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SESSION V: AGRICULTURAL AND ENVIRONMENTAL HAZARDS

PAPER 2: REDUCING REGULATORY UNCERTAINTY IN POLLUTANT TRADING

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REDUCING REGULATORY UNCERTAINTY IN POLLUTANT TRADING

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While economists have long championed so-called "market approaches" to pollution control, it remains a curious fact that few such approaches have been legislated in the United States, and only a handful of these can be termed successful. In particular, water pollutant trading schemes, which date back several decades in concept (Dales, 1968), have enjoyed a singular lack of enthusiasm among non-economists. This is especially evident for schemes which call for trading among both point and nonpoint sources. Although several trading projects have been initiated, only one small transaction between point and nonpoint sources has occurred so far--a mere 11 pounds of stormwater phosphorus reduction credited against the requirements of point sources in Colorado's Dillon Reservoir. For evaluation of point-nonpoint pollutant trading, then, an examination of actual examples goes only so far. At most, one can develop a list of obstacles said to have prevented trades from taking place to date (Apogee Research, 1992; U.S. General Accounting Office, 1992).

Why this paucity of trading activity? After all, several decades of federal and state water pollution regulations seem to have pretty much wrung out any cost efficiencies in controlling most types of pollution from most point sources. Meanwhile, nonpoint sources, particularly farmland, remain essentially unregulated. It stands to reason that the marginal cost of reducing water pollution will often be lower among nonpoint sources than they are among point sources. (See, for example, Malik, et al., 1994.) Why aren't trading schemes taking advantage of potential cost savings?

In this paper, we postulate that uncertainties associated with nonpoint source pollution and with certain features of pollutant trading may tend to outweigh the potential benefits of pollutant trading from the standpoint of regulatory agencies and point source dischargers. After identifying several major sources of such uncertainties, we outline a trading scheme for a typical phosphorus-polluted water body in an agricultural watershed. The scheme limits uncertainty while preserving the efficiency-seeking features of trading to effect water quality improvements.

The Problem

Phosphorus has been found to contribute to algae growth and associated water quality degradation in lakes and streams throughout the country. Numerous studies (see, for example, Minnesota Pollution Control Agency, 1994) conclude that both urban and agricultural land management activities are to blame. We know that certain management practices, such as conservation tillage and riparian vegetation buffers, can be used to reduce phosphorus loadings from agricultural lands, and that certain technology changes can be result in lower phosphorus concentrations in effluent from wastewater treatment plants. It is with the tradeoff between urban and agricultural phosphorus reduction practices that this paper is concerned.

Because current pollution control regulations apply mainly to point sources, we begin our consideration of urban-agricultural trade-offs there. Consider a watershed with both urban and agricultural land uses in which point sources face anticipated phosphorus control standards. Under current enforcement agency practice, these standards will have to be met by expensive in-plant modifications. If permitted, there would be several non-engineering options open to such a point source. The prospect of substantial financial outlays to meet the standard through in-plant modifications provides a substantial incentive to try something else--almost anything else--first. For example, the point source could lobby the enforcement agency to:

- Lower the standard, arguing that the known cost of compliance exceeds any (usually unmeasured) societal benefits of cleanup.
- Fund an information/education program that seeks to convince farmers not to pollute. The cost of necessary practice changes would be borne voluntarily by the farmers.

- Shift some pollution liability (and compliance costs) to farmers, perhaps through the imposition of mandatory farm practices or farm-level water quality standards.
- Shift some pollution liability to upstream governments such as counties or watershed districts. Those units would be free to subsidize, regulate, or exhort practice changes by farmers--whatever it takes to reduce pollution loads to required levels, at the point the river leaves their jurisdictions.
- Impose taxes on farm inputs or farm technologies that pollute, or on excessive field losses of sediment, which transports phosphorus to surface waters.
- Pay farmers to implement appropriate practices.
- Allow the point-source to pay farmers to implement practices that reduce phosphorus loads within the watershed, by an amount that is equivalent to the point source's in-plant phosphorus load reduction requirement.

Clearly, the point source would prefer any option except the last, because in each of the others, someone else would have to bear the cost of meeting the water quality standard. But for present purposes, assume that the first six options are either ineffective or are foreclosed: the point source has to bear the total cost of cleanup.

The point source's decision thus is reduced to the following choice: either accomplish the required load reduction "on site," with plant modifications, or bring about an equivalent reduction "off site," on farms within the watershed. The latter option is what we mean by point/nonpoint pollutant trading. (In air quality regulation circles, this option is known as an "offset.")

One usually thinks of a market as governing transactions of saleable commodities, services, or other enforceable property rights. What would be "traded" here? Our scheme, developed below, is essentially an authorized transfer of the <u>locus</u> of pollution control. The point source pays its agent (the farmer) to install a practice. The regulatory agency agrees that this will satisfy a stated proportion of the point source's pollution reduction obligation. There is no transfer of "pollution rights;" rather, the point source has simply purchased some remotely-provided pollution reduction services. The market is one of services, not of rights.

Suppose that reliable evidence shows that farmers could effect phosphorous load reductions at a cost below that of in-plant modifications required of the point source. Wouldn't the point source immediately opt for trading? Not necessarily. Pollutant trading schemes are beset by uncertainties that impose substantial transaction costs--often to the point where no trades take place. Four major categories of uncertainty are of interest here:

1. Water quality uncertainty. Substituting uncertain nonpoint source reductions for highly predictable point source load reductions may result in reduced water quality.

2. Practice uncertainty. Agricultural land management practices may not be installed as specified, or they may not bring about a desired amount of phosphorus load reduction.

3. Enforcement uncertainty. A point source that has entered into a trade may be found in violation of its NPDES permit if the enforcement agency later changes its mind.

4. Price uncertainty. The point source may pay more than it needs to for load reductions, or the farmer may settle for less than the point source would have paid.

These uncertainties go to the heart of what differentiates point from nonpoint source pollution regulation. In particular, nonpoint source pollutant loads and the effectiveness of management practices are dependent on unpredictable weather events, primarily rapid snowmelt and heavy rainstorms. Being grounded in nature, such uncertainties can't be eliminated. However, through proper instrument design that limits these uncertainties, the transaction costs associated with point-nonpoint trading may be reduced to the extent that point sources and enforcement agencies perceive potential net benefits from trading.

We propose a four-fold path: (1) To reduce water quality uncertainty, we would restrict the domain of eligible pollutants to those whose impact is largely unchanged as they move through a water body. We would also restrict the domain of water quality problems to those that are "chronic" and not subject to single catastrophic events. (2) To reduce practice uncertainty, we would restrict the domain of eligible remedial practices to those that are visible and whose effectiveness can be predicted within acceptable degrees of certainty. (3) To reduce enforcement uncertainly, we would conduct trading by legally enforceable mechanisms associated with, but not incorporated with, the NPDES permit. (4) To reduce price uncertainty for both point sources and nonpoint sources, we would adopt one of three approaches that can help to identify low-cost providers of pollution-reduction services. All four uncertainty-reducing measures are elaborated upon below.

Water quality Uncertainty

In principle, any pollutant could be traded. If point and nonpoint source loadings can be measured and compared within a well defined mixing zone, such as a lake, river segment or river basin, then trade-offs are possible. In practice, however, problems of measurement within an acceptable trading area pose difficulties. How can a unit of loading 120 miles upstream be compared with a comparable discharge at the mouth of a river? Where should the impact of the loadings be measured? Which form of the pollutant should be measured? When and where? In the spring or summer, at low-flow or somewhere in between?

Only if the pollutant is strongly conservative, i.e., not subject to significant change or distance, can we treat loadings as geographically invariant. Phosphorous is such a pollutant. Even though total phosphorus varies in degrees of solubility and biological availability over time and distance, eventually all phosphorus that enters a water system becomes available to algae.

For our purposes, the unit to be measured is total phosphorus pollutant loadings, rather than ambient phosphorus concentrations. The reason is strictly practical: phosphorus loading measurements can be correlated to point and nonpoint management measures more easily, and with more confidence, than ambient concentrations could be correlated with source reduction measures.

Why total phosphorus, and not orthophosphorus or bio-available phosphorus? Again, the answer is practical. Phosphorus, being a conservative pollutant, eventually is converted to bio-available form if left in an aqueous environment for a sufficient period of time. In this form, it acts as a growth stimulant for certain types of algae in phosphorus-sensitive waters. Thus, control of total phosphorus loadings will be necessary to reduce phosphorus pollution in a fairly large watershed or basin, where the residence time of phosphorus loadings is sufficient to allow conversion into bio-available form.

For simplicity we assume that a unit of nonpoint phosphorus loading (usually measured in pounds) is equivalent to a unit of point source loading, as might be the case for a non-sensitive lake within a large watershed where long-term loading reductions are needed to improve water quality. Our basic approach would still be the same, however, if we were to use a designated trading ratio to meet a margin of safety for nonpoint source loading reduction estimates.

<u>Practice Uncertainty</u>

The principal task of the enforcement agency, once it decides to use a market-oriented phosphorus reduction program such as that outlined here, is to reduce transaction costs while not unduly jeopardizing its confidence that the program will actually reduce pollution by desired amounts. Two elements of our proposal are specifically designed to reduce these transaction costs.

<u>(1) Prior Practice Agreement</u>: It would be extremely time-consuming and expensive for the regulatory agency to have to evaluate and approve each and every nonpoint practice installation. We

suggest that instead the agency publish in advance an approved list of practices, each with minimum design criteria to ensure a minimum level of abatement. The installation of an approved practice at any location in the trading area will automatically constitute a certified reduction of a stated amount. For example, a properly designed 33-foot riparian buffer along any stream of more than 50 cfs capacity might be associated with a phosphorous-reduction "credit" of 200 lbs./mi./yr. All that the point source would have to demonstrate is that the riparian buffer is in place and meets minimum design criteria. The regulatory agency would then automatically reduce ("offset") required phosphorous treatment at the treatment plant by 200 lbs./yr.

(2) Easily monitored practices. To reduce the cost of monitoring and enforcement of contracted practices (which should be borne by the point source, not by the enforcement agency), the approved practice list should consist of only practices that can be readily confirmed by visual inspection. Riparian buffers, for example, or feedlot diversions, would probably make the list, but low-input fertilizer practices such as "smart farming" would not, even though they might in reality accomplish as much or more phosphorous reduction for equal contract expenditures.

Enforcement Uncertainty

Phosphorous emissions to American waterbodies are presently regulated in large part by state administration of National Pollutant Discharge Elimination System (NPDES) permits. These currently govern only point sources such as WWTPs. While one could envision a market-oriented phosphorous reduction program that completely forgoes the NPDES permit approach, we don't propose such a radical departure from current practice. All that would be needed to implement the trading scheme we propose would be authorization within the framework of the permit for the point source to "contract out" for its phosphorous reducing activities. A "side agreement" to the formal NPDES, spelling out the terms of a trading arrangement acceptable to the regulatory agency but still providing the flexibility to cope with weather problems and other uncertainties inherent in nonpoint pollution control. Such arrangements are not common, but they are not unknown in recent American regulatory history.

Regulated point sources would have three options to meet three pollutant reduction obligations. The first, of course, would be to install modifications at the existing plant. The second would be to contract with nonpoint sources within the specified trading area to install prior-approved practices to achieve equivalent loading reductions. The third would be to pay a specified amount of money for each unit of required pollutant reduction into a common pool, the management of which would be the responsibility of the enforcement agency. (This option, pioneered by North Carolina's Tar-Pimlico Basin project, would shift some of the transaction costs from the point source to the enforcement agency.) The point source would presumably select the option or combination of options that were most cost-effective. By agreement, the regulatory agency would be indifferent about which action or actions the point source takes.

Under this system, liability for pollution damages remains with the point source. The farmer is bound only by contractual obligation, and the enforcement agency has no recourse against the farmer in the event of failure. A related consideration is the <u>additionality</u> of the nonpoint source reductions specified in a trading contract or achieved through a state-managed fund. That is, are such reductions additional to nonpoint source reductions that would have been achieved without trading? Or, does trading in some measure substitute for nonpoint source reductions that would have (or should have) been done anyway?

Unless nonpoint source reductions specified in a trade are wholly additional, trading effects a de-facto relaxation of water quality standards and a weakening of the pollution control regulatory apparatus. To avoid this, we propose that criteria and procedures be developed to clearly indicate which types of nonpoint source practices should be considered eligible for trading, and which should not be. (This would take the form of an amendment to the approved practice list, discussed above.) We do not specify here what those criteria and procedures should be, because considerable variation exists among state nonpoint source policies and programs. However, we do suggest that every state's trading system eligibility criteria be directed at the same goal: 100% additionality.

Some states might choose to declare trading-ineligible any practice required under state or federal law. Soil conservation practices on highly erodible fields, for example, are already a condition for eligibility in federal commodity subsidy programs, and feedlots with more than 1,000 animal units are already controlled under the NPDES. Other states might simply guarantee that funding for nonpoint source pollutant-reducing management practices will be maintained at pre-trading levels, so that trading will represent wholly additional funding. Still other states may wish to specify "stewardship standards"--requiring farmers to satisfy minimal requirements before becoming eligible for point-nonpoint trading contracts.

The manner in which the additionality requirement is met could profoundly affect the marginal cost of nonpoint source phosphorus reductions, and thereby any potential gains from trading. If the least costly nonpoint source options are all declared ineligible for trading, the cost of trading will obviously be greater. Less obviously, interactions between eligibility criteria and regulatory policy could also influence the distribution of potential gains from trade. Suppose some mandatory nonpoint management practices remained eligible for trading, and no public funding was provided to help farmers defray their new costs. The all farmers required to install the practices would want to trade. Competitive bidding among farmers would tend to drive the supply price of phosphorus reduction services to near zero, and the point source would be able to meet its own mandated pollution reduction at little or no cost. Trading policy, in such a case, would not prevent a shift in the cost of pollution reduction almost entirely to the nonpoint source.

Price uncertainty

Even if the point source knows which and how much of the approved nonpoint control practices will achieve its phosphorus reduction requirements, it doesn't know what it will have to pay, because it doesn't know which farms will be the lowest cost providers. Three approaches suggest themselves.

The first is a fixed-offer, first-taker process, somewhat like the federal Conservation Reserve Program. The point source decides what it is willing to pay, announces it, and signs with the first farmer who comes in the door. If the fixed offer is below all farms' costs, then no farmer will install the practice. If the offer is above all costs, then all farmers will come in the door. If between, the procedure has succeeded in identifying and contracting with the lower cost farmers, but not at the lowest possible cost, except by chance. One strategy for the point source is to first announce a price that is sure to be lower than either farm's opportunity cost, then gradually raise the announced price until one and only one farmer accepts.

A second approach is for the point source to engage in a planning exercise that calculates/estimates the opportunity cost for each eligible farmer and then approaches the lowest cost farmer with an offer just slightly higher than this estimate. This would ensure that the payment is lowest cost, but the price discovery process could prove to be quite expensive. (This is not the sort of "targeting" that is usually proposed for nonpoint problems. There, the task is to identify where the problem comes from. Here, it is to find the lowest cost solution. Targeting might still be useful even when, as is the case here, there is full information about the physical nature of the system.)

A third way to identify the lowest-cost farm practice is to have farmers bid to sign contracts. The point source would simply take the lowest bid. Given appropriate attention to the structure of the bidding process (notably, ensure that each farmer is convinced that there is a nonzero chance of not signing the contract), this system would result in a least-cost "winning bid" somewhat greater than the lowest opportunity cost. (For details, see Kozloff and Taff, 1990).

In all three approaches, the identification of the lowest-cost contract will have no impact on the water quality goals (by construction), as long as some contract is signed and enforced. Consequently, the enforcement agency need concern itself only with broad oversight of the enforcement (but not the identification) process.

An illustration: Riparian buffers to reduce phosphorus loads

Here we demonstrate by plausible example that the potential for efficiency-seeking trades is nonzero, but not limitless. There are known, effective, quantifiable abatement measures for both point and nonpoint sources of phosphorus (Senjem, 1994). Pollutant trading opportunities arise where a significant difference exists in the cost of pollution abatement among sources within a watershed or basin. Thus, a critical component of this investigation is a comparison of phosphorus loading reduction costs for a range of point and nonpoint source measures. Here, we highlight reduction cost estimates for one nonpoint source action (riparian buffers) and one point source technology (ferric chloride treatment). We do this by way of illustration, not proof: point sources will clearly want to do some of their own testing of these estimates.

Permanent vegetation strips along streamcourses are widely touted for their purported water quality and wildlife habitant enhancement potentials. Because they involve the cessation of essentially all crop and livestock activity, they are also less likely to be mandated than are practices such as conservation tillage: they could still be "tradeable," even if some agricultural management becomes regulated.

The cost of a buffer strip is simply the payment required by the farmer to give up cultivation rights, plus an establishment cost, consisting of grass seeding and perhaps tree planting. In the midwest, riparian land in agricultural areas could be rented for $100 an acre or less. With a one-time cost of establishing a grass riparian buffer strip of approximately $50 an acre, with maintenance costs about $15 an acre annually. Thus, assuming a 20-year life for a newly established buffer, the annualized cost is approximately $120/ac.

The effectiveness of a riparian buffer in preventing phosphorus from entering the water will vary with the volume and velocity of loadings from adjacent upland fields, as well as the width and vegetative cover of the buffer strip itself. A conservative estimate is that a buffer area 33 feet wide along a field drainage ditch or stream will prevent 50 percent of sediment-borne phosphorus from a 250-foot-wide adjacent portion of the field from entering the water channel. (In addition, it will hold in place 95 percent of the sediment that otherwise would have been exported from the now-grass-covered area. We do not include this supplemental benefit in our calculations).

Along both sides of a one-mile length of field ditch, then, 33-foot a riparian buffer would take up eight acres while protecting 61 acres of adjacent upland. The amount of phosphorus intercepted by the buffer, and the cost per pound of preventing phosphorus loadings is summarized in the following table. (For details, see Senjem, 1994).

Costs of reducing phosphorus by riparian strips

Sediment Delivery (tons/acre)	Phosphorus Delivery (pounds/mile)	Phosphorus Interception (pounds/acre)	Cost of Phosphorus Interception (dollars/lb.)
5	343	23.4	5.06
4	274	18.9	6.35
3	206	14.2	8.45
2	77	9.5	12.63
1	69	4.8	25.00

The point source will compare this range of costs with in-plant modifications to achieve the same purpose. The current ferric chloride treatment technology demonstrates clear economies of size, Treatment plants below 1 mgd face phosphorous reduction costs of more than $30/lb., while larger plants pay less than $10/lb.

Mentally superimposing our riparian buffer costs estimates, we conclude that there may exist trading opportunities between smaller treatment plants (less than 30 mgd) and farmers with relatively high sediment delivery (3 tons/acre/year or more) on their riparian fields. For example, a typical 10 mgd plant (serving, say, a city of 40,000) needs to remove 67,000 pounds of phosphorus each year in order to reach a 1 mg/l phosphorus effluent limit. Ferric chloride treatment could be installed and maintained for an annualized cost of $640,000. An equivalent reduction in phosphorus loadings would require the installation of 4,700 acres of riparian strip, protecting lands with a 3 tons/acre/year sediment delivery. At $120/ac./yr., this will cost $564,000/yr.--a slight financial improvement over in-plant phosphorus treatment. As the figure shows, the relative cost advantage of the riparian strips improves for wastewater treatment plants smaller than this. For larger plants, the search costs for cheaper nonpoint reduction sites may be prohibitive.

These trades will not take place, however, even with favorable relative practice costs, if transaction costs are too high. We focus on reducing regulatory uncertainty in this paper. The other major source of transaction costs, finding and signing up the appropriate landowners, is properly the subject of another paper.

<u>Evaluation</u>

Once a market-oriented pollution reduction scheme, such as that outlined here, is implemented, how will we know if it is working? It is not enough, probably, that measured pollution levels in the river can be shown to diminish. We must also demonstrate that the market scheme is in some sense superior to the regulatory system it replaces.

One could, of course, measure all costs and benefits of both approaches. But this would be expensive. A more parsimonious evaluation effort focuses on the individual transactions. If one accepts--as would the regulatory agency in our scheme--that approved practices will indeed achieve their stated pollution reduction targets, then it will be sufficient to examine the relative costs of unit reductions. If the land management practice is demonstrably cheaper than achieving the same reduction as could the point source, then market-oriented scheme is more cost effective.

How do we determine such relative costs? By observing the market. If trades occur, then the market scheme has lower costs (including transaction costs borne by the trading parties). If trades don't occur, then either practice costs or transaction costs are too high.

The simplicity of this evaluation framework should be quite appealing from the regulatory agency's perspective. Its usefulness rests, as we noted, on the initial decision by the agency to authorize and calibrate the list of trading-eligible practices. The costs associated with creating and maintaining this practice list, as well as those associated with the monitoring of actual practice maintenance, should be enfolded into the costs faced by the trading parties themselves. That way, all costs of the marketing scheme are seen by market participants, so that observation of trading behavior tells us all we need to know about the relative efficiencies of the two pollution control strategies.

Summary

A well-crafted point-nonpoint trading policy could make scarce public funds generate more water quality improvement than would otherwise occur. This would result partly from the efficiency gains of introducing an incentive-based policy to complement--not replace--current programs. And the scheme outlined here could be implemented and effectively administered in most states now, with a few appropriate regulatory agency changes. Just as important, a point-nonpoint trading policy could provide a flexible and fair method of determining which sources are to be held responsible for how much pollutant load reduction.

American point and nonpoint water pollution source policies have evolved along radically different lines. The integration of these widely divergent policies is fraught with difficulties, but point-nonpoint source trading is explicitly designed to bridge these two worlds. A modest trading system such as we outline here could be politically palatable, cost-effective, and water-quality improving. More complicated schemes, while perhaps sounder in principle, run the risk of never being taken seriously in practice.

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