning points. Each such point—indeed, every point on an EKC—is associated with specific customs, traditions, property arrangements, and community rules that constitute the institutions for managing resources. Changes in the relative values of resources and the emergence of newly recognized resources generate institutional change, but change does not occur unless ordinary human beings bring it about. The institutions that community leaders build for managing resources can be sustained if they have certain traits that combine to require resource conservation and accountability.

In this article, I have used the EKC concept to launch a discussion of environmental-management institutions and the traits that assure their sustainability. I recounted stories about natural-resource management and institutional change to illustrate the notion of turning points, institutional design, entrepreneurship, and sus-

tainability. At present, the United States is involved in the redesign of water-quality-management institutions. An initial examination of these institutions suggests that sustainability may be enhanced. However, reflection on our past national experience warrants more caution than optimism when we forecast such institutional outcomes. What might be a more open road for acceleration of the race to the top can easily become a thicket of regulations that delays or even reverses this progress.

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