Trading on Water

Trading can be a cheaper answer to water quality problems, creating a win-win solution for all.

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Over the centuries, water has provided society with numerous products and services, including transport, food, drinking water, irrigation, recreation, and protection. The world's lakes, rivers, and oceans have also been used as a dumping ground for by-products of industrial development and residential refuge. Until recently, however, very little attention was paid to water quality.

This ignorance of human influence on water quality culminated in such notorious events as Ohio's Cuyahoga River catching on fire in 1969 and the lawsuit against W.R. Grace over contamination of drinking-water wells in Woburn, Massachusetts, which was memorialized in the book and movie *A Civil Action*.[1] The Cuyahoga fire, in fact, helped spark the rise of environmental movements, the establishment of the U.S. Environmental Protection Agency, and the passage of the federal Clean Water Act in 1972.

Water Woes

Water quality is a relative term. The quality of water needed for drinking, recreation, fishing, and aquatic habitat is higher than that required for transportation or agriculture. In 1998, 45 percent of assessed U.S. rivers and streams and 54 percent of assessed lakes, reservoirs, and ponds were threatened or impaired for their designated uses.

The U.S. coastlines are similarly affected. Ninety-eight percent of the Great Lakes shorelines and 24 percent of the ocean shorelines assessed were listed as threatened or impaired. The causes of impairment include nutrients, siltation, pathogens, metals, toxics, pesticides, organic matter, temperature, and oxygen-depleting substances.[2]

The problem is not restricted to just the United States. Across the world, more than a billion people do not have access to safe drinking water. In developing countries, water quality problems principally result from untreated sewage and industrial wastes, while developed countries are plagued more by agricultural runoff and industrial effluents.[3]

Evidence of water quality impairment is abundant. In 1991, the 600-mile (1,000-kilometer) algal bloom on the Darling River in Australia was the result of modifications and reductions in water flow, pollution from sewage treatment works and industry, agricultural runoff, and lower than expected rainfall.[4]

Just as dramatic was the cyanide spill from the Aurul Gold Mine into the Lapus and Somes Rivers at Baia Mare in northern Romania in 2000. This spill made its way to the Tisza River in Hungary, creating a carpet of dead fish before reaching the Danube River in Yugoslavia.[5]

More subtly, the decline of the blue crab and oyster fisheries in the Chesapeake Bay in the United States, caused by deteriorating water quality and over-harvesting, stimulated the states and districts draining into the bay to form an agreement in 1983 to restore the bay's biota.

Restoration programs consist of nutrient reduction from agricultural lands and wastewater facilities, toxic chemical reduction from industry and other sources, fisheries management, and habitat restoration.[6]

Cause and Effects

Some water quality problems are local while others have far-reaching consequences. Consider nutrient pollution, for example. Agricultural fertilizer typically contains two nutrients: phosphorus and nitrogen. Phosphorus, which reaches water bodies attached to soil particles, causes algal blooms and eutrophication in freshwater ecosystems. It is typically a local problem.

Conversely, nitrogen is highly soluble, entering water bodies through runoff, leaching, and atmospheric deposition, and its effect is generally felt some distance from the actual source of the pollution.

The Gulf of Mexico's hypoxic—oxygen-depleted—zone, coined the "Dead Zone," has been attributed to nitrogen from farmland in the Mississippi basin, principally the Missouri River.[7] This oxygen-starved area in the Gulf grew to an all time high of 8,000 square miles (20,000 square kilometers) in 1999.

The increasingly pervasive red tides in the East China Sea are yet another example of nitrogen-induced water quality problems. Nitrogen applied by farmers along the Yangtze River is necessary to meet the increased food demand of a growing Chinese population, but it is also causing substantial economic damage to the region's seafood industry.

In 1998, more than 100 fish farmers in a Hong Kong fishing village used the motors of their sampans to turn back the red tide threatening their fish farms. This action saved about two-thirds of their fish.[8]

Water pollutants fall into two broad categories: point-source and nonpoint-source pollution. Point-source pollution occurs wherever the pollutant can be pinpointed to a specific source of origin, such as the discharge from a pipe into a water body. Nonpoint-source pollution, on the other hand, is diffuse in nature and its precise origin cannot be identified. Examples of this type of pollution include contaminated runoff from farmland, construction sites, and urban areas.

Improvements in monitoring technology and the enforcement of pollution regulations have lead to significant reductions in point-source pollution in the developed world.

In the United States, municipal wastewater treatment plants and industrial facilities all require permits under the Clean Water Act to discharge into rivers, lakes, and oceans. These permits limit the amount and type of pollutants discharged. Violations of these permit levels result in fines. In 1999, more than $20 million in criminal penalties were assessed under the act.[9]

In the developing world, the situation is more desperate. Buenos Aires, Argentina, for example, treats only 2 percent of its wastewater. The costs of collection and primary treatment are still expensive—about $1,500 per household—in many developing countries, with the costs of meeting the more stringent regulations of developed countries being even higher.[10] Even though the technology is available to treat municipal wastewater, significant institutional changes in planning, finance, operations, and management of treatments plants are needed before even point-source pollution can be effectively reduced in these countries.

Nonpoint-source pollution is more difficult to identify, monitor, and control, and it is only now that the developed countries have started to expend significant time and money on addressing this problem. So, it may be some time before this source of water quality pollution is confronted in the developing countries.

Regulation

A number of mechanisms are being used to address water quality problems around the world. As the extent and nature of water quality impairment has become more prevalent, the set of potential solutions has also grown.

The earliest efforts at controlling water quality took a regulatory command-and-control approach. This was either in the form of technology-based or performance-based standards placed on municipal wastewater treatment plants and industrial facilities. Technology standards specified the type of equipment or processes that each industry needed to adopt to meet a water quality target. A performance standard, on the other hand, specified the target and gave industries and treatment plants greater flexibility in the methods they could employ to meet that target.

Even though this regulatory approach achieved initial success, it does place heavy financial burdens on facilities to continually upgrade their equipment, and regulators must keep abreast of new technological advances. It provides little opportunity or incentive for facilities to be innovative.

In the United States, between 1974 and 1994, local governments and the federal construction grants program spent approximately $213 billion for the construction or upgrades of municipal wastewater treatment plants to control point-source pollution. During the next 20 years, an additional $330 billion will likely be required to construct new plants and replace aging facilities to meet the water quality level and treatment demand of a growing population.[11]

One significant omission from this regulatory requirement in the United States is the absence of control over concentrated animal feeding operations. To require a permit, a farm must be larger than 1,000 animal units—one unit being equivalent to a cow and calf or 1,000 pounds (450 kilograms) of liveweight—and the government must deem that the farm is discharging into a water body causing a water quality problem. As a result, only 1 percent of the 1.1 million farms in the United States have permits under the Clean Water Act.[12]

Given that livestock waste is about 130 times greater than human waste, there is remarkably little control of this source of water quality degradation. The 1,600 dairy farms in California's Central Valley, for instance, produce an amount of waste equivalent to that of 21 million people, or seven times more than the people living in the Central Valley produce.[13] Thus, the existing permitted discharge facilities have to shoulder the burden of increasingly stringent water quality standards, while other significant sources of pollution remain uncontrolled.

Nonpoint-source pollution, whose source is more difficult to identify than point-source discharges, cannot be as easily controlled by regulation. Moreover, the cheaper, easier-to-achieve reductions in pollution have already occurred, and costs are escalating for point sources to meet the tougher water quality standards imposed on them. These factors have led to an evolution of various economic policies aimed at improved water quality.

Subsidies and Taxes

Taxes and subsidies have been used to indirectly reduce pollution. Taxes place a penalty on polluters, much like the stick in the carrot-and-stick analogy. Conversely, subsidies are the carrot and provide incentives, usually financial, for polluters to reduce their emissions.

The United States has used a number of subsidy-based policies to influence water quality. The Conservation Reserve Program, for instance, was aimed at reducing soil loss from agricultural land. Almost 34 million acres of highly erodible cropping land had been taken out of production by 1990, with the 2000 enrollment at 31.5 million acres. In return for retiring their land for 10 years, farmers receive a yearly rental payment from the government, with the level of payment reflecting the productivity of the land. The estimated net social value of the program between 1985 and 1990 is $4.2 billion to $9 billion, with $1.3 billion to $4.2 billion in benefits being attributed to improved surface water quality.[14] By comparison, the net government cost of the program over this period was estimated at $6.6 billion to $9.3 billion.[15]

A similar program, the Wetland Reserve Program, was introduced in 1990, providing financial incentives for farmers to voluntarily restore and protect wetlands. Wetlands are recognized as important filters for many substances that degrade water quality; they also provide flood control, wildlife habitat, and recreation. As of July 2000, more than 900,000 acres of wetlands were enrolled in this program.[16]

Encouraging establishment of buffer strips and other conservation practices is also achieved through cost-share arrangements within programs like the U.S. Department of Agriculture's Environmental Quality Incentive Program, which provides financial and technical assistance to help farmers protect soil, water, and other natural resources.

Where emissions can be tied to inputs such as fertilizers and pesticides in the production process, taxing these inputs has been a common practice in OECD countries. Fertilizer taxes have been introduced in Finland, Norway, and Sweden. Frequently, the revenue from these taxes is earmarked for certain uses. Sweden, for instance, uses its fertilizer and pesticide tax to finance environmental research and improvements.

Earmarking these funds for such projects improves the political acceptability and transparency of the taxes, but a number of pitfalls can trip up the unwary. Inducing polluters to reduce their discharges is only partially achieved with earmarking, and sometimes it can provide incentives to over-invest. In certain river basins in the Netherlands, for instance, high-water effluent charges resulted in 20 percent over-capacity in treatment facilities.[17]

Trading

Perhaps the most exciting and innovative mechanism being discussed today is water quality trading. Trading is generally talked about in the context of nutrient impairment but has been used with other substances like biological oxygen demand.

As an adjunct to regulation, trading increases the flexibility facilities have to meet a water quality standard, thereby lowering the overall cost of compliance. Each industrial facility or municipal wastewater treatment plant faces different regulatory compliance costs, depending upon size, scale, age, and overall efficiency. The cost in meeting tighter water quality standards is therefore cheaper for one facility than for another. Those facilities whose upgrade costs are lower thus have an opportunity to make additional reductions beyond their obligation and to sell these additional reductions to facilities whose costs are higher.

Two types of trading are currently in vogue: open and closed. Closed trading is the most common type. It operates under a cap-and-trade system in which an upper limit on the total emission of a particular pollutant from all dischargers in a specified area, such as a watershed, is mandated by law, and facilities are allowed to trade discharge levels as long as the collective discharge from all sources is below the cap. The TMDL—total maximum daily load—process under the Clean Water Act is an example of a regulatory cap being placed on water quality within watersheds or impaired areas. Dischargers are allocated an emission allowance and any emission reduction that the discharger achieves below the regulatory standard, commonly called credits, can be traded.

Open trading is used where the ambient water quality conditions are being met and there has not yet been a regulatory cap implemented for a watershed. This type of trading allows for economic growth and development to occur while maintaining or even improving water quality, and it can be used to avoid or delay the imposition of regulation. For trading to occur, a baseline for emissions in the watershed is determined.

The definition of the baseline can vary depending on the institutions that are establishing the market. Under the trading rules being established for the water quality market in Michigan, for example, the baseline refers to the current land or nutrient management practices being implemented by land or industry owners in each watershed.[18]

Credits are generated when reductions below the baseline are made. These credits can either be banked, traded, or used to comply with the permitted discharge limits for individual point sources. This system offers operational flexibility and water quality improvements in the absence of mandatory caps. As with closed trading, the reductions must be real, surplus, and enforceable before they can be counted as credits.

Trading can occur between two point-source facilities, like municipal wastewater treatment plants, or between a point source and nonpoint source such as a farm.

Point-source facilities are generally controlled by a discharge permit; nonpoint sources are not. The inclusion of nonpoint sources into trading programs has raised the question of uncertainty in the amount of reduction actually achieved by these sources. For nonpoint sources to reduce their nutrient contribution to water bodies, some kind of best management practice is typically implemented. These practices may include changing tillage practices, excluding livestock from water bodies, or creating filter strips of vegetation along a water body to provide a buffer.

To address this reduction uncertainty, a trading ratio or discount factor is commonly applied to nonpoint-source reductions. For example, if the trading ratio is set at 2 to 1, a nonpoint source has to produce two pounds of nutrient reduction to create one pound of credit.

Case Studies

Many studies have illustrated that the inclusion of trading as part of a water quality improvement strategy achieves significant improvements at a much lower cost than is achieved by other mechanisms. In a recent study of nutrient reduction options in three watersheds in the Upper Midwest, for instance, trading was by far the most cost-effective option.[19] The study compared the costs of meeting tighter nutrient standards by requiring point sources to meet 100 percent of the obligation, by implementing best management practices through agricultural conservation subsidies, by a combination of point-source performance requirements and point-source/nonpoint-source trading, and by a joint trading and targeted performance-based conservation subsidy program.

For the Saginaw Bay, Michigan, watershed, the joint trading/targeted conservation subsidy scenario reduced the costs of meeting tighter water quality standards by 82 percent compared with traditional command-and-control regulation on point sources.

Similar, but smaller, cost reductions were seen for the Minnesota River watershed in Minnesota and the Rock River watershed in Wisconsin.

Water quality trading programs have been in existence since the 1980s but have not enjoyed the successes of some other trading programs like the Acid Rain Trading Program.

The first trading program for water quality in the United States was established for the Dillon Reservoir, a source of drinking water for Denver, Colorado, 70 miles to the east. Rapid urban growth, decreasing water quality, and increasing reliance on the reservoir for Denver's drinking water led to the creation of the Dillon Bubble, the watershed area that feeds into the reservoir.

Under the trading program, point sources within the bubble could purchase phosphorus reduction credits from existing urban nonpoint sources like lawn and road runoff and septic tank seepage. In practice, however the upgrading of the municipal wastewater facilities achieved such high phosphorus reductions that no trades were made between point and nonpoint sources. The only trades to occur were two nonpoint-source trades.

The Cherry Creek Reservoir, also a source of drinking water for Denver, has a similar program. As the areas around these reservoirs further develop, more trades are expected to occur within these programs.[20]

The Tar-Pamlico program in North Carolina is probably the best known water quality trading program in the United States. This program was established to avoid tighter point-source permit limits and to reduce the cost of meeting nutrient load reduction requirements. When the North Carolina Division of Environmental Management designated the Tar-Pamlico basin as nutrient-sensitive waters, in response to increasing numbers of fish kills and algal blooms, a coalition of municipal and industrial dischargers formed the Tar-Pamlico Association.

The association agreed to reduce its nutrient discharges into the basin and to share a single nitrogen discharge limit in lieu of individual nitrogen limits being assigned to each discharger. The association enforces the limit and internally allocates discharge limits among its members. If the association exceeds the annual limit, it pays into an agricultural fund that farmers draw from to pay for best management practices, which reduce the amount of nonpoint-source nutrients they discharge into the basin.[21]

The Tar-Pamlico program can be considered a hybrid between a trading program and an effluent tax. The credits are purchased for a fixed price, and there is no direct connection between the credits point-source dischargers use to meet nutrient limits and the credits generated through the best management practices fund.[22]

In Australia, a salinity trading scheme along the Hunter River uses real-time trading of salinity credits to ensure that salinity levels in the river do not exceed a regulatory limit. Salinity levels, which have increased from coal mining activities, electricity generation, and land clearing, were starting to harm irrigated agriculture in the region. The solution was to develop a trading scheme that allocated salt credits to participants.

During times of high river flows, participants are able to discharge salty water according to the number of salt credits they hold. Credit holders can use their credits for their own discharges or they can trade credits to other dischargers. This scheme provides a cost-effective mechanism for reducing salinity levels in the Hunter River, as well as a mechanism that allows new mines or industries to enter the region without compromising water quality.[23]

Trading's Potential

As the extent and cause of water quality problems are clarified, the potential for trading as an integral part of the solution is steadily growing.

Now that nitrogen from the Mississippi basin has been identified as the main culprit in causing the Dead Zone in the Gulf of Mexico, who is to say that trading could not play a key role in alleviating the problem?

To date, most trading programs have concentrated on phosphorus, which affects freshwater ecosystems and necessarily raises concerns over local water quality problems, usually at the small watershed level.

These ecosystems are not greatly harmed by nitrogen; serious problems arise only when excess nitrogen loads reach the oceans. Nitrogen trading therefore opens up the possibility for trading within considerably larger geographic areas than present trading schemes recognize.

With the development of Internet market places like NutrientNet, the potential for more widespread adoption of nutrient trading seems likely.[24] The NutrientNet website is designed to give agricultural nonpoint sources of nutrients a first-cut estimate of their nutrient contribution to a watershed, the likely reductions they can achieve through adopting a variety of mitigation options, and the cost of implementing nutrient reduction activities. Similarly, point sources can make an initial estimate of the costs associated with reducing their nutrient emissions. In addition, buyers and sellers of nutrient credits can post their offers on the website, providing a centralized market for trading to occur. Finally, trades can be registered and tracked for greater transparency and monitoring of trading activities.

Water quality improvements have also been tied to other environmental benefits. In an analysis of climate change strategies for United States agriculture, for instance, nutrient trading provided significant reductions in greenhouse gas emissions and in soil loss, in addition to water quality benefits.[25] The synergies between environmental goods and services are reason enough for developing comprehensive strategies to address environmental problems.

With environmental policy moving away from traditional command-and-control approaches and toward more market-based incentives, trading can provide a unique cost-effective solution to many water quality problems. Trading can reduce the cost of compliance by industrial and municipal facilities to meet increasingly more stringent water quality standards, it allows unregulated sources of pollutants such as agriculture and urban nonpoint sources to be part of the solution, and it improves water quality.

Among the various policy options available, trading is potentially the most effective, as it provides a win-win solution for regulators, industrial and municipal facilities, agriculture, and society as a whole.■

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NOTES

1. *Anderson v. W.R. Grace & Co.*, 628 F. Supp. 1219 (D. Mass., 1986). Residents of Woburn, Massachusetts, filed this federal lawsuit, alleging that the contamination of drinking water wells caused a high incidence of leukemia in their community. Jonathan Harr's book *A Civil Action*, which was made into a movie, documents the case and the lives of the principal parties affected by the case.

2. U.S. Environmental Protection Agency, *The Quality of Our Nation's Waters, A Summary of the National Water Quality Inventory: 1998 Report to Congress*, EPA 841-S-00-001 (Washington, DC: Office of Water, USEPA, 2000).

3. Carmen Revenga et al., *Pilot Analysis of Global Ecosystems: Freshwater Systems* (Washington, DC: World Resources Institute, 2000).

4. State of the Environment Advisory Council, *State of the Environment Australia 1996* (Collingwood, Australia: Environment Australia, CSIRO Publishing, 1996).

5. Environmental News Service, "Cyanide Spill Mine Reopens in Romania" <http://ens.lycos.com/ens/jun2000/2000L-06-16-03.html>.

6. Chesapeake Bay Program, "America's Premier Watershed Restoration Program" <http://www.chesapeakebay.net>.

7. Donald A. Goolsby et al., *Flux and Sources of Nutrients in the Mississippi-Atchafalaya River Basin*, Topic Report 3, submitted to White House Office of Science and Technology Policy Committee on Environment and Natural Resources, Hypoxia Work Group (May 1999).

8. Frank Langfitt and Heather Dewar, "China's Prosperity Turns Seas Toxic," *Sun* (September 27, 2000).

9. U.S. Environmental Protection Agency, *Annual Report on Enforcement and Compliance Assurance Accomplishments in 1999*, EPA 300-R-00-005 (Washington, DC: Office of Enforcement and Compliance Assurance, USEPA, 2000).

10. World Resources Institute, *World Resources 1996-1997: A Guide to the Global Environment: The Urban Environment* (New York, NY: Oxford University Press, 1996).

11. Association of Metropolitan Sewage Agencies and the Water Environment Federation, *The Cost of Clean* (Alexandria, VA: Water Environment Federation, March 1999).

12. Robert W. Adler, Jessica C. Landman, and Diane Cameron, *The Clean Water Act 20 Years Later* (Washington, DC: Island Press, 1993).

13. United States Senate, *Animal Waste Pollution in America: Environmental Risks of Livestock and Poultry Production*, report compiled by the Minority Staff of the United States Senate Committee on Agriculture, Nutrition and Forestry, for Senator Tom Harkin (D-IA) (Washington, DC, 1997).

14. Tim C. Osborn and Kazim Konyar, "A Fresh Look at the CRP," *Agricultural Outlook*, USDA/ERS, AO-166 (Washington, DC: Economic Research Service, August 1990), pp. 33-37.

15. USDA Economic Research Service, *Agricultural Resources and Environmental Indicators,* Agricultural Handbook No. 705 (Washington, DC: Economic Research Service, 1994).

16. Natural Resources Conservation Service, Wetland Reserve Program <http://wl.fb-net.org/wrp-acres.gif>.

17. Timothy O'Riordan, *Ecotaxation* (London, UK: Earthscan Publications, 1997).

18. Personal communication with David Batchelor, market-based environmental program specialist, Michigan Department of Environmental Quality (January 2001).

19. Paul Faeth, *Fertile Ground: Nutrient Trading's Potential to Cost-Effectively Improve*

Water Quality (Washington, DC: World Resources Institute, 2000).

20. Michigan Department of Environmental Quality, *Great Lakes Trading Network, Second Semi-Annual Report to the Great Lakes Protection Fund* (December 1998) <http://www.deq.state.mi.us/swq/>.

21. North Carolina Department of Environment and Natural Resources, Tar-Pamlico Nonpoint Source Strategy and Nutrient Trading Program <http://h2o.enr.state.nc.us/nps/tarp.htm#phase1>.

22. Faeth, *Fertile Ground*. Other nutrient trading programs that have been or are being established or discussed in the United States include programs for the lower Boise River, Idaho; the Minnesota River, Minnesota; the Long Island Sound, Connecticut; the Little Miami River, Ohio; the Fox-Wolf, Rock, and Red Cedar Rivers, Wisconsin; the Chesapeake Bay; and the state of Michigan.

23. New South Wales Environmental Protection Agency, *Hunter Valley Salinity Trading Scheme* (1999).

24. World Resources Institute, NutrientNet <http://www.nutrientnet.org>.

25. Paul Faeth and Suzie Greenhalgh, *A Climate and Environmental Strategy for U.S. Agriculture* (Washington, DC: World Resources Institute, 2000).