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Policy Reforms Needed for Better Water Quality and Lower Pollution Control Costs

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Water pollution control has been a top environmental policy priority for decades, an area of significant state and federal regulation, and the focus of enormous public and private spending. Yet significant water quality problems remain. For example, a recent U.S. Environmental Protection Agency (EPA) assessment finds that 46% of U.S. rivers and streams are in poor biological condition, 25% are in fair condition, and only 28% are in good condition (EPA, 2016). This situation is in large degree due to fundamental flaws in the nation's water quality policy architecture, with highly uneven regulation of polluting sectors. The same architecture has resulted in pollution controls that are unnecessarily expensive, to the point that the incremental costs of additional water quality protection exceed the benefits (Olmstead, 2010). Innovations in water quality policy are essential to improve the effectiveness and economic efficiency of water quality protection. Agriculture is at the center of necessary reforms. With some exceptions, agriculture is lightly regulated under the existing architecture yet a major cause of remaining water quality problems. It is also a vastly underutilized source of comparatively low cost pollution reductions (EPA, 2001).

Point versus Nonpoint Pollution
Pollution sources are commonly differentiated as point or nonpoint sources. Point sources discharge pollutants directly into receiving waters through a pipe or other discrete conveyance. Pollutants from nonpoint sources follow diffuse and often complex pathways from their point of origin to receiving waters. For example, nitrogen applied to farm fields may be removed in surface runoff, leach into groundwater, or enter the atmosphere as a gas later to return to the Earth's surface with wet (rain, snow) or dry (dust) deposition.

Agriculture and Water Quality

The most recent EPA National Water Quality Inventory lists agricultural nonpoint source (NPS) (see Box) pollution as the leading cause of water quality impairments on surveyed rivers and streams, the third-largest cause for lakes, the second largest for wetlands, and a major contributor to contamination of estuaries and groundwater (EPA, 2017). Of particular concern is nutrient pollution, which the EPA describes as "one of America's most widespread, costly and challenging environmental problems" (EPA, 2009). Plant nutrients are essential for healthy aquatic ecosystems, but human activities (agriculture, fossil fuel combustion, industrial processes, human settlements) can increase nutrients (especially nitrogen (N) and phosphorous (P)) above "natural levels," leading to reduced biodiversity, diminished productivity of commercial and sports fisheries, loss of waterfowl habitat, various disamenities from algal blooms, and—in some cases—risks to human health from elevated nitrates in drinking water and toxic algae. High-profile examples of nutrient pollution are found in the Chesapeake Bay, Florida Everglades, Gulf of Mexico, and Lake Erie, but water quality degradation from excess nutrients is widespread. For example, more than two of every five river and stream miles have nutrient levels that are too high (EPA, 2016).

Although the causes of specific nutrient pollution problems vary from place to place, agriculture is a pervasive contributor and often the major source of excess nutrients. Farmers typically apply nutrients in synthesized fertilizers or animal manures to increase output. In some regions with high livestock densities, manure may be applied to cropland and pasture land as much to dispose of it as to increase fertility. Surface runoff, leaching, and other natural process move nutrients from barnyards, fields, and pastures into water resources. Surface runoff also moves sediment to water resources, with the result that sediment pollution problems sometimes accompany nutrient problems.

The Chesapeake Bay is a leading case study for nutrient and sediment pollution. The largest estuary in the United States, the Chesapeake has ecological, economic, cultural, and historical significance. It has also been highly stressed by human settlement and agricultural and industrial activity, particularly by nutrients and sediments. The Chesapeake Bay Program (2017) estimates that agricultural NPS pollution contributes 42% of N and 55% of P entering the bay. Agriculture is also the leading source of sediments (S) entering the bay, contributing 60%.

The bay has been a focus of research on nutrient pollution and a focus of significant nutrient pollution policy initiatives and spending for nutrient pollution control since the 1980s. Insufficient progress toward water quality goals led the EPA to issue a Total Maximum Daily Load (TMDL) for the bay in 2011. TMDLs are limits on pollution loads required by the Clean Water Act (CWA) for waters that do not meet water quality standards. The bay TMDL requires the six states in the 64,000-square-mile watershed and the District of Columbia to reduce N, P, and S from managed sources by 26%, 24%, and 15% by 2025 compared to 2009 levels. The reductions required for agricultural NPS pollution for N, P, and S are 36%, 30%, and 29% respectively.

Agricultural Nonpoint Source Policy

A fundamental question facing policy-makers now is how to bring about the changes in farming practices and agricultural systems needed to achieve water quality goals. The technological means, conventionally known as Best Management Practices (BMPs), for substantially reducing nutrient and sediment pollution from agriculture are well known. Missing are the policy mechanisms necessary to bring about sufficient BMP adoption. Some BMPs have private benefits that may lead farmers to adopt them, but—in general—pollution control in agriculture is costly. With farmers seeking to survive and thrive in competitive agricultural markets, some combination of carrots and sticks is required to achieve established goals.

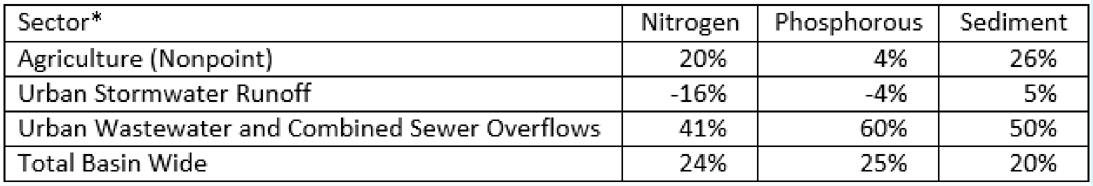
The policy architecture of water quality protection in the United States is defined by the 1972 CWA, legislation that nationalized the control of point sources (PS) of pollution by requiring PS dischargers to obtain and comply with discharge permits that set effluent limits. The CWA assigned responsibility for control of NPS pollution, of which agriculture is by far the most important, to the states. Municipal stormwater and confined animal feeding operations (CAFOs) were initially treated as NPS pollution under the CWA, but urbanized areas and CAFOs exceeding certain size thresholds have been redefined as PS pollution and are regulated as such.

Agricultural NPS policies implemented by the states typically emphasize voluntary adoption of BMPs, with programs to educate farmers about problems and solutions, and to facilitate BMP adoption by providing technical and financial support (Shortle et al., 2012). The limited effectiveness of this approach has led some states to include certain mandatory elements, typically in the form of modest technology standards (Kling, 2013). In such cases, voluntary adoption is typically the default approach, with limited regulatory enforcement unless triggered by some event.

While the states have legal responsibility for agricultural NPS pollution, the most significant investments in controlling the problem come from U.S. Department of Agriculture conservation programs authorized by federal farm legislation (Shortle and Uetake, 2015). The most significant is the Environmental Quality Incentives Program (EQIP), which was established in 1996 to provide technical and cost-shared financial assistance for the installation of conservation practices.

CWA regulations have been effective in reducing PS discharges. While federal and state agricultural NPS programs have had positive effects, they generally fall short of what is needed to achieve water quality goals (Shortle et al., 2012). The Chesapeake Bay once again serves to illustrate. Comprehensive time series data on PS and NPS pollution loads to specific bodies of water is generally not available, but decades of research have provided exceptional data for the bay, indicating the relative effectiveness of PS versus agricultural NPS policies. Consistent with the policy architecture described above, municipal and industrial PS pollution have been subject to increasingly stringent regulations, while agricultural NPS pollution has been addressed largely through voluntary approaches.

Table 1. Chesapeake Bay Pollution Reductions: 1985–2009



Sector*	Nitrogen	Phosphorous	Sediment
Agriculture (Nonpoint)	20%	4%	26%
Urban Stormwater Runoff	-16%	-4%	5%
Urban Wastewater and Combined Sewer Overflows	41%	60%	50%
Total Basin Wide	24%	25%	20%

Notes: *Excludes septic systems, forests, and atmospheric deposition to tidal and nontidal waters.
Source: Chesapeake Bay Program (2017) – Loads to Chesapeake Bay Simulated Using CBP Phase 5.3.2 Watershed Model.

Table 1 provides estimates of changes in pollution loads to the bay between 1985 and 2009. Agricultural NPS loads have declined over the period. Agricultural programs have certainly played a role in this reduction, but reductions in cropland acres and economic and technological developments that improve the private benefits of certain BMPs (e.g., no-till, soil testing) are also factors. In percentage terms, the agricultural NPS N and S reductions are about half those for urban wastewater sources, and a small fraction of the urban wastewater P reductions. To fully appreciate the differences, it is important to recognize that the urban population of the watershed has grown steadily and substantially (34% between 1985 and 2016).

Urban stormwater trends are contrary to the PS and agricultural NPS trends, reflecting the substantial growth of urban areas in the bay watershed and limited regulation of urban stormwater as NPS pollution after the enactment of the 1972 CWA. Stormwater, like agriculture, is a major target of the Chesapeake Bay TMDL.

Limitations of the current policy architecture are also well illustrated by Lake Erie (International Joint Commission, 2014). Prior to the 1970s, excess nutrient loads and severe eutrophication greatly reduced the lake's value for fishing, water supply, and aesthetics. Phosphorous from municipal sewage treatment plants was the leading cause. Regulations and investments beginning in the 1970s reduced phosphorous loads by more than half by the mid-1980s. However, nutrient problems returned in the early 2000s and have become more severe since, punctuated by widespread harmful algal blooms. While a variety of factors contributed to the relapse, increased dissolved P (a highly potent form) from nonpoint sources, particularly agriculture, play a leading role.

Improving Effectiveness and Efficiency Part I

The voluntary approach to agricultural NPS pollution emerged from traditional soil and water conservation programs that provide farmers with technical and cost-shared financial assistance to implement conservation practices. In theory, conservation practices provide private benefits to farmers (e.g., improved soil productivity), motivating their interest in adoption, and societal benefits that justify public assistance. Given that some soil and water conservation practices serve to protect water quality and the large societal investments in the infrastructure for providing support for conservation, expanding the scope of conservation programs to include water quality objectives makes good sense. There are, however, fundamental limitations of the approach for water quality protection.

One limitation is that conservation programs typically have multiple goals. These goals are always not complementary, with the result that resources for water quality protection must compete with resources for other objectives within conservation budgets, and some practices supported by these programs are at odds with water quality goals. The USDA Natural Resource Conservation Service allocated obligated almost $2.4 billion out of a total of $5.7 billion for practices that at least in part improved water quality during 2009–2015 (U.S. Government Accountability Office, 2017). Most of this amount (75%) was for practices that addressed environmental concerns in addition to water quality.

A second limitation is that resources allocated to water quality protection through conservation programs are not adequately targeted in space. Efficient use of scarce public funds would prioritize critical source areas (e.g., particular watersheds and locations within them) to achieve the “biggest bang for the buck.” Existing conservation programs provide very limited discretion for spatial targeting. Also important to efficient water quality protection is the effectiveness and cost of the practices utilized. A study of the costs to agriculture of the Chesapeake Bay TMDL found that prioritizing practices based on their cost-effectiveness along with crude spatial targeting could reduce annualized costs of achieving the required agricultural N and P load allocations across the six bay watershed states by 27%–80% compared to the costs of the Phase I watershed implementation plans developed by the states with little consideration to cost-effectiveness (Kaufman et al., 2014).

Finally, a fundamental limitation of the current approach is that it relies on payments to farmers. This essentially holds water quality protection hostage to the amount of public conservation spending. Conservation investments are already budget-constrained, with demand for funds routinely in excess of supply. The importance of this restriction is likely to increase as federal and state discretionary budgets are increasingly squeezed by entitlements and unfunded pension obligations (Shortle et al., 2012).

Fundamentally, the traditional voluntary compliance model for water quality protection makes water quality protection in agriculture supply driven rather than demand driven. Details of pollution control investments that are funded by the public and of fundamental importance to water quality protection depend on the choices individual farmers make about whether or not to participate in water quality programs and the control practices they are willing to adopt from the menu supported by those programs. This kind of system can assure desired water quality outcomes and efficiency in the use of public funds only if the payment model can effectively limit funding to critical source zones and to water quality practices that are cost-effective, induce eligible farmers to adopt the most efficient practices even when there are few or no private benefits from their use, and allocate sufficient public funds to get the job done. This is not the existing system.

Improving Effectiveness and Efficiency Part II

Innovations in agricultural NPS policies are crucial if they are to be effective, efficient, and make good use of public funds. Before discussing options, it is important to identify another compelling reason for policy reform. Smart initiatives for reducing water pollution from agriculture could also substantially improve the overall economic efficiency of water quality protection. The U.S. policy architecture is not only ineffective in controlling NPS pollution, it is also grossly inefficient, with far more than required being spent to achieve the resulting water quality benefits. For example, based on a review of benefit-cost studies, Olmstead (2010) concludes that the incremental benefits of the CWA exceeded the incremental cost through the late 1980s, but the reverse has been true since then. This is not because of low benefits from water quality protection but because of highly inefficient policy. PS regulations implemented under the CWA prevent utilization of least-cost control technologies and have until recently prevented cost-reducing allocations of abatement across alternative sources to exploit differences in marginal abatement costs. The United States has ended up relying on very high-cost pollution abatement from heavily regulated PS pollution, while lower-cost agricultural NPS pollution goes largely unregulated.

Key elements of better policies for agriculture include switching from an incentive model in which farmers are paid to implement pollution-reducing farming practices to one in which payments are received for actual or expected improvements in water quality (pay-for-performance), switching from a resource allocation model that targets limited resources to high-priority problems in high-priority places (targeting), utilizing payment mechanisms that minimize payments in excess of farmers’ willingness to accept, and shifting from a pay-the-polluter model to more of a polluter-pays approach (Shortle et al., 2012). Further, there are situations in which regulatory mandates make good economic sense. For example, bans on certain harmful practices or mandates for prevention practices that are known to be cost-effective in environmentally sensitive locations in watersheds with significant or chronic water quality problems may sometimes be the cheapest way to achieve water quality protections. The best strategies will likely entail mixes of incentives and regulatory constraints (Shortle et al., 2012).

These types of innovations should be considered for both USDA agri-environmental programs and for state agricultural NPS programs. The presence of both types implies opportunities for and likely benefits from federal and state coordination, which would likely require federal policy reforms that enable greater flexibility in the way that USDA Natural Resource Conservation Service programs are delivered so that they can be tailored to local needs and state and local policies. Another important federal policy reform would be to expand conservation compliance requirements in both federal and state programs. In the case of the federal government, this would make participation in income support programs contingent on water quality compliance (Claassen et al., 2004). State and local governments provide various economic benefits to agriculture—such as use-value taxation and purchase of developments—typically without requiring an environmental quid pro quo (Shortle and Uetake, 2015).

Addressing the overall efficiency of water quality protection requires shifting from the current paradigm in which PS and NPS pollution are managed separately to one in which they are managed jointly at watershed scales. The most obvious way to achieve integration is through water quality trading (WQT) programs that impose caps on aggregate pollution loads applicable to PS and NPS pollution and allow trading between sources of both types to allocate pollution reductions efficiently among types. As one indicator of the potential cost savings, the EPA (2001) estimated that expanded use of water quality trading between PS and NPS pollutors could reduce compliance costs associated with TMDL regulations by $1 billion or more annually between 2000 and 2015, but this estimate understates the potential gains. A recent study for the Chesapeake Bay estimates that trading between urban and municipal polluters and agricultural NPS sources could reduce Chesapeake Bay TMDL compliance costs by as much as $1.2 billion annually (Van Houtven et al., 2012). This estimate reflects enormous differences in control costs between comparatively expensive PS controls and comparatively cheap agricultural NPS controls. Urban stormwater costs are especially large.

Several dozen WQT initiatives have been developed in some form since the mid-1980s. These initiatives include planning exercises and pilot and active programs. Agriculture is addressed in many of these initiatives, and almost all are within the United States. Most programs have been developed since the mid-1990s, prompted by the interest of state water quality authorities in cost-effective approaches to TMDL compliance, encouraged and supported by EPA policy guidance and EPA and USDA technical and financial support. Most programs manage nutrients, especially phosphorous. A particularly noteworthy trading program outside the United States is the Lake Taupo nitrogen program in Waikato, New Zealand, which is the only trading program devoted exclusively to agricultural sources.

The most noted feature of WQT programs developed to date is the lack of trading activity. Most have had few if any trades, and there are no major success stories like those for air emissions trading. However, assessments indicate that in many instances these programs suffer from limited investment in the development of successful trading platforms, design flaws, and an absence of economic fundamentals needed to drive trades (Fisher-Vanden and Olmstead, 2013). Further, the CWA is itself a significant institutional barrier to efficient markets due to restrictions that prevent fully realizing potential gains from trade (Fisher-Vanden and Olmstead, 2013). But while there are no “great” successes in agricultural WQT, several programs suggest that the mechanism has potential as an element of better water quality policy (Shortle, 2013). Phosphorous trading programs on the Greater Miami River in Ohio and the South Nation River in Ontario, Canada, and the Lake Taupo nitrogen trading program in New Zealand are especially encouraging examples of WQT programs that include agriculture (Shortle, 2013). Taken together, these highly innovative programs demonstrate that carefully designed, context-sensitive markets can produce economically and environmentally beneficial trading activity (Shortle, 2013).

Summary

Agriculture is a leading cause of remaining water quality problems in the United States. Efficiently managing the water quality impacts of agriculture is first and foremost a policy problem. Decades of research on relationships between farming systems and water quality and technologies to reduce agricultural nonpoint pollution provide the sector with a substantial technological toolkit for water quality protection. The policy challenge is to induce the implementation of the right practices in the right places (within fields and watersheds) to achieve water quality goals at least cost. The existing policy architecture relies excessively on voluntary implementation of controls by farmers, focuses on effort rather than outcomes, and allocates scarce resources inefficiently across places and sectors. Common-sense policy reforms identified in this article offer pathways to improve water quality and reduce the social costs of water pollution control.

For More Information

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