AGRICULTURE AND WATER QUALITY: A CLIMATE-INTEGRATED PERSPECTIVE

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I. INTRODUCTION

The significant impact of agriculture on water quality has been known for many years. Indeed, based on the vast majority of available information, agriculture is responsible for the lion's share of water quality impairment in the United States, and has been so for quite some time.[1] While control programs have resulted in success stories for some kinds of impacts on a local or even regional scale, from a broad national perspective the effects of agriculture on water quality have not changed significantly.[2] Likewise, agriculture and water quality experts, government officials, politicians, farmers, and environmental groups have been debating the most appropriate policy responses to those problems for decades. Although details change, the broad contours of the policy discourse have remained remarkably similar, at least since 1972, when Congress adopted the "modern" version of the Federal Water Pollution Control Act,[3] commonly known as the Clean Water Act (CWA),[4] and since Congress began to incorporate a new set of environmental protections into the Farm Bill in recent decades.[5]

Environmental groups (and some academics) typically argue that existing controls on agricultural water pollution are insufficient to address

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1. *See infra* Part II.A.
2. *See infra* Part II.B.
3. Federal Water Pollution Control Act of 1972, Pub. L. No. 92-500, 86 Stat. 816 (codified as amended at 42 U.S.C. §§ 1571–99 (2012)). Congress first passed the Federal Water Pollution Control Act in 1948, Pub. L. No. 80–85, ch. 750, 62 Stat. 1155, and amended it several times thereafter before passing the "modern" version in 1972. *See* WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW § 4.1.A.4.a (2d ed. 1994) (stating that the 1948 Federal Water Control Act was amended five times before it was substantially revised in 1972).
4. Congress adopted this short title in the 1977 amendments. Clean Water Act of 1977, Pub. L. No. 95-217, §§ 1–2, 518, 91 Stat. 1566, 1566.
5. *See generally* Mary Jane Angelo, *Corn, Carbon, and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 GEO. MASON L. REV. 593, 594 (2010) (finding 2008 Farm Bill's complex agricultural policies outdated and substantially contributing to climate change); John H. Davidson, *The Federal Farm Bill and the Environment*, 18 NAT. RESOURCES & ENV'T 3, 3–5, 36–39 (Summer 2003) (providing an overview of Farm Bill conservation options and environmental policy concerns). A detailed history of the various shifting Farm Bill environmental programs is certainly relevant to the impacts of agriculture and water quality, but beyond the scope of this analysis.

the magnitude of the problem, and that delegation of agricultural water pollution control to the states—with only minimal oversight by the U.S. Environmental Protection Agency (EPA) or other federal agencies or officials—has not worked over the past forty years.[6] Moreover, while continuing to support Farm Bill programs designed to provide incentives for farmers to protect water quality and other environmental resources, on the whole, environmental groups criticize the extent to which farm subsidies promote unsustainable farming practices, leading to water pollution as well as other environmental and natural resource problems.[7] Although individual programs implemented under both the CWA and the Farm Bill have undoubtedly reduced water pollution from some farms in some watersheds and for some kinds of pollution, viewed from a national perspective the magnitude and severity of agricultural water pollution has not improved dramatically for decades.[8]

Representatives of agriculture, on the other hand—to the extent that such a large and diverse community of producers and associated businesses can be generalized—oppose water pollution controls that might be dictated at the national scale as a "one size fits all" solution to problems that vary by crop, soil type, weather, topography, hydrology, and a range of other conditions.[9] They also argue that education, cost-sharing, and similar incentives are more likely to prevent agricultural water pollution than rigid regulations,[10] and that farmers have inherent incentives to be good stewards of their land.[11]

There sits the debate, effectively stuck in the same place for twenty years or more. Although researchers continue to develop more and better methods to curb agricultural pollution, and some experts believe as a result that effective controls are available from a technological perspective,[12] little

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6. *See infra* Part III.

7. *See, e.g.*, Sara Sciammacco, *EWG Farm Bill Platform*, ENVTL. WORKING GRP., (Apr. 16, 2012), http://www.ewg.org/agmag/2012/04/ewg-farm-bill-platform/ (urging Congress to reject cuts to voluntary conservation programs and to promote implementation of sustainable farming practices).

8. *See infra* Part II.B.

9. *See Protecting Water Quality,* AM. FARMLAND TRUST, http://www.farmland.org/programs/environment/water-quality/default.asp (last visited Apr. 9, 2013) (advocating for use of best management practices, and establishing water quality trading markets and policies that support conservation practices).

10. *See, e.g.*, *id.* (suggesting a preference for incentive programs for nonpoint source pollution regulation).

11. *See* James S. Shortle et al., *Reforming Agricultural Nonpoint Pollution Policy in an Increasingly Budget-Constrained Environment*, 46 ENVTL. SCI. & TECH. 1316, 1318 (2012) (arguing farmers adopt conservation practices due to self-interest).

12. *See, e.g.*, Eric A. Davidson et al., *Excess Nitrogen in the U.S. Environment: Trends, Risks, and Solutions,* ISSUES IN ECOLOGY, Winter 2012, at 14 (theorizing that the technology exists to reduce undesirable nitrogen releases, but requires cross-sector and cross-discipline collaboration to succeed).

progress has been made and few new ideas have been proposed in the policy arena. Environmental groups brought numerous lawsuits[13] and the EPA adopted stricter guidance[14] to force states to identify impaired water bodies and to develop appropriate controls on all pollution sources, including agriculture, through the "total maximum daily load" (TMDL) provision of the CWA[15] and the EPA's regulation implementing that provision.[16] Although states have developed tens of thousands of TMDLs in response,[17] there is little empirical evidence that this process has curbed agricultural pollution materially. According to EPA's analysis, TMDLs have resulted in the complete restoration of only 354 out of approximately 33,000 water bodies for which TMDLs have been adopted primarily to address nonpoint source pollution.[18]

Climate change, in turn, is likely to exacerbate agricultural water pollution and to complicate associated control efforts.[19] Ironically, however, that very set of complications has the potential—if policy makers respond rationally and collaboratively—to break the policy logjam in this arena. Although the mainstream agricultural community has been slow to acknowledge it, climate change has the potential to hurt agricultural operations economically in a number of ways. Those impacts, in turn, might

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This assertion appears to be borne out by the fact that water quality improvements have been shown in areas in which public investments have resulted in the implementation of available control methods. *See* Shortle et al., *supra* note 11, at 1318 (noting farmers prefer to share cost of programs with public).

13. *See, e.g.*, Sierra Club v. Hankinson, 939 F. Supp. 865 (N.D. Ga. 1996) (seeking implementation of CWA provisions on water quality limited segments and TMDLs); Idaho Sportsmen's Coal. v. Browner, 951 F. Supp. 962, 964 (W.D. Wash. 1996) (seeking to require EPA to develop TMDLs for Idaho waters). *See generally* Robert W. Adler, *Integrated Approaches to Water Pollution: Lessons from the Clean Air Act*, 23 HARV. ENVTL. L. REV. 203, 205, 253 (1999) (describing citizen suits attempting to force states to set TMDLs); Oliver A. Houck, *TMDLs, Are We There Yet?: The Long Road Toward Water Quality-Based Regulation Under the Clean Water Act*, 27 ENVTL. L. RPTR. 10391, 10395–96 (1997) (discussing 1990's litigation that started EPA's nonpoint pollution regulation).

14. *See* Memorandum from Robert Perciasepe, Assistant Administrator, Envtl. Prot. Agency, to Regional Administrators Regional Water Division Directors, New Policies for Establishing and Implementing Total Maximum Daily Loads (TMDLs) (August 8, 1997) [hereinafter "Perciasepe Memorandum"], *available at* http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/ratepace.cfm (calling for setting of TMDLs for all waters and actively including states in the enforcement process).

15. 33 U.S.C. § 1313(d)(1)(A), (C) (2006).

16. 40 C.F.R. § 130.7 (2012).

17. *See Watershed Assessment, Tracking & Environmental Results: Approved TMDLs by State*, ENVTL. PROT. AGENCY, *available at* http://ofmpub.epa.gov/waters10/attains_nation_cy.control#tmdls_by_state (last updated Jan. 30, 2013) (identifying 49,323 TMDLs total since 1995). Of those TMDLs, EPA estimates that more than 33,000 address waters impaired primarily by nonpoint sources. U.S. ENVTL. PROT. AGENCY, A NATIONAL EVALUATION OF THE CLEAN WATER ACT SECTION 319 PROGRAM 7–8 (2011), *available at* http://water.epa.gov/polwaste/nps/cwact.cfm [hereinafter EPA NATIONAL EVALUATION].

18. EPA NATIONAL EVALUATION, *supra* note 17, at 4.

19. *See infra* Part IV.A.

further jeopardize both global food security and the security of U.S. agricultural exports in global markets.

The interests of farmers, environmentalists, and consumers may have diverged to a large degree when focusing exclusively on agricultural water pollution. The silver lining of integrating climate change into this scenario, however, is that a larger suite of parties might have a common interest in solutions designed to simultaneously address the production and environmental impacts of climate change. It suggests that more progress may be possible by broadening the focus of the inquiry from how farmers can produce food, fiber, and related products with less water pollution to how farmers can adapt to the significant likely impacts of climate change in ways that are both economically and environmentally sustainable.

Part II of this article reviews past and current information on the water quality impacts of U.S. agriculture. Part III presents a similar review of policy proposals to address the current impasse over agricultural water pollution and explains why those solutions have achieved only limited success. Part IV discusses the predicted effects of climate change on U.S. agriculture from both an economic and a water quality perspective, and explores ways in which shared solutions to those problems might be addressed. Part V concludes by suggesting that viable solutions to this difficult set of issues are more likely to be found by broadening the focus of the inquiry based on goals that are mutually beneficial from an economic and environmental perspective.

II. WATER QUALITY IMPACTS OF U.S. AGRICULTURE: A LARGELY STAGNANT PROBLEM

The significant adverse effects of U.S. agriculture on water quality have been understood for a long time. Although discreet improvements can be seen in individual watersheds and for specific pollutants—particularly where significant targeted public funding or subsidies have been used effectively—on a national scale the relationship between agriculture and water quality has not changed dramatically in recent decades.

A. Historical Understanding

Some accounts have suggested that the role of nonpoint source pollution generally, and agricultural runoff in particular, did not become apparent until the masking effect of industrial and municipal point source pollution was reduced through the permitting and effluent limitation provisions of the CWA.[20] That view significantly understated our knowledge of agricultural and other sources of runoff pollution when the 1972 Act was adopted. For example, the Senate Committee Report accompanying the 1972 legislation, acknowledged the magnitude and scope of agricultural water pollution:

> One of the most significant aspects of this year's hearings on the pending legislation was the information presented on the degree to which nonpoint sources contribute to water pollution. Agricultural runoff, animal wastes, soil erosion, fertilizers, pesticides and other farm chemicals that are a part of runoff [and other nonpoint sources] . . . are major contributors to the Nation's water pollution problem.[21]

Less than a year later, the National Water Commission's report reached a similar conclusion:

> Chemical fertilizers and pesticides can cause serious adverse effects if they reach waters in excessive quantities. Current evidence suggests that these chemicals are entering waters in increasing concentrations. Nitrogen and phosphorus, the two chief nutrients in agricultural fertilizers, directly stimulate and feed the growth of algae. . . . [D]ense algae blooms reduce water quality by increasing turbidity and forming scum and floating mats. Heavy algae growth may compete with other aquatic life forms for dissolved oxygen."[22]

After two decades of implementing the CWA's nonpoint source pollution

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20. *See, e.g.*, U.S. ENVTL. PROT. AGENCY, EPA-506/9-89/003, A REPORT TO THE CONGRESS: ACTIVITIES AND PROGRAMS IMPLEMENTED UNDER SECTION 319 OF THE CLEAN WATER ACT—FISCAL YEAR 1988 at 7 (1989) (suggesting that it was not until significant progress had been made in controlling point source pollution that the full importance of nonpoint source pollution became apparent).

21. S. REP. NO. 92-414, at 39 (1972), *reprinted in* 1972 U.S.C.C.A.N. 3668, 3705.

> Water pollution resulting from agricultural production is clearly a growing problem of great magnitude and complexity. Agriculture is now one of the major contributors to the degradation of the quality of our navigable water. The basic problem is one of managing the inputs and outputs of agricultural production to maintain the quality of the water, air, and soil environment while economically producing food and fiber.

Id. at 15.

22. NAT'L WATER COMM'N, WATER POLICIES FOR THE FUTURE: FINAL REPORT TO THE PRESIDENT AND TO THE CONGRESS OF THE UNITED STATES BY THE NATIONAL WATER COMMISSION 66–67 (1973) [hereinafter NAT'L WATER COMM'N].

control programs,[23] however, the EPA continued to paint a similar picture:

> Agriculture is the nation's largest contributor to nonpoint source pollution; states attributed 41 percent of their nonpoint source problems to this source. [H]owever, if the category of sources reported as "unknown" were eliminated from the analysis, agriculture would account for more than half the nonpoint source pollution in the United States. Indeed, it is notable that, as reported in the [state reports under CWA section 305(b)], agriculture is the leading source of water pollution in the United States, even when point source impacts are included in the analysis.[24]

In its biennial National Water Quality Inventory published in 1992, the EPA reported that agriculture was partially responsible for 72% of impaired river miles, 56% of impaired lake acreage, and 43% of impaired estuarine area.[25] Indeed, by the late 1980s and early 1990s a consensus had emerged among the EPA and state water quality officials that agricultural and other nonpoint source pollution exceeded point source pollution in both scope and magnitude.[26]

B. Current Information

Another two decades have passed in which the EPA, the U.S. Department of Agriculture (USDA) through the Natural Resources Conservation Service (NRCS), and the states have worked to deal with agricultural nonpoint source pollution, particularly through section 319 of the CWA,[27] the Environmental Quality Incentives Program (EQIP),[28] and other relevant Farm Bill programs. Despite those efforts, however, states continue to identify agriculture as a significant source of water pollution. According to state reports, agriculture is at least partially responsible for impairment in a reported 123,669 river miles, more than 1.8 million lake

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23. *See infra* Part II.A for a description of those provisions.

24. U.S. ENVTL. PROT. AGENCY, EPA-506/9-90, MANAGING NONPOINT SOURCE POLLUTION: FINAL REPORT TO CONGRESS ON SECTION 319 OF THE CLEAN WATER ACT 17 (1992).

25. U.S. ENVTL. PROT. AGENCY, EPA 841-R-94-001, NATIONAL WATER QUALITY INVENTORY, 1992 REPORT TO CONGRESS at ES-11, ES-14, ES-18 (1994).

26. EPA NATIONAL EVALUATION, *supra* note 17, at 10–11.

27. 33 U.S.C. § 1329(a)(1)(A), (B), (D) (2006).

28. 16 U.S.C. §§ 3839aa–3839aa-9 (2006).

acres, and over 3,000 square miles of estuaries.[29] On the other hand, agricultural pollution is now reported as responsible for a much lower *percentage* of impaired water bodies than was true twenty years ago.[30] It is not clear, however, whether the latter decline reflects the fact that states and the EPA now identify and report on so many more discrete sources of impairment, or whether the overall magnitude of agricultural pollution and its contribution to water quality impairment has declined.

In November of 2011, the EPA issued its own "national evaluation" of the section 319 program.[31] The report's title is somewhat misleading, however, because the EPA limited its analysis to an assessment of how states use their section 319 funds, and did not expressly try to evaluate the program's success in achieving water quality goals.[32] The report critiqued and made recommendations about broad program management issues such as the need for states to update their statewide programs,[33] to include more detail in grant documents, and to enhance the rigor of annual progress evaluations.[34] It also underscored the significant gap between state program funding and funding needs.[35] It is interesting, however, that while the EPA did not purport in this program evaluation to assess nonpoint source pollution control progress (or lack thereof) nationally—or to explore the reasons for the overall degree of success of the section 319 program over the past twenty-five years—it did conclude that the watershed-specific approaches embraced by Congress in section 319 were not likely to suffice in addressing the problem.[36] Rather, EPA suggested that some combination of additional regulatory controls, more comprehensive statewide programs, and watershed health initiatives are needed to make significant additional progress.[37]

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29. *Watershed Assessment, Tracking & Environmental Results: National Causes of Impairment*, ENVTL. PROT. AGENCY, *available at* http://ofmpub.epa.gov/waters10/attains_nation_cy.control#causes (last updated Feb. 2, 2013).

30. *See id.* (dividing the above data by total reported impaired waters and concluding agriculture is responsible for 24 percent of impairment in rivers and streams, and 14 percent of impairment in lakes and estuaries).

31. EPA NATIONAL EVALUATION, *supra* note 17.

32. *Id.* at 1.

33. Twenty-eight states have not updated their state nonpoint source management plans since 1999-2000. *Id.* at 142.

34. *See id.* at 1–2 (addressing improvements that can be made to states' section 319 programs).

35. *See id.* at 3 (suggesting need for increased funding to better implement section 319 programs). For the first time in 17 years, in FY 2011 total section 319 grant funding dropped below $200 million, and EPA is pessimistic about its ability to fund every state program at sufficient levels. *Id.* at 143–44.

36. *Id.* at 13.

37. *Id.* at 13–14.

On the other hand, although it was not EPA's intent to conduct an overall program effectiveness evaluation in terms of measuring the degree to which section 319 has succeeded in improving water quality, the background data included in the report confirm the massive ongoing nature of the problem. The EPA reiterated that agriculture remains the leading source of impairment of rivers, streams, lakes, ponds, and reservoirs.[38] Crops and livestock are the dominant source of nutrients contributing to the significant ongoing pollution of the Gulf of Mexico and the Chesapeake Bay.[39] Based on an earlier statistical analysis, the EPA estimated that nonpoint source pollution was the primary source of impairment in 33,820 water bodies subject to TMDLs—more than three quarters of the total nationally.[40] Direct studies of the health of aquatic ecosystems and the species that inhabit them confirm these levels of impairment and the overwhelming contribution of agriculture to that degradation.[41]

More recently, the U.S. Government Accountability Office (GAO) issued a report critiquing the effectiveness of the CWA section 319 program and assessing its relationship to Farm Bill water quality programs.[42] The GAO concluded that the section 319 program continues to face problems of accountability and effectiveness, as reflected in ongoing agricultural pollution trends. According to the GAO, less than half (45%) of program funds are spent on projects designed to improve water quality directly, while the remaining 55% is spent on indirect efforts such as education, staffing, and planning.[43] More than a quarter of all funded projects did not meet any of the identified project goals, while more than half of the remaining projects faced delays and achieved project goals only partially.[44] Many projects funded by section 319 lacked methods to ensure that

38. *Id.* at 5–6, figs. A-1 & A-2.

39. *Id.* at 6–7, fig. A-3.

40. *Id.* at 7–8, app. A.

41. *Id.* at 8–9 (reporting from EPA's National Aquatic Resource Surveys and other comprehensive evaluations of aquatic resource degradation).

42. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-12-335, NONPOINT SOURCE WATER POLLUTION: GREATER OVERSIGHT & ADDITIONAL DATA NEEDED FOR KEY EPA WATER PROGRAM 28, 31 (2012).

43. *Id.* at 13–15. Direct water quality improvement projects included erosion control measures and fencing to keep cattle out of streams or riparian zones. *Id.* at 17. Indirect approaches include state and local capacity building, public education and outreach, watershed planning, and staffing. *Id.* at 13. These state funding allocations are generally consistent with EPA program guidance, which directs states to use approximately half of their section 319 grant funds for watershed-based plans in individual watersheds, and the remaining funds for more general program activities and management. *See id.* at 13 (stating 45 percent of projects funded with section 319 funds involved direct approaches); Nonpoint Source Program and Grants Guidelines for States and Territories, 68 Fed. Reg. 60,653 (proposed Oct. 7, 2003) (EPA guidelines).

44. U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 42, at 17–20.

voluntary program participants were committed to achieving project goals, which is particularly important for agricultural pollution control where participation by multiple landowners is necessary for project success, leading to limited measurable improvements in water quality.[45] Moreover, although EQIP and other Farm Bill programs have the potential to complement EPA and state efforts under section 319, the GAO found that some practices funded by EQIP might have inadvertent adverse water quality effects absent adequate mitigation.[46]

Agricultural pollution control efforts have shown some successes, however, particularly for individual pollutants in particular watersheds, or for specific farms or farm practices. The GAO, for example, concluded: "states have funded many projects that have helped successfully address nonpoint source pollution and restore and protect water bodies across the country. . . ."[47] EPA began to report on "success stories" under the section 319 program as early as 1994 (seven years after that program was implemented),[48] and it periodically updates those successes on its website.[49] As of December of 2011, EPA reported that 356 water bodies in forty-nine states have been partially or fully restored through projects supported by section 319 funds.[50] Similarly, NRCS reports that EQIP projects have achieved significant pollution reduction in individual watersheds.[51]

Other sources of information, however, suggest that agricultural water pollution remains a significant problem and that control efforts over the past forty years under the CWA yielded only limited success when viewed on a national scale, as opposed to improvements in particular targeted watersheds. For example, a recent nationwide scientific analysis of nonpoint source pollution risk to watershed health identified agricultural pollution from cultivated crops, feedlots and grazing as the leading source

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45. *Id.* at 19–23.

46. *Id.* at 41–42.

47. *Id.* at 11.

48. *See* U.S. ENVTL. PROT. AGENCY, EPA 841-S-94-004, SECTION 319 SUCCESS STORIES: A CLOSE-UP LOOK AT THE NATIONAL NONPOINT SOURCE POLLUTION CONTROL PROGRAM 1 (1994) (reporting examples of successful remediation of watersheds).

49. *See Section 319 Success Stories*, U.S. ENVTL. PROT. AGENCY, http://water.epa.gov/polwaste/nps/success319/ (last visited Feb. 9, 2013) (including stories about projects that partially or fully restored watersheds, projects that have resulted in progress toward attaining water quality goals, and stories about aquatic ecosystem restoration).

50. GOV'T ACCOUNTABILITY OFFICE, *supra* note 42, at 17. The GAO Report cites nonpoint source pollution control (both agricultural and urban) examples from Pennsylvania, Michigan, Washington, and West Virginia. *Id.* at 17–19.

51. *See id.* at 41 (reporting EQUIP-based improvements in key watersheds across the county); *National Water Quality Initiative*, NAT'L RES. CONSERVATION SERV., U.S. DEP'T OF AGRIC., http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1047761 (last visited Apr. 9, 2013) (reporting EQIP water quality successes in individual watersheds).

of that risk.[52] According to the U.S. Geological Survey (USGS), agricultural chemicals, including contamination from both pesticides[53] and nutrients, pose similar risks to groundwater.[54] In fact, ambient concentrations of nutrients in agricultural areas have either remained constant or increased in recent years notwithstanding ongoing control efforts. The USGS concluded that those pollution sources "continue[d] to pose risks to aquatic life and human health."[55] In nearly 30% of agricultural streams tested, one or more samples had nitrate concentrations above the EPA's maximum contaminant level under the Safe Drinking Water Act.[56] Nitrogen and phosphorus levels in most streams tested were significantly higher than the EPA's recommended water quality criteria for nutrients.[57]

Regionally, agricultural water quality impacts can be quite significant in terms of demonstrable resource impairment. In the Chesapeake Bay, agricultural runoff from row crops and from poultry and other livestock operations continues as the largest source of nutrients and sediment that impairs the health of the Bay and its resources.[58] Agricultural pollution from farms and livestock operations throughout the Mississippi River basin is the predominant source of the hypoxic "dead zone" in the Gulf of Mexico.[59] But while the Gulf of Mexico hypoxia has been most widely reported, approximately 300 other hypoxic zones exist along the U.S. coastline.[60] Moreover, pollution from unpermitted Concentrated Animal

52. Thomas C. Brown & Pamela Froemke, *Nationwide Assessment of Nonpoint Source Threats to Water Quality*, 62 BIOSCIENCE 136, 140 (2012). This review reported, for example, that nonpoint source loadings of nutrients were five times higher than point source loadings, and that nutrient concentrations in streams draining predominantly agricultural watersheds were nine times higher than in forested watersheds and four times higher than in rangeland watersheds. *Id.* at 139.

53. U.S. GEOL. SURVEY, FACT SHEET 2004-3098, STUDIES BY THE U.S. GEOLOGICAL SURVEY ON SOURCES, TRANSPORT, AND FATE OF AGRICULTURAL CHEMICALS (2004) (revealing that approximately half million tons of pesticides are applied to crops in United States every year, and U.S. Geological Survey (USGS) detected at least one pesticide in 97 percent of water samples, in over 90 percent of fish samples in agricultural streams, and in almost 60 percent of shallow wells sampled in agricultural regions).

54. *See* U.S. GEOL. SURVEY, FACT SHEET 2010-3078, NUTRIENTS IN THE NATION'S STREAMS AND GROUNDWATER: NATIONAL FINDINGS AND IMPLICATIONS (2010) (noting the high concentration of nitrate in groundwater) [hereinafter USGS FACT SHEET 2010-3078].

55. *Id.* (finding that total nitrogen concentrations were highest in agricultural streams, on average six times above background levels, and phosphorus concentrations in both agricultural and polluted urban watersheds are likewise six times greater than background levels). *See also* Davidson et al., *supra* note 12 at 2, 9–12 (reporting on transport of excess nitrogen from agricultural applications into U.S. streams and groundwater).

56. 42 U.S.C. § 300g-1 (2006).

57. USGS FACT SHEET 2010-3078, *supra* note 54.

58. EPA NATIONAL EVALUATION, *supra* note 17, at 6–7, fig. A-3.

59. *Id.*

60. Davidson et al., *supra* note 12, at 1.

Feeding Operations (CAFOs) can generate acute pollution in particular watersheds because of the high concentrations of animals and the waste they produce.[61]

Thus, the impacts of agriculture on water quality have now been documented more precisely and more extensively than they were in the early 1970s, but the basic picture remains similar. The control techniques necessary to mitigate agricultural water pollution clearly exist, as evidenced by documented successes in particular watersheds where controls have been funded and implemented successfully. The fact that agricultural pollution continues to dominate water quality impairment at a national level, however, suggests that more programmatic policy solutions need to be explored. As shown in the following section, however, for the most part that debate has remained just as stagnant over the past several decades as have the data on agricultural water pollution.

III. U.S. AGRICULTURE AND WATER QUALITY: A STAGNANT POLICY DEBATE

Just as the impacts of agriculture on water quality have remained relatively constant for the past four decades, the basic parameters of the policy debate have not changed much over the same period: to regulate or not to regulate, that is the question. To some extent that question suggests a sharper contrast than is actually the case because, as noted below,[62] many states and localities have adopted regulatory controls for nonpoint source pollution. It may be more accurate to suggest that the most controversial debate has been whether control of nonpoint source pollution should be more universal and guided by federal requirements as opposed to by individual states.[63] My intent here is not to advocate for one approach or the other, as I have previously,[64] but to demonstrate that the singular focus on

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61. *See* U.S. ENVT'L PROT. AGENCY, EPA/600/R-04/042, RISK ASSESSMENT EVALUATION FOR CONCENTRATED ANIMAL FEEDING OPERATIONS 1 (2004), *available at* http://nepis.epa.gov/Adobe/PDF/901V0100.pdf (noting large volumes of manure produced from CAFOs may be released "to watersheds environments during the catastrophic breach of holding facilities").

62. *See infra* notes 88 & 89, and accompanying text.

63. Others have just as validly suggested that the correct policy juxtaposition is whether we should continue to follow a "pay the polluter" approach or to embrace the more traditional "polluter pays principle" for pollution control generally. *See* Shortle et al., *supra* note 11, at 1316–17 (discussing reform of agricultural nonpoint pollution policy); Ved P. Nanda, *Agriculture and the Polluter Pays Principle*, 54 AM. J. COMP. L. 317, 338–39 (2006) (concluding polluter pays principal is not fully applicable to US agriculture but move exists towards agricultural producers assuming responsibility for preventing and mitigating pollution).

64. For purposes of full disclosure, in other contexts I have argued for adoption of stricter regulatory approaches to nonpoint source pollution. *See, e.g.*, ROBERT W. ADLER, JESSICA C. LANDMAN

this aspect of the underlying debate has contributed to the policy paralysis and to a lack of significant progress in achieving on-the-ground success.

A. Previous Debates and Policy Choices

1. The Predominantly Non-Regulatory Focus of Agricultural Pollution Control Programs

a. Clean Water Act Agricultural Pollution Control

From its perspective in 1972, Congress initially expressed skepticism about our ability to deal as effectively with agricultural and other forms of nonpoint source pollution as we could with point source discharges, but also acknowledged that some forms of controls were available: "The Committee recognizes, at the outset, that many nonpoint sources of pollution are beyond present technology of control. However, there are many programs that can be applied to each of the categories of nonpoint sources and the Committee *expects* that these controls will be applied as soon as possible."[65] The National Water Commission mirrored that skepticism a year later in its report to the President and Congress:

> The methods for controlling nonpoint pollution sources are in a more primitive stage of development than the techniques for remedying point-sources [sic]. By and large, pollution caused by such processes as soil erosion, mineralization, land runoff, acid drainage, and oil spillage is not susceptible to control through conventional abatement methods; however, some nonpoint source pollution is preventable by exercise of control over contributing elements or activities. . . . Similarly, pollution resulting from improper use of pesticides and fertilizers could be controlled by banning, restricting, or requiring more careful appreciation of potential pollutants. However, such direct regulation involves a difficult balancing of economic and environmental values.[66]

& DIANE M. CAMERON, THE CLEAN WATER ACT, 20 YEARS LATER 241–42 (1993) (advocating regulatory nonpoint source controls); Robert W. Adler, *Water Quality and Agriculture: Assessing Alternative Futures*, 25 U.C. DAVIS L. REV. 77, 77 (2002) (comparing alternative approaches to agricultural water pollution).

65. S. REP. NO. 92-414, *supra* note 21, at 39 (emphasis added).

66. NAT'L WATER COMM'N, *supra* note 22, at 74.

To address both its uncertainty about the availability of known, easily applied control methods and its reticence to adopt mandatory national control requirements for a problem it perceived to be highly variable across the country, Congress sought to address those impacts first through the state-oriented nonpoint source planning provisions in section 208 of the CWA.[67] Section 208 required states (or localities within states) to identify areas with "substantial water quality control problems,"[68] and then to establish a planning agency for each such area to develop a "continuing areawide comprehensive waste treatment management planning process" designed to address the full range of point sources and nonpoint sources contributing to those problems.[69] With respect to agricultural pollution in particular, this provision required:

> [A] process to (i) identify, if appropriate, agriculturally and silviculturally related nonpoint sources of pollution, including return flows from irrigated agriculture, and their cumulative effects, runoff from manure disposal areas, and from land used for livestock and crop production, and (ii) set forth procedures and methods (including land use requirements) to control to the extent feasible such sources.[70]

The somewhat tepid "to the extent feasible" standard in this provision was significantly less demanding than the analogous "best available technology economically achievable" (BAT) requirement for point sources.[71] Nevertheless, the "expectation" expressed by the 1972 Senate

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67. 33 U.S.C. § 1288(a) (2006).

68. *Id.* § 1288(a).

69. *Id.* § 1288(b). Some authors focus on the degree to which section 208 served as the nonpoint source pollution control provision of the 1972 Act. *See, e.g.*, David Zaring, Note, *Agriculture, Nonpoint Source Pollution, and Regulatory Control: The Clean Water Act's Bleak Present and Future*, 20 HARV. ENVT'L L. REV. 515, 522–25 (1996) (reviewing nonpoint source pollution controls in Clean Water Act). However, section 208 in fact required comprehensive, integrated plans to address pollution from municipal and industrial point sources, mine-related pollution, construction-related pollution, salt water intrusion, residual waste, and land disposal of waste in addition to nonpoint source pollution from farming and logging. 28 U.S.C. § 1288(b)(2)(A)–(K). *See, e.g.*, Raymond A. Sales, *Implementing Section 208: What Does it Take—A Report on Growth Management and Water Quality Planning*, 11 URB. LAW. 604, 614, 618–23 (1979) (discussing how planning for water quality may lead to particular land management practices and growth control strategies); Michael B. Phillips, *Developments in Water Quality and Land Use Planning: Problems in the Application of the Federal Water Pollution Control Act Amendments of 1972*, 10 URB. L. ANN. 43, 43–45, 87–88 (1975) (highlighting FWPCA's waste treatment management plan requirements).

70. *Id.* § 1288(b)(1)(F).

71. 33 U.S.C. § 1311(b)(2)(A) (2006). The suite of technology-based controls for point sources varied by time, pollutant, and nature of the discharge, particularly as the statute was subsequently

Committee that those controls that were available "will be applied as soon as possible"[72] at least suggested the intent to adopt somewhat more aggressive federal programs if the states failed to do so, or to do so sufficiently to redress nonpoint source pollution on a level roughly on par with the ambitious parallel efforts Congress adopted to control pollution from point sources.[73] When Congress revisited the issue five years later, however, it remained unenthusiastic about the prospect of federal regulation of nonpoint sources: "Between requiring regulatory authority for nonpoint sources, or continuing the section 208 experiment, the committee chose the latter course, judging that these matters were appropriately left to the level of government closest to the sources of the problem."[74]

This congressional deference to state and local nonpoint source pollution control efforts comports with the general philosophy expressed in the CWA "to recognize, preserve, and protect the primary responsibilities and rights of States to prevent, reduce, and eliminate pollution, to plan the development and use (including restoration, preservation, and enhancement) of land and water resource . . . ."[75] Moreover, unlike other programs for which Congress required the EPA to step in absent sufficient state action,[76] the only federal sanction for an inadequate section 208 program was EPA withdrawal of program approval and associated federal grant funding.[77] That was hardly a powerful incentive if a state lacks enthusiasm for the program to begin with.

A decade later, during the process of considering what became the 1987 amendments to the CWA, Congress again revisited the issue of nonpoint source pollution, but reached similar conclusions. On the one hand, Congress continued to express a strong *intent* that states adopt significant measures: "The conference substitute establishes a national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint

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amended, *see id.* §§ 1311(b), 1314(b), 1316, 1317, but the "best available technology" requirement is representative for purposes of comparison.

72. S. REP. NO. 92-414, *supra* note 21, at 39.

73. *See* 33 U.S.C. §§ 1311–1314, 1342(1) (2006) (requiring point sources to obtain permits limiting discharges based on best technology and, at a minimum sufficiently to meet ambient water quality standards).

74. S. REP. NO. 95-370, at 9 (1977).

75. 33 U.S.C. § 1251(b) (2006).

76. *See, e.g.*, *id.* §§ 1313(c)(1) (water quality standards program), 1313(d)(1)(A), (C) (total maximum daily load program), 1342(c) (point source permitting program).

77. *Id.* §§ 1288(b)(4)(D), (f)(3).

sources of pollution."[78] On the other hand, it continued to favor a predominately state-directed approach to the problem: "[The bill] places the major responsibility for designing and implementing the program at the State level and provides the States with substantial flexibility in defining best management practices to reduce runoff and in designing and implementing a suitable program to achieve implementation of the practices by identified sources."[79] In part, legislators explained this decision in light of the variable "site-specific factors such as crops, soil type, and slope of the land."[80]

In the 1987 amendments, Congress adopted a provision[81] that was more specific to nonpoint source pollution than was section 208, but not significantly different in its overall approach to the problem. The resulting section 319 of the CWA[82] established a new, two-step planning program to address nonpoint source pollution. First, section 319 directs each state to prepare an assessment report that: identifies those waters that "cannot reasonably be expected to attain or maintain applicable water quality standards or the goals and requirements of [the Act]" without additional nonpoint source pollution controls; identifies either individual nonpoint sources or categories of sources that contribute to the problem; describes a process for identifying "best management practices" (BMPs) to control that pollution "to the maximum extent practicable;" and identifies state and local nonpoint source control programs to implement those measures.[83] Second, section 319 required the states to prepare a statewide nonpoint source pollution management plan with BMPs for particular categories of nonpoint sources, programs "to achieve implementation of" BMPs, and related schedules and identification of authority and funding to implement the program.[84]

In adopting section 319, Congress raised the stakes to a modest degree. Unlike section 208, section 319 authorized the EPA to step in and take

78. Joint Explanatory Statement of the Committee of Conference, H.R. REP. NO. 99-1004, at 143 (1986) (Conf. Rep.), *reprinted in* 2 ENVTL. & NATURAL RES. POLICY DIV. OF CONG. RESEARCH SERV., LIBRARY OF CONG. RESEARCH SERV., LIBRARY OF CONG., A LEGISLATIVE HISTORY OF THE WATER QUALITY ACT OF 1987 (PUBLIC LAW 100-4) INCLUDING PUBLIC LAW 97-440; PUBLIC LAW 97-117; PUBLIC LAW 96-483; AND PUBLIC LAW 96-148, AT 832 (1988).

79. S. REP. NO. 98-282, at 3, 3 (1988), *reprinted in* 3 ENVTL. & NATURAL RES. POLICY DIV. OF CONG. RESEARCH SERV., LIBRARY OF CONG., A LEGISLATIVE HISTORY OF THE WATER QUALITY ACT OF 1987 (PUBLIC LAW 100-4) INCLUDING PUBLIC LAW 97-440; PUBLIC LAW 97-117; PUBLIC LAW 96-483; AND PUBLIC LAW 96-150, at 2197 (1988).

80. *Id.* at 2197.

81. Water Quality Act of 1987, Pub. L. No. 100-4, § 316, 101 Stat. 7, 52 (adding CWA § 319).

82. 33 U.S.C. § 1329(a)(1)(A), (B), (D) (2006).

83. *Id.* § (a).

84. *Id.* § (b).

action in the event of state default, but *only* with respect to the assessment report required by section 319(a), and not with respect to the management plan itself.[85] Moreover, Congress tightened the expectation for nonpoint source controls from the “extent feasible” standard in section 208 to the “maximum extent practicable” language in section 319.[86] That heightened expectation means less than it otherwise might, however, absent actual implementation, and a *requirement* for implementation remains absent. Section 319 authorized states to consider regulatory approaches to implementation along with non-regulatory strategies such as “technical assistance, financial assistance, education, training, technology transfer, and demonstration projects.”[87] Thus, states are not actually required to adopt regulatory or other mandatory implementation measures. However, some states adopted regulatory nonpoint source controls for some kinds of pollution or within some parts of the state relatively early in the history of section 319 implementation,[88] and many more have followed suit since then.[89] Moreover, as with section 208, section 319 authorized the EPA to disapprove state management programs and to withhold federal grant funding for those programs if necessary,[90] but not to adopt and implement a federal program if a state failed to do so effectively. Again, the main “sanction” for a state’s failure to control nonpoint source pollution is withholding of grant funds to control nonpoint source pollution.

b. Farm Bill Agricultural Pollution Control

The federal government has also implemented efforts to address agricultural water pollution and other environmental impacts caused by farming and ranching through the frequently shifting details of federal farm policy and legislation.[91] Congress first intervened significantly in farm

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85. *Id.* § (d)(3).

86. *Compare id.* § 1288(b)(2)(F), *with id.* § 1329(a)(1)(C).

87. *Id.* § 1329(b)(2)(B).

88. *See* ENVTL. LAW INST., ENFORCEABLE STATE MECHANISMS FOR THE CONTROL OF NONPOINT SOURCE WATER POLLUTION, 2–4, 9 (1997) (discussing diversity of state law attempts to address nonpoint source issues).

89. *See* EPA NATIONAL EVALUATION, *supra* note 17, at 33–64 (surveying individual state and local regulatory programs to address nonpoint source pollution).

90. *See* 33 U.S.C. §§ 1329(d)(2), (h)(8) (2006) (describing procedure for proposed management plans and requirement for federal grant funding).

91. Federal farm policy is governed by the so-called “default” or “permanent provisions” adopted in the Agricultural Adjustment Act of 1938, Pub. L. No. 75-430, 52 Stat. 31, and the Agricultural Act of 1949, Pub. L. No. 81-439, 63 Stat. 1051, but those provisions can be—and typically are—augmented or overridden by periodic “farm bills” adopted by Congress every five years. *See* Charlene C. Kwan, Note, *Fixing the Farm Bill: Using the “Permanent Provisions” in Agricultural Law to Achieve WTO Compliance*, 36 B.C. ENVTL. AFF. L. REV. 571, 577–79 (2009) (arguing for return to

conservation policy during the New Deal, mainly as part of efforts to address the severe soil erosion problems associated with the Dust Bowl.[92] Congress began to focus more closely on water quality and other environmental protection issues *per se*, however, around the same time as it began to focus more specifically on nonpoint source water pollution in the 1987 CWA amendments. In Title XII of the Food Security Act of 1985 (the 1985 "Farm Bill"),[93] Congress adopted a series of programs designed specifically to provide incentives for farmers to protect sensitive areas such as highly erodible lands[94] and wetlands.[95] Congress zeroed in on water quality and other environmental effects even more specifically when it created the EQIP as part of the Federal Agricultural Improvement and Reform Act of 1996 (the 1996 Farm Bill).[96]

Water quality and other environmental programs under the Farm Bill, however, have been weighted even more overwhelmingly in favor of non-regulatory approaches to reducing the environmental impacts of agriculture.[97] Many of the programs are designed mainly to subsidize farmers to keep environmentally sensitive lands out of production.[98] Other programs, such as the conservation security program[99] and especially the EQIP,[100] provide federal financial assistance for environmentally beneficial practices, including water quality improvement measures, adopted by agricultural producers.

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loan-based support system established in previous Farm Bills). *See generally* U.S. DEP'T OF AGRIC., ECON. RESEARCH SERV., AGRIC. INFO. BULL. NO. 485, HISTORY OF AGRICULTURAL PRICE-SUPPORT AND ADJUSTMENT PROGRAMS, 1933–84 (1984) [hereinafter HISTORY OF AGRICULTURAL PRICE-SUPPORT & ADJUSTMENT PROGRAMS].

92. Soil Conservation and Domestic Allotment Act of 1936, Pub. L. No. 74-461, 49 Stat. 1148; *see generally* VANCE JOHNSON, HEAVEN'S TABLELAND—THE DUST BOWL STORY (1974) (explaining the geological conditions, exacerbated by historical land use patterns, that led to the Dust Bowl's soil erosion problems).

93. Food Security Act of 1985, Pub. L. No. 99-198, § 1201–54, 99 Stat. 1354, 1504-18.

94. *Id.* §§ 1211–13.

95. *Id.* §§ 1221–23.

96. Federal Agriculture Improvement and Reform Act of 1996, Pub. L. No. 104-127, § 334, 110 Stat. 1996 (adding EQIP to 1996 Farm Bill).

97. *See* Shortle et al., *supra* note 11, at 1317–18 (describing the subsidies inherent in U.S. Department of Agriculture conservation and water quality programs).

98. *See* 16 U.S.C. §§ 3831–3835a (2006) (conservation reserve program to protect highly erodible lands and marginal pasture land), 3837–3837f (wetland reserve program), 3838n–3838q (grassland reserve program).

99. *Id.* §§ 3838d–3838g.

100. *Id.* §§ 3839aa–3839aa-9.

2. Exceptions and Experimentation: CZARA and TMDLs

In the face of this overall congressional philosophy to defer to the states and to forego mandatory efforts to control agricultural and other nonpoint source pollution—in favor of approaches such as education and financial assistance—two programs potentially moved in the direction of a more mandatory approach to nonpoint source pollution control. In the first, Congress itself adopted a regulatory program, but only for a defined geographic area in the coastal zone, with the expressed possibility of adopting such an approach nationally if it proved successful. In the second, environmental groups and—to a more limited extent representatives of major point source dischargers—advocated for use of an existing CWA program (TMDLs) as a tool to increase the pressure for mandatory nonpoint source controls.

a. Nonpoint Source Controls in the Coastal Zone

In the first of these two experiments, Congress created a geographically limited but somewhat more aggressive approach to nonpoint source pollution control in amendments to the Coastal Zone Management Act (CZMA)[101] adopted in section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA).[102] Congress described this program somewhat modestly as "an update and expansion of the State nonpoint source management program developed under [CWA section 319] as the program . . . relates to land and water uses affecting coastal waters,"[103] while one commentator referred to it as "Congress's first viable attempt to control nonpoint source pollution."[104]

The new CZARA provision required states with approved coastal zone management programs to integrate them with their section 319 programs under the CWA. The most significant change in section 6217, however, was the requirement that state programs "provide for the implementation, at a

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101. *Id.* §§ 1451–1466. The CZMA encourages and authorizes coastal states to adopt comprehensive planning and management programs to preserve and protect coastal resources. *See* Ronald J. Rychlak, *Coastal Zone Management and the Search for Integration*, 40 DEPAUL L. REV. 981, 984–90 (1991) (outlining CZMA legislative scheme).

102. Omnibus Budget Reconciliation Act of 1990, Pub. L. No. 101-508, § 6217, 104 Stat. 1388, 1388-314 to -319 (codified as amended at 16 U.S.C. § 1455b).

103. 16 U.S.C. § 1455b(a)(2).

104. Clare F. Saperstein, *State Solutions to Nonpoint Source Pollution: Implementation and Enforcement of the 1990 Coastal Zone Amendments Reauthorization Act Section 6217*, 75 B.U. L. REV. 889, 891 (1995). *See also id.* at 900 (referring to the program as "the beginning of effective nonpoint source pollution controls").

minimum, of management measures"[105] in guidance adopted by the EPA in cooperation with other identified federal officials and agencies.[106] In this respect, Congress intentionally moved from the CWA approach in which nonpoint source controls were adopted entirely by individual states to one in which state control measures must conform to federal guidelines adopted by the EPA. However, this program provided more individual state flexibility than is reflected in nationally uniform effluent limitations guidelines for point sources.[107] Moreover, Congress enacted a definition of management measures that much more closely aligned with the stricter "best technology" concept applicable to industrial point sources,[108] also in an intentional effort to pattern nonpoint source controls after the technology-based point source control requirements of the CWA.[109] Finally, states risk the loss of federal grants for both water pollution control and for coastal zone management programs if they fail to implement these requirements.[110]

The major promise of the CZARA provision was that it would force a more serious evaluation of BMPs for agricultural and other nonpoint sources in the face of concerns about the generally lax nature of purely state-identified BMPs under both section 208 and section 319, particularly

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105. 16 U.S.C. § 1455b(b).

106. *Id.* § 1455b(g). The consulting federal officials included the Secretary of Commerce, who is charged with implementing the CZMA generally, and the Director of the U.S. Fish and Wildlife Service. *Id.* § 1455b(g)(1).

107. *See* H.R. REP. NO. 101-964, at 331, 335 (1990), *reprinted in* 1990 U.S.C.C.A.N. 2374, 2680 (Conf. Rep.) (stating that implementation of coastal nonpoint source pollution controls should be implemented by states with federal guidance); 136 CONG. REC. E3724-02 (daily ed. Nov. 2, 1990) (extension of remarks by Rep. Gerry E. Studds) 1990 WL 207054 [hereinafter Studds Extension of Remarks]. Section 6217, derived from H.R.2647, was originally intended as a stand-alone bill to reauthorize the CZMA. Representative Studds was the principal sponsor. *Id.*

108. The definition states:

> For purposes of this subsection, the term 'management measures' means economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.

16 U.S.C. § 1455b(g)(5). *Compare id.*, *with* 33 U.S.C. § 1314(b)(2)(A) (2006) (description of "best available technology" for existing industrial point source discharges), *and* 1316(a)(1) (description of performance standards for new industrial point source dischargers).

109. *See* Studds Extension of Remarks, *supra* note 107 (indicating that the provision was patterned expressly after the standard for BAT controls under CWA section 304(b)(2), but were not intended to be as specific due to the more variable nature of nonpoint source problems and controls). Representative Studds also underscored that the CZARA requirements call for implementation by individual states to become effective, in contrast to the CWA's technology-based controls, which apply uniformly as a matter of federal law. *Id.* at E-3725.

110. 16 U.S.C. §§ 1455b(c)(3), 1455b(c)(4).

given the stricter, BAT-like statutory definition in CZARA.[111] The EPA did adopt BMP guidance pursuant to this provision,[112] and the EPA and the National Oceanic and Atmospheric Administration (NOAA) jointly implement the CZARA program.[113]

There appears to be no comprehensive assessment of the effectiveness of the CZARA program particularly relative to its non-regulatory cousin in section 319 of the CWA.[114] Whether or not the CZARA program has shown success within the coastal zone, however, Congress clearly has not yet chosen to extend the experiment inland to the rest of the CWA section 319 program.

b. Total Maximum Daily Loads

Stimulated largely through citizen suit litigation,[115] a second major attempt to alter the federal government's predominately non-regulatory approach to nonpoint source pollution was the effort to resurrect the total maximum daily load (TMDL) program under CWA section 303(d),[116] at least in part as a tool to stimulate more effective nonpoint source controls. Section 303(d) requires states to: identify those water bodies for which the first round of technology-based point source controls did not suffice to attain the state's ambient water quality standards;[117] establish a pollution budget for each identified impaired water body known as a TMDL "at a level necessary to implement the applicable water quality standards;"[118] and integrate the TMDL into the state's overall water pollution control

111. *See* Studds Extension of Remarks, *supra* note 107 at E-3725 (indicating that the provision was intended to reflect a "substantial advance" on the CWA's nonpoint source control requirements).

112. U.S. ENVTL. PROT. AGENCY, EPA-840-B-92-002, GUIDANCE SPECIFYING MANAGEMENT MEASURES FOR SOURCES OF NONPOINT POLLUTION IN COASTAL WATERS iii, 1-1 (1993).

113. *See Coastal Zone Act Reauthorization Amendments (CZARA) Section 6217*, WATER: POLLUTED RUNOFF, ENVTL. PROT. AGENCY, http://water.epa.gov/polwaste/nps/czara.cfm (last visited Apr. 9, 2013) (describing CZARA controls of costal nonpoint pollution); *The Coastal Nonpoint Pollution Control Program*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., U.S. DEP'T OF COMMERCE http://coastalmanagement.noaa.gov/nonpoint/welcome.html (last visited Apr. 9, 2013) (describing administration of the program).

114. No such analysis is referenced on either agency program website cited in note 113.

115. *See supra*, note 13, and accompanying text.

116. 33 U.S.C. § 1313(d) (2006).

117. *Id.* § 1313(d)(1)(A). This provision itself refers to the first round of "best practicable technology" standards for industrial dischargers and "secondary" treatment for municipal sewage treatment plants, *see id.* § 1314(b), but EPA has abandoned that limitation in its TMDL regulations because the deadlines for stricter technology-based limitations have now long passed. *See* 40 C.F.R. § 130.7(b) (2012) (requiring states to identify waters for which all applicable technology-based standards "are not stringent enough to implement any water quality standards (WQS) applicable to such waters").

118. *Id.* § 1313(d)(1)(C). Analogous requirements apply to thermal discharges. *Id.* § 1313(d)(1)(B),(D).

programs.[119] In theory, TMDLs create a "zero sum game" in which sufficient controls must be placed on aggregate pollution sources contributing to violation of an applicable water quality standard in a particular water body to attain the standard. If additional controls on point sources are not sufficient to achieve that requirement, presumably stricter nonpoint source controls will be needed in order to meet the standard.[120]

Unlike the analogous program to ensure attainment of ambient air quality standards under the Clean Air Act,[121] the EPA did not devote much effort to implementing the TMDL program until prompted to do so by a rash of citizen suits brought by environmental groups beginning in the 1990s.[122] Since that time, the EPA convened a Federal Advisory Act Committee[123] to study the issue and make recommendations on how to implement the TMDL program more effectively[124] and revised its TMDL regulations[125] and guidance.[126] Pursuant to the revived program as well as judicial consent decrees, states have now written thousands of TMDLs for impaired water bodies around the country.[127]

Like CZARA, the TMDL program adds some *potential* impetus to efforts to control nonpoint source pollution, but it has significant limitations as well. At a minimum, it forces more precise analysis of the extent to which agriculture and other nonpoint sources contribute to impairment of

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119. *Id.* §§ 1313(c), (e)(3)(C) (requiring integration of TMDLs into the state's "continuing planning process" for water pollution control).

120. *See* Pronsolino v. Nastri, 291 F.3d 1123, 1123–33 (9th Cir. 2002) (rejecting argument that TMDLs only apply to point sources).

121. 42 U.S.C. § 7410 (2006) (requiring State Implementation Plans ("SIP"s) necessary to attain and maintain National Ambient Air Quality Standards). *See generally* Adler, *supra* note 13, at 207 (noting the differences in implementation of the two statutes).

122. *See supra*, note 13, and accompanying text. EPA frankly acknowledged its initial decision to de-emphasize TMDLs in an early Federal Register notice regarding the program: "EPA has not considered the development of TMDL's [sic] as a high priority since many of the practical results are being achieved through State water quality management processes." Total Maximum Daily Loads Under the Clean Water Act, 43 Fed. Reg. 60,664, 60,664 (proposed Dec. 22, 1978).

123. *See* 5 U.S.C. app. 2 §§ 1–15 (2006) (authorizing and governing federal advisory committees).

124. FED. ADVISORY COMM. ON THE TMDL PROGRAMS, U.S. ENVTL. PROTECTION AGENCY, REPORT OF THE FEDERAL ADVISORY COMMITTEE ON THE TOTAL MAXIMUM DAILY LOAD (TMDL) PROGRAM (1998), *available at* http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/2004_12_14_tmdl_faca_facaall.pdf. In the interest of full disclosure, the author served as a member of this FACA Committee.

125. Revisions to the Water Quality Planning and Mgmt. Regulation and Revisions to the NPDES Program in Support of Revisions to the Water Quality Planning and Mgmt. Regulation, 65 Fed. Reg. 43,586 (July 13, 2000) (codified at 40 C.F.R. pts. 9, 122, 123, 124, and 130). *See also* James Boyd, *The New Face of the Clean Water Act: A Critical Review of the EPA's New TMDL Rules*, 11 DUKE ENVTL. L. & POL'Y F. 39, 41 (2000) (critiquing these regulations).

126. Perciasepe Memorandum, *supra* note 14.

127. *See* EPA NATIONAL EVALUATION, *supra* note 17.

individual watersheds and of assignment of specific load allocations by individual source or at least category of source.[128] However, as is true under other provisions of the CWA and EPA regulations, the regulations governing LAs for nonpoint sources include no requirements for regulatory or other mandatory implementation, except as individual states might determine on their own initiative.[129] By sharp contrast, WLAs for point sources "constitute a type of [enforceable] water quality-based effluent limitation."[130]

Moreover, as is true for section 319, and for related reasons, the EPA has only partial authority to implement a TMDL-based solution to nonpoint source pollution. Section 303(d)(2) requires the EPA to adopt TMDLs for states that fail to do so adequately.[131] However, that section provides no independent authority for the EPA to implement a TMDL once adopted. Upon EPA adoption of TMDLs for a state, the statute indicates that the state "shall incorporate them into its current plan under subsection (e)."[132] Short of withholding program grant funding, however, it is not clear how the EPA can enforce that requirement consistent with the Supreme Court's current jurisprudence governing how and when the federal government can force a state to take regulatory action.[133] The EPA can prohibit state-issued permits for point sources that do not properly implement a TMDL through

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128. *See* 40 C.F.R. §§ 130.2(f) (defining "Loading capacity" as "[t]he greatest amount of loading that a water can receive without violating water quality standards"); 130.2(g) (defining a "Load allocation (LA)" as "[t]he portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources"); 130.2(h) (defining a "Wasteload allocation (WLA)" as "[t]he portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution"; and 130.2(g)(i) (defining a TMDL as the "sum of the individual WLAs for point sources and LAs for nonpoint sources and natural background"); § 130.7 (establishing the process for states to develop TMDLs).

129. *See* 40 C.F.R. § 130.6(c)(4) (2012) (requiring that state water quality management plans must describe "regulatory and non-regulatory programs, activities and Best Management Practices" regarding nonpoint sources, and "require" regulatory measures "where they are determined to be necessary *by the State* to attain or maintain an approved water use or where non-regulatory approaches are inappropriate in accomplishing that objective") (emphasis added).

130. *Id.* § 130.2(h). NPDES permits must include applicable water quality-based effluent limitations which are then enforceable by government agencies and citizens. *See* 33 U.S.C. § 1311(b)(1)(C) (2006) (requiring that permits include water quality-based effluent limitations); *id.* § 1342(a) (authorizing government enforcement); *id*. § 1365 (authorizing citizen suits). *See* Friends of Pinto Creek v. U.S. EPA, 504 F.3d 1007 (9th Cir. 2007), *cert. denied*, 555 U.S. 1097 (2009) (determining in citizen suit that EPA should have refused defendant mining company a NPDES permit due to absent discharge limitation compliance schedule).

131. 33 U.S.C. § 1313(d)(2).

132. *Id.*

133. *See* New York v. United States, 505 U.S. 144, 161–62, 166–68, 178, 188 (1992) (prohibiting the federal government from requiring or coercing states to implement regulatory programs, but allowing inducement through funding incentives, preemption, or partial preemption).

water-quality-based effluent limitations.[134] In extreme (although politically unlikely) cases, the EPA can implement the point source permitting program for a state where the state is not properly implementing a delegated program.[135] Consistent with the EPA's inability to implement a state nonpoint source management program directly, however, there is no mechanism for the EPA to implement or enforce load reductions necessary to implement or enforce the nonpoint source component of a TMDL.

Perhaps the EPA's most aggressive effort to date to use TMDLs to address nonpoint source pollution has been its recently adopted interstate TMDL for the Chesapeake Bay.[136] Billed by the EPA as a comprehensive "pollution diet" for the Bay,[137] the agency's action is more accurately a collection of TMDLs because it established load limits for three pollutants (nitrogen, phosphorus, and sediment),[138] and subdivided those allocations among 92 tidal water segments within the Bay.[139] The Bay jurisdictions[140] submitted Watershed Implementation Plans (WIPs) for each of those segments, which the EPA approved with a series of "backstop" allocations and control actions to be used if necessary to ensure that the TMDL's pollution control targets are met. Necessarily, the states can only meet the targets included in their WIPs if they successfully reduce nitrogen, phosphorus, and sediment loadings from nonpoint sources.

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134. *See* 33 U.S.C. §§ 1311(b)(1)(C) (2006) (requiring effluent limitations for point sources necessary to implement water quality standards), 1342(d) (authorizing EPA to object to permits that do not meet all applicable requirements).

135. *See id.* § 1342(c) (allowing EPA delegation of NPDES programs to states, with concomitant authority to withdraw approval of non-complying state programs).

136. Notice for the Establishment of a Total Maximum Daily Load (TMDL) for the Chesapeake Bay, 76 Fed. Reg. 549 (Jan. 5, 2011); *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment*, CHESAPEAKE BAY PROGRAM OFFICE, ENVTL. PROT. AGENCY (Dec. 29, 2010) [hereinafter Chesapeake Bay TMDL], *available at* http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html (last visited Apr. 9, 2013) (providing Executive Summary of the Final Chesapeake Bay TMDL and the full TMDL). EPA agreed to adopt a TMDL for the Bay in consent decrees in response to citizen suits filed in the late 1990s. *See, e.g.*, Am. Canoe Ass'n v. EPA, 54 F.Supp. 2d 621, 624 (E.D. Va. 1999) (approving consent decree in which EPA agreed to adopts TMDLs for a wide range of Virginia water bodies). EPA and other federal agencies agreed that the TMDL would serve as a cornerstone of the federal government's strategy to restore the Bay in response to President Obama's Executive Order on Bay cleanup. *See* Exec. Order No. 13,508, 73 C.F.R. 235 (2012) (articulating federal government's Bay restoration strategy).

137. *See* Chesapeake Bay TMDL, *supra* note 136, at ES-3.

138. *See id.* at ES-1 (setting annual watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus, and 6.45 billion pounds of sediment, requiring reductions from current loadings of 25 percent, 24 percent, and 20 percent respectively).

139. *See id.* at ES-3 (describing TMDL's composition).

140. These jurisdictions include all of the states in the Chesapeake Bay watershed (Maryland, Virginia, Pennsylvania, New York, Delaware, and West Virginia), plus the District of Columbia. *See id.* at ES-1 (stating the jurisdiction).

It is far too early to know how successful this effort will be, but both agricultural interests and environmental groups have challenged different aspects of the Chesapeake Bay TMDL in federal court. Agricultural groups argue that the EPA exceeded its statutory authority in promulgating the interstate TMDL.[141] Environmental groups allege that the pollution trading aspects of the TMDL violate the CWA.[142] The dueling lawsuits underscore the extent to which the debate over nonpoint source pollution policy remains just as divisive now as it was in 1972, thus perpetuating the policy impasse discussed in the following section.

C. The Ongoing Policy Impasse

The above analysis indicates that not much has changed in recent decades in terms of the nature, severity, and extent of nonpoint source pollution and the resulting impairment of U.S. waters. Likewise, little has changed in the policy dialogue over the same period.

Independent observers have concluded that voluntary, non-regulatory programs to control nonpoint source pollution have not been sufficient to address the problem on a national scale,[143] while also questioning whether Congress is likely to have the political will to regulate or tax nonpoint sources.[144] Commentators lament the inequity inherent in imposing strict, enforceable control obligations on municipal and industrial point sources without insisting on similar efforts from nonpoint sources.[145] Moreover,

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141. Am. Farm Bureau Fed'n v. EPA, 278 F.D.R. 98, 101 (M.D. Pa. 2011).

142. *See, e.g.*, Complaint for Declaratory and Injunctive Relief at 2, 10, Food & Water Watch v. EPA, No. 1:12-cv-01639-RC (D.D.C. filed Oct. 13, 2012) [hereinafter Complaint for Declaratory and Injunctive Relief] (alleging that "[t]he Chesapeake TMDL authorizes a water pollution trading system and offset system that contravenes EPA's authority and duty" under Clean Water Act).

143. *See, e.g.*, Douglas R. Williams, *When Voluntary, Incentive-Based Controls Fail: Structuring A Regulatory Response To Agricultural Nonpoint Source Water Pollution*, 9 WASH. U. J. L. & POL'Y 21, 121 (2002) ("For the past several decades, the nation's reliance on voluntary, incentive-based programs for controlling agricultural nonpoint source pollution has not yielded satisfactory improvements in water quality."); *see also* Adler, *supra* note 64, at 90 (2002) ("The agricultural community has been asking us to trust them to do the right thing voluntarily for 30 years now and it has not worked."); Robert W. Adler, *Controlling Nonpoint Source Pollution: Is Help on the Way (From the Courts or EPA)?*, 31 ENVTL. L. RPTR. 10,270, 10,270 (2001) ("While significant amounts of money have been spent and substantial programs have been developed to address the problem, the nature and magnitude of the problem does not seem to have changed significantly.").

144. *See* Zaring, *supra* note 69, at 544 ("It is unlikely that strict regulation or taxation of agricultural runoff will be imposed on farmers in the near future.").

145. *See* Robert L. Glicksman & Matthew R. Batzel, *Science, Politics, Law, and the Arc of The Clean Water Act: The Role Of Assumptions in the Adoption of a Pollution Control Landmark*, 32 WASH. U. J. L. & POL'Y 99, 114, 116, 132–33, 137 (2010) ("Congress must work with state and local governments to overcome the political barriers that thus far have thwarted efforts to extract from

analysts question the wisdom of continuing to leave nonpoint source controls to state and local discretion rather than enhancing federal authority.[146] At least according to some scientists, the problem is no longer a lack of viable technical solutions, as Congress believed might be the case when it adopted the 1972 Act,[147] but rather a vacuum of the policy reforms necessary to implement available technologies on the ground.[148]

For these and other reasons, as addressed above,[149] most environmental groups have persisted in advocating a shift to a federal regulatory approach to nonpoint source pollution control analogous to the CWA approach to point source controls. Meanwhile, agricultural interests are equally strident in opposing anything other than the existing state-centered approach, particularly given the variable nature of agriculture and the conditions under which it is conducted. Congress has adopted no significant changes to the nonpoint source pollution control provisions of the CWA in a quarter of a century now, despite failed efforts to adopt major amendments during the 103th and 104th Congresses (1993–1995).[150]

Somewhere in the middle of the voluntary–regulatory dichotomy lies the concept of point–nonpoint source trading, as the Chesapeake Bay TMDL currently envisions.[151] Rather than requiring point sources to squeeze increasingly small increments of pollutants from their discharge at increasingly high costs, trading allows point sources to take credit for equal or greater—but presumably cheaper—reductions in pollution from nonpoint

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nonpoint sources the same commitments to reducing discharges that the CWA already has demanded of point sources.").

146. *See* William L. Andreen, *Water Quality Today—Has the Clean Water Act Been a Success?*, 55 ALA. L. REV. 537, 593 (2004) ("The CWA has never addressed non-point source pollution in a straightforward comprehensive way. Instead, it has been treated as something of an afterthought, a troublesome area to be primarily left in the hands of state and local government.").

147. *See supra* note 21 and accompanying text.

148. *See* Brown & Froemke, *supra* note 52, at 145 (arguing regulation is necessary to address and control nonpoint source pollution); Shortle et al., *supra* note 11, at 1316–17 (arguing that policy reforms addressing agricultural pollution management are necessary to achieve water quality goals).

149. *See supra* notes 6–8 and accompanying text.

150. *See, e.g.*, *Reauthorization of the Clean Water Act: Hearings on S. 1114 and S. 1302 Before the Subcomm. on Clean Water, Fisheries, and Wildlife of the S. Comm. on Env't and Pub. Works*, 103d Cong. 1 (1993) (suggesting increased regulations of nonpoint sources through Clean Water Act); *see generally* Claudia Copeland, *Water Quality: Implementing the Clean Water Act*, CONG. RESEARCH SERV., (last updated October 1, 2002), *available at* http://www.policyalmanac.org/environment/archive/crs_water_quality.shtml (providing an overview of congressional attempts to significantly amend the Clean Water Act). *See generally* 88 WATER RES. UPDATE (1992) (presenting contemporaneous perspectives on CWA reauthorization regarding agricultural pollution and other issues).

151. *See* Complaint for Declaratory and Injunctive Relief, *supra* note 142 and accompanying text (discussing lawsuit challenging pollution trading aspects of Chesapeake Bay TMDL).

sources.[152] As EPA's TMDL regulations suggest, "If Best Management Practices (BMPs) or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs."[153]

Applying the concept of trading to nonpoint source pollution, however, faces several challenges, which potentially explain why the idea has been proposed for a long time,[154] but has shown limited success at best.[155] Most fundamentally, the effectiveness of trading programs requires the initial allocations to be set at the correct level, with an appropriate degree of conservatism, to ensure that the desired environmental goal is actually met.[156] In the case of TMDLs, that means that WLAs and LAs must be set low enough, and with an adequate "margin of safety" that addresses variable flow conditions and scientific uncertainties,[157] to ensure that the water quality standards will be met during all times of the year if the respective allocations (pollutant load reductions) are achieved. A trading regime also works best when all sources are subject to enforceable control limits,[158] but are allowed to buy and sell allowances within those limits. That ensures that all reductions are subject to some form of verification and enforcement, so that any traded reductions are, in fact, achieved. Because

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152. *See* Ann Powers, *Reducing Nitrogen Loading on Long Island Sound: Is There a Place for Pollutant Trading?*, 23 COLUM. J. ENVTL. L. 137, 149 (1998) (describing theory and history of water quality trading).

153. 40 C.F.R. § 130.2(i) (2012).

154. *See* Powers, *supra* note 152, at 163–67 (discussing EPA's 1996 Draft Framework for Watershed-Based Trading); *id.* at 186–94 (surveying limited number of existing water quality trading programs dating to 1981).

155. *See id.* at 194–96 (concluding that existing water quality trading programs, although arguably established satisfactorily, did not result in significant numbers of actual trades and "did not produce the desired load reductions"). This is not the only commentary on the applicability of trading to agricultural pollution. *See, e.g.*, Corey Longhurst, Note, *Where Is the Point? Water Quality Trading's Inability to Deal with Nonpoint Source Agricultural Pollution*, 17 DRAKE J. AGRIC. L. 175, 176–77 (2012) (arguing for adoption of performance based standards in form of best management practices for farmers); Thomas K. Ruppert, *Water Quality Trading and Agricultural Nonpoint Source Pollution: An Analysis of the Effectiveness and Fairness of EPA's Policy on Water Quality Trading*, 15 VILL. ENVTL. L.J. 1, 2 (2004) (examining EPA's policy on water quality trading and its potential ability to help improve water quality).

156. *See* Lesley K. McAllister, *The Overallocation Problem in Cap-and-Trade: Moving Toward Stringency*, 34 COLUM. J. ENVTL. L. 395, 410–26 (2009) (arguing that allocations have been set too high in existing environmental trading programs and evaluating resulting problems).

157. *See* 33 U.S.C. § 1313(d)(1)(C) (2012) (requiring states to set TMDLs "with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality").

158. *See* Lesley K. McAllister, *Beyond Playing "Banker": The Role of the Regulatory Agency in Emissions Trading*, 59 ADMIN. L. REV. 269 *passim* (2007) (addressing enforcement problems in pollution trading programs).

only point sources are subject to enforceable effluent limitations under the CWA, a rigorous point–nonpoint source trading system requires some kind of equivalent mechanism to ensure that nonpoint source reductions can be verified and enforced. Point sources are less likely to purchase nonpoint source credits if they retain the compliance risk that the purchased credits will not materialize, but it is equally untenable for the system (i.e., the public in the form of water pollution) to bear that risk.

Second, trading is only a viable means of controlling nonpoint source pollution in areas where both point and nonpoint sources are responsible for water quality impairment. In large rural watersheds in which agricultural or other forms of nonpoint source pollution predominate, there are few if any point sources with an incentive to purchase nonpoint source credits in order to reduce their pollution control costs. That does not mean that TMDLs do not apply or are not appropriate for watersheds impaired predominately by nonpoint sources.[159] It does suggest, however, that point–nonpoint source trading is, at best, a potential solution only for a subset of the large number of water bodies for which TMDLs have been developed to address impairment from agricultural pollution and other nonpoint sources.[160] Logically, it is in rural agricultural watersheds where point sources are least likely to contribute significantly to water pollution problems, except perhaps in large "aggregate" watersheds facing significant pollution from a large range of source categories, such as the Mississippi River/Gulf of Mexico and the Chesapeake Bay.

IV. THE EFFECT OF CLIMATE CHANGE ON AGRICULTURE AND WATER QUALITY: STORM CLOUDS AND SILVER LININGS

Climate change is likely to have two related sets of impacts relevant to agriculture and water pollution. First, changes in temperature, precipitation, and other climatic variables will affect the viability of crop production throughout the country. Those impacts, in turn, will affect not only domestic agriculture, but also global food production and the U.S. position in global agricultural markets. Second, changes in temperature, hydrology, and other factors will alter the vulnerability of aquatic ecosystems to pollution. On the other hand, these dual sets of adverse impacts might provide an ironic opportunity to seek shared, compatible solutions to both

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159. *See* Pronsolino v. Nastri, 291 F.3d 1123, 1140–41 (rejecting argument that TMDLs are not required for nonpoint source pollution-dominated water bodies).

160. *See supra* note 17 and accompanying text (noting high percentage of TMDLs in which nonpoint sources are the dominant source of impairment).

problems and thereby to move past the longstanding impasse in agricultural water pollution policy.

A. Climate Change Impacts on Agriculture and Water Quality

The effects of climate change on U.S. agriculture will not be evenly distributed. Some crops and some regions will be hit very hard, while others will face a mixture of losses and benefits, and the effects on some regions will not even be "negative" in the sense of net production losses.[161] Moreover, uncertainty surrounds efforts to predict the exact effects of climate change on a range of conditions that might affect agriculture.[162]

Nevertheless, virtually all producers will face at least some significant climate-induced changes in production conditions, with varying degrees of associated impacts and problems. Some producers will experience increased drought or longer-term aridity,[163] accompanied by increased water demand

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161. *See* WILLIAM R. CLINE, GLOBAL WARMING AND AGRICULTURE, IMPACT ESTIMATES BY COUNTRY 128 (2007) (predicting variable impacts of climate change on U.S. agriculture by region).

162. For example, global circulation models vary in predictions of the exact impact of rising greenhouse gas emissions (GHGs) on global average temperatures (GATs). NAT'L RESEARCH COUNCIL, ADVANCING THE SCIENCE OF CLIMATE CHANGE 225–27 (2010). It is then even more challenging to predict the effect of rising GATs on factors that may affect agriculture, such as the amount, timing, intensity, and form (rain versus snow) of precipitation. *See* U.N. ENVTL. PROGRAMME, CLIMATE CHANGE SCIENCE COMPENDIUM, 7 U.N. Sales No. 09.III.D.24 (2009) [hereinafter CLIMATE CHANGE SCIENCE COMPENDIUM]; STEVEN L. MARKSTROM ET AL., U.S. GEOLOGICAL SURVEY, U.S. DEP'T OF THE INTERIOR, SCIENTIFIC INVESTIGATIONS REPORT 2011-5077, INTEGRATED WATERSHED-SCALE RESPONSE TO CLIMATE CHANGE FOR SELECTED BASINS ACROSS THE UNITED STATES 1 (2012), *available at* http://pubs.usgs.gov/sir/2011/5077/SIR11-5077_508.pdf (evaluating hydrologic response to various projected carbon emission scenarios). In addition, researchers continue to debate the potentially offsetting positive effects of carbon fertilization on some crops. *See* William Easterling et al., *Food, Fibre and Forest Products*, *in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY, CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 273, 275 (Martin Parry et al. eds., 2007), *available at* http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm (discussing impacts of climate change on agriculture); U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 71–73 (2009), *available at* http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf (discussing positive and negative crop response to increased levels of warming).

163. *See* CLIMATE CHANGE SCIENCE COMPENDIUM, *supra* note 162, at 9; Guiling Wang, *Agricultural Drought in a Future Climate: Results from Fifteen Global Climate Models Participating in the IPCC Fourth Assessment*, 25 CLIMATE DYNAMICS 739, 739–40 (2005) (examining the greenhouse gas effects on soil water storage). "Drought" definitions vary considerably depending on context but they generally refer to comparatively shorter reductions in precipitation within a region relative to some other factor, such as crop needs, human needs, or some pre-determined "average" for the region; while "aridity" refers to a longer-term climatic condition in which precipitation is lower than in other regions. *See* Robert W. Adler, *Balancing Compassion and Risk in Climate Adaptation: U.S. Water, Drought, and Agricultural Law*, 64 FLA. L. REV. 201, 209–213 (2012) (discussing variable nature of drought definitions).

due to higher temperatures, increased evapo-transpiration, and reduced soil moisture.[164] Others will face risks from more frequent or more intense flooding, or direct impacts from intense precipitation events.[165] Temperature will affect crop production in numerous ways. Some crops or crop varieties, as well as livestock, will exceed their heat tolerance and either face productivity declines or lose regional viability altogether.[166] Changes in the seasonality of plant physiology—such as the timing of seed or grain production—can also adversely affect production, as can changes in nighttime temperatures and frost patterns.[167] Crop and livestock production could also suffer—or face higher production costs—due to increased risks from weeds, insects, and other pests.[168]

At the same time, climate change is likely to exacerbate the effects of agriculture and other sources of pollution on water quality. For example, higher water temperatures will result in lower levels of dissolved oxygen, increased concentrations of phosphorus and other pollutants, increased algal blooms, and high levels of bacteria and fungi.[169] Areas receiving more precipitation and more intense storms will generate more and more intense runoff, which will increase loadings of sediment, nutrients, pesticides,

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164. *See* U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, *supra* note 162, at 72 (noting higher temperatures will cause plants to use more water); Raymond P. Motha & Wolfgang Baier, *Impacts of Present and Future Climate Change and Climate Variability on Agriculture in the Temperate Regions: North America*, *in* INCREASING CLIMATE VARIABILITY AND CHANGE 137, 147–50 (James Salinger et al. eds. 2005).

165. *See* Easterling et al., *supra* note 162, at 275 (noting particular climate change scenarios); P.C.D. Milly et al., *Increasing Risk of Great Floods in a Changing Climate*, 415 NATURE 514, 514–16 (2002).

166. *See* M.J. Salinger et al., *Reducing Vulnerability of Agriculture and Forestry to Climate Variability and Change: Workshop Summary and Recommendations*, 70 CLIMATIC CHANGE 341, 347 (2005); U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, *supra* note 162, at 78 (stating "[t]he more the U.S. climate warms, the more production will fall").

167. *See* U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, *supra* note 162, at 72 (noting grain-filling period of wheat and grains "shortens dramatically" as temperatures rise); INTERGOVERMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY, WORKING GROUP II CONTRIBUTION TO THE IPCC FOURTH ASSESSMENT 99, 102–03 (Martin Perry et al. eds., 2007).

168. *See* Easterling et al., *supra* note 162, at 19, 283 (discussing impacts of climate change on weed and insect pests, diseases, and animal health); U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, *supra* note 162, at 75–76 (noting that weed control already costs United States over $11 billion per year).

169. *See* U.S. ENVTL. PROT. AGENCY, NAT'L WATER PROGRAM STRATEGY, RESPONSE TO CLIMATE CHANGE 8–9 (2008) [hereinafter NAT'L WATER PROGRAM STRATEGY], *available at* http://water.epa.gov/scitech/climatechange/upload/2008-National-Water-Program-Strategy-Response-to-Climate-Change.pdf (discussing impacts of warmer water temperatures); U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, *supra* note 162, at 46 (discussing changes in water quality).

animal wastes, pathogens, and other contaminants.[170] If farmers rely on more agricultural chemicals to compensate for reduced soil fertility or to battle new or increased weeds and pests, those chemicals are likely to seep or run off into surface and ground waters in increased amounts. In coastal areas, saltwater intrusion will further impair available water sources or generate significantly higher treatment costs to make it usable by farmers and others.[171] Moreover, water bodies themselves will become more vulnerable to agricultural and other pollution. Higher water temperatures will stress or render indigenous aquatic species no longer viable in existing habitats, and increase eutrophication and algae growth.[172]

Therefore, unless addressed wisely, climate change adaptation challenges will adversely affect either water quality and aquatic ecosystem integrity, or the economic viability of U.S. agriculture, or both. These climate change effects could tip the balance in the longstanding policy impasse discussed above in one direction or the other, but neither extreme would necessarily be constructive. One possible policy response to this seemingly irreconcilable set of problems would be to choose people over fish, or food and fiber production over water quality. If the question is posed in such an "either-or" fashion—as is often unfortunately the case—many people and decision makers would prefer to maintain the viability and productivity of our agricultural economy at the expense of water quality. Even viewed purely from a food policy perspective, however, that strategy would be short sighted. Notwithstanding the critical importance of row crop agriculture and grazing to our diets and our economy, the negative economic effects of polluted water are significant and can also impair economic productivity in terms of food production and otherwise.

Alternatively, if climate change results in even more serious agricultural water pollution problems than we have faced in the past, we could decide to mitigate those impacts through increased regulation of farmers. Whether or not that is politically feasible, which is questionable,[173] it would not necessarily solve the long-term problems—the impact of climate change on water quality and the vulnerability of our agricultural economy—if regulation rendered existing farming operations economically

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170. *See* NAT'L WATER PROGRAM STRATEGY, *supra* note 169, at 10–14 (discussing rainfall and snowfall levels and distribution); U.S. GLOBAL CLIMATE CHANGE RESEARCH PROGRAM, *supra* note 162, at 48.

171. *See* NAT'L WATER PROGRAM STRATEGY, *supra* note 169, at 16–17 (discussing impacts of sea level rise).

172. *See id.* at 8 (noting certain organisms are sensitive to temperature changes).

173. If Congress and the state have not elected, for the most part, to regulate agricultural water pollution under relatively prosperous conditions, it seems even less likely that they would do so when agriculture is facing potentially severe economic constraints due to climate change.

unviable or significantly less competitive in global markets. Less profitable agricultural operations can ill afford additional pollution control methods. Lowering the economic viability of agriculture will compromise the productivity needed to feed a global population expected to reach nine billion people by 2050[174] and the competitiveness of U.S. agriculture in those global markets.[175]

Indeed, successful pollution control and economic health have always been positively and bi-directionally correlated. Healthy businesses can better afford to invest in effective controls, and efficient production can both reduce costs in the long run—especially after those investments are amortized—and generate safer, more marketable products.[176] All participants in the debate over agricultural water pollution, then, will be better off if we can search for shared, compatible solutions to the problems of climate change and agriculture.

B. A Search for Shared, Compatible Solutions

So where is the silver lining in this seemingly intractable set of problems? How might the negative effects of climate change on agriculture help with this forty-year political impasse on how to address agricultural water pollution?

174. *World Population Prospects, the 2010 Revision*, U.N. DEP'T OF ECON. & SOCIAL AFFAIRS, POPULATION DIV. (2011), *available at* http://esa.un.org/unpd/wpp/index.htm (last updated Dec. 6, 2012). The U.N. estimates that global agricultural production must increase by 50 to 70 percent by 2050 to meet anticipated demand. *See* U.N. ENV'T PROGRAMME, FOOD & AGRIC. SEC., UNEP POLICY SERIES NO. 4, IDENTIFYING SYNERGY AND TRADEOFFS, at 5 (2011) (estimating that global agricultural production must increase by 50 percent by 2030 to meet anticipated demand); Olivier de Schutter, Report Submitted by the Special Rapporteur on the Right to Food, Human Rights Council Sixteenth Session, U.N. Doc. A/HRC/16/49 (Dec. 17, 2010) (approximating an increase of 70 percent required to meet need by 2050).

175. Production increases in some regions can offset declines elsewhere, but only if price, income, distribution, and trade policy support the necessary food transfers. *See* GERALD NELSON ET AL., INT'L FOOD & AGRIC. TRADE POLICY COUNCIL & INT'L CTR. FOR TRADE AND SUSTAINABLE DEV., THE ROLE OF INTERNATIONAL TRADE IN CLIMATE CHANGE ADAPTATION: ISSUE BRIEF NO. 4 (2009) (arguing agricultural productivity investments are crucial to adjust to climate change).

176. Indeed, this concept is at the heart of the evolving concept of sustainability, in which economic, environmental, and social health all contribute to, and are helped by, a move toward increased sustainability. *See* JOHN C. DERNBACH, ACTING AS IF TOMORROW MATTERS, ACCELERATING THE TRANSITION TO SUSTAINABILITY 3–4 (2012) (stating "the object of sustainability is to maximize the positive contribution of human activities to the environment, the economy, and society at the same time").

1. Reframing the Debate

One potential answer is to reframe the debate in a manner designed to promote a better alignment of interests. To date, some major representatives of U.S. agricultural interests have been among the most ardent of climate change skeptics.[177] At some point—maybe sooner rather than later given the drastic impacts that U.S. farmers faced during the hot, dry summer of 2012[178] and equally frightening predictions of the same or worse in coming years[179]—mainstream agricultural interests will realize that climate change is not only real, but extremely bad for farmers. As shown above, in some parts of the country, climate change will render existing agricultural operations significantly more difficult or significantly more expensive. In others, such as portions of the Southern Great Plains, agriculture may no longer be viable at all by the end of the century.[180]

In short, it is likely to be climate change, not regulation, that might force a solution. Climate change will put some U.S. farmers out of business, make certain crops or crop varieties no longer viable in particular places because of heat, aridity or other limitations, or allow those practices to continue only if we address those changes wisely. Solutions to these potentially dramatic problems ("adaptation measures"[181]) will have to entail significant rethinking of fundamental production decisions. These decisions include what we grow, where we grow it, how we grow it, with what inputs,

177. *See, e.g.*, Allison Winter, *Farm Bureau Fights Back Against Climate Bill's 'Power Grab,'* N.Y. TIMES, (Jan. 11, 2010), http://www.nytimes.com/cwire/2010/01/11/11climatewire-farm-bureau-fires-back-against-climate-bills-93758.html?pagewanted=all (noting American Farm Bureau Federation's position that there exists no agreed upon scientific assessment of impact or extent of anthropogenic carbon dioxide emissions).

178. *See U.S. Drought 2012: Farm and Food Impacts*, U.S. DEP'T OF AGRIC., http://www.ers.usda.gov/topics/in-the-news/us-drought-2012-farm-and-food-impacts.aspx (last visited Apr. 9, 2013) (depicting 2012 drought as "the most severe and extensive" in 25 years and as "seriously affect[ing] U.S. agriculture, with impacts on the crop and livestock sectors and with the potential to affect food prices at the retail level").

179. *See* Aiguo Dai, *Increasing Drought Under Global Warming in Observations and Models*, 3 NATURE CLIMATE CHANGE ONLINE 52, 57 (2012), http://www.nature.com/nclimate/journal/v3/n1/full/nclimate1633.html (arguing foreseeable increases in drought due to various causes); Hristio Boytchev, *Climate Models that Predict More Drought Win Further Scientific Support*, WASH. POST (Aug. 13, 2012), http://articles.washingtonpost.com/2012-08-13/national/35491296_1_droughts-climate-models-climate-researcher (noting global warming will play increasingly important role in abundance and severity of future droughts in U.S. during next two decades).

180. *See* CLINE, *supra* note 161, at 128, tbl F-1 (describing the impact climate change will have on agricultural output).

181. *See generally* NAT'L RESEARCH COUNCIL, ADAPTING TO THE IMPACTS OF CLIMATE CHANGE 17–27 (2010) (discussing climate change adaptation generally); CLINE, *supra* note 161, at 67–70 (discussing adaptation measures for agriculture and forestry more specifically).

how efficiently (in terms of water, fertilizer, and pesticide and herbicide use), and with what environmental impacts. For example, agricultural regions that have traditionally relied on irrigation, but that may face declining water supplies, may have to shift to more drought-tolerant crops or crop varieties. Farmers in other regions may face similar decisions about crop choices due to factors such as changing temperature extremes, temperature ranges, and diurnal or annual timing. Higher risks from weeds and pests may similarly affect production decisions or methods, with either increased agricultural chemical use or shifts to non-chemical pest control and weed control options, such as biological pest control or pest-resistant crops, more diverse cropping patterns that are less vulnerable to pests that proliferate in monocultures, and low-till or no-till agriculture.

Moreover, it is not possible to consider the U.S. agricultural economy in isolation from its international cousins. The United States has been one of the dominant forces in global markets for commodity crops[182] at least since World War II, and U.S. agriculture was affected significantly by global shortages or surpluses before then.[183] Today, U.S. farm policy has ripple effects around the world, because subsidies or significant shifts in production levels in major exporting nations can affect global supply and demand as well as prices, which in turn can either help or hurt farmers in smaller countries.[184] Therefore, to the extent that U.S. production shifts due to climate change, there may be significant impacts on food supplies and agricultural economies around the world.

From the reverse perspective, agriculture in many parts of the world is significantly more vulnerable to climate change than in the United States.[185] In subtropical regions, such as the Sahel in Africa and in portions of Southeast Asia and Latin America, for example, crops are already closer to their natural heat tolerances, meaning that increases in temperature will

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182. A "commodity crop" is one that can be stored in large quantities for relatively long periods of time without spoilage and therefore is amenable to global trading on a large scale without refrigeration or other more expensive transport and storage costs. Examples are grains such as corn, wheat, or rice, or legumes such as soybeans. *See* Kwan, *supra* note 91, at 574 (defining "commodity crop" as "easy to transport and virtually indestructible).

183. *See* Adler, *supra* note 163, at 247–54 (linking U.S. agricultural policy in part to global supply and demand through World Wars I and II and the Great Depression and Dust Bowl).

184. *See* DARYLL E. RAY ET AL., AGRIC. POLICY ANALYSIS CTR., RETHINKING U.S. AGRICULTURE POLICY: CHANGING COURSE TO SECURE FARMER LIVELIHOODS WORLDWIDE 30 (2003) (analyzing current U.S. agricultural policy and its effects on global agriculture).

185. *See* JODIE KEANE ET AL., INT'L CENTRE FOR TRADE & SUSTAINABLE DEV., CLIMATE CHANGE AND DEVELOPING COUNTRY AGRICULTURE: AN OVERVIEW OF EXPECTED IMPACTS, ADAPTATION AND MITIGATION CHALLENGES, AND FUNDING REQUIREMENTS vii (2009), *available at* http://ictsd.org/downloads/2011/12/climate-change-and-developing-country-agriculture.pdf (describing vulnerability of developing countries to climate change).

push some crops beyond their limits sooner than in more temperate zones.[186] Likewise, drought and desertification have already reached crisis proportions in many subtropical regions, leading to a large number of major famines and accompanying refugee crises and other social and economic disruption in those regions.[187] Although not as desirable as helping those countries themselves to adapt to changing agricultural conditions so that they can better meet their own population's needs for food, fiber, and other basic agricultural products, one aspect of climate change adaptation will be enhanced food transfers from countries with agricultural surpluses to those with large deficits. If U.S. production also declines dramatically due to climate change, its ability to help offset a global imbalance between food supply and nutrition demand will be far more limited, with accompanying human rights and global security implications.[188]

Perhaps, then, we (meaning the collective "we" of agriculturalists, environmentalists, academics and other policy analysts, decision makers, and the general public) need to stop thinking about this as purely a water quality problem, or as any other isolated environmental problem. Likewise, we should abandon the decades-long rhetorical framework in which we evaluate agricultural water pollution predominately as: (1) a "conflict" between agricultural and environmental interests; and (2) purely a debate about regulation versus voluntary or other approaches.

Instead, we might reframe the issues. First, how we can plan to meet the demand for food, fiber, construction materials, energy, and other goods and services that U.S. agriculture provides—both for domestic needs and for global markets—in light of major expected potential production losses

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186. By 2020, an additional 60 to 90 million hectares of land in Sub-Saharan Africa are projected to become more arid, and yields from rain-fed agriculture could decline by as much as 50 percent. Similarly, crops could decline by up to 30 percent in central and south Asia, substantially increasing hunger risks. INTERGOVERMENTAL PANEL ON CLIMATE CHANGE, *supra* note 167, at ch. 9.

187. *See* Robert W. Adler, *Drought, Sustainability and the Law*, 2 SUSTAINABILITY 2176, 2185–87 (2010) (chronicling historical droughts in sub-Saharan African nations); James Forole Jarso, *Africa and the Climate Change Agenda: Hurdles and Prospects in Sustaining the Outcomes of the Seventh African Development Forum*, 29 SUSTAINABLE DEV. LAW & POL'Y 38 (Winter 2011) (explaining how erratic rainfall pattern in Africa has exacerbated food security problems); Richard Munang & Johnson N. Nkem, *Using Small-Scale Adaptation Actions to Address the Food Crisis in the Horn of Africa: Going Beyond Food Aid and Cash Transfers*, 3 SUSTAINABILITY 1510, 1511–12 (2011) (arguing that food system inequities are exacerbated by climate change and drought).

188. *See* KOKO WARNER ET AL., IN SEARCH OF SHELTER: MAPPING THE EFFECTS OF CLIMATE CHANGE ON HUMAN MIGRATION AND DISPLACEMENT iv (2009), *available at* http://www.careclimatechange.org/files/reports/CARE_In_Search_of_Shelter.pdf (noting those living in least developed countries and island states will be affected first and worst by impacts of climate change); Ben Wisner et al., *Climate Change and Human Security,* RADIX (April 15, 2007), http://www.radixonline.org/cchs.html (arguing climate change poses threats to national security, international security, and human security).

in other regions of the world? Second, can we do so under changing and uncertain climatic conditions, in a way that is both economically and environmentally sustainable, and preserves the competitiveness of U.S. agriculture in global markets?

2. Aligning Multiple Interests

Simply reframing the question, of course, at best only takes us in a new direction with the potential to generate more promising solutions. Moving from the reframed question to one or more solutions also requires both a mechanism to match public and private interests and successful ideas on how those interests should be aligned to achieve mutually beneficial goals.

In previous work, I proposed a potential mechanism designed in part to achieve a better alignment of public and private interests in the context of the massive public expenditures that have been devoted to agricultural water pollution control in recent decades. Without suggesting that this is the only possible approach to achieve this pairing of interests—and indeed, I hope many more might be proposed—it can serve as an illustration of how this might be achieved.

In *Priceline for Pollution: Auctions to Allocate Public Pollution Control Dollars*,[189] I critiqued our decades-old policy, under both Clean Water Act and Farm Bill programs, of throwing huge amounts of public dollars at agricultural water pollution control programs without adequate accountability or success measures. None of those funding sources, of course, are free of guiding criteria or standards, but others have critiqued them as inadequate and ineffective.[190] It is possible, then, that the primary flaw in our previous approaches to agricultural pollution is not that we have chosen to subsidize private pollution control with public dollars rather than regulating farmers, but that we have subsidized in an inefficient way with little or no effective means of measuring or even requiring effective use of those funds.

189. Robert W. Adler, *Priceline for Pollution: Auctions to Allocate Public Pollution Control Dollars*, 34 WM. & MARY ENVT'L L. & POL'Y REV. 745 (2010).

190. *See, e.g.*, Shortle et al., *supra* note 11, at 1318 (noting water quality would improve if funding increased, but traditional programs have serious weaknesses); James M. McElfish, Jr. et al., *Inventing Nonpoint Controls: Methods, Metrics and Results*, 17 VILL. ENVTL. L.J. 87, 88–99 (2006) (summarizing federal guiding criteria for state nonpoint programs); Timothy D. Searchinger, *Cleaning Up the Chesapeake Bay: How to Make an Incentive Approach Work for Agriculture*, 16 SE. ENVTL L.J. 171, 173–95 (2007) (arguing progress on Chesapeake Bay cleanup requires balanced approach and heavy reliance on incentives in agricultural management sector)*; see also* EPA NATIONAL EVALUATION, *supra* note 17 (suggesting NPS program priorities should factor into how funds are utilized); U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 42, at 9 (summarizing EPA's guidelines for states' utilization of section 319 funds).

An alternative is to borrow a concept from the Colorado River Salinity Control Program, which also devotes significant public funding to the control of both point and nonpoint source salinity pollution in the Colorado River Basin.[191] In the early years of the salinity program, following the traditional methods it had used for decades for dams and other water projects, the Bureau of Reclamation (BoR) selected salinity reduction projects using a traditional public works model.[192] Later, the USDA added its traditional federal assistance approach to subsidize farmers to reduce their salinity inputs into the system.[193] Both internal and external reviewers critiqued the cost-effectiveness of this strategy, and Congress adopted legislative reforms[194] suggesting a "basinwide" approach to the salinity problem.[195] As a result, the BoR, in cooperation with the Colorado River Basin states, shifted to a public auction approach. Program funds are now allocated to those who can demonstrate that they can reduce salt loadings to the river most cost-effectively, measured in cost per ton of salt removed from the river, regardless of the source, after accounting for any risk that the project will not be implemented effectively.[196] In the roughly decade and a half since BoR adopted the auction approach, the cost-effectiveness of salinity reduction measures in the basin has improved dramatically.[197]

In my earlier analysis, I suggested using nutrient and sediment pollution of the Chesapeake Bay as an experimental model for using the reverse auction approach to tackle a more traditional but longstanding and intractable agricultural pollution problem.[198] Rather than throwing public money at anyone who can meet generic program criteria independent of cost-effectiveness or any other measure of accountability, under this approach agency officials would solicit bids based on who can reduce more pounds of nitrogen, phosphorus, or sediment loadings at the lowest costs,

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191. *See* Adler, *supra* note 189, at 766–82 (tracing salinity control program history). The salinity program history in this article was based on a more extensive earlier analysis prepared for the National Academy of Public Administration. *Id.* at n.125.

192. *See id.* at 773–77 (defining the traditional public works model and detailing how it was used for the salinity control program).

193. *See id.* at 777–80 (describing how the federal government was involved in funding and overseeing the salinity control program).

194. Colorado River Basin Salinity Control Act, Amendment, Pub. L. No. 104-20, 109 Stat. 255 (1995) (codified as amended at 43 U.S.C. 1571).

195. *See* Adler, *supra* note 189, at 780–82 (citing and describing studies by the Bureau of Reclamation, the Department of Interior's Office of the Inspector General, and the General Accounting Office).

196. *Id.* at 781–82 (explaining how the open bidding process allowed federal officials to fund projects based upon how they reduced the salinity of the water and the efficiency of the cost).

197. *Id.* at 782.

198. *See id.* at 799–800, 803, 805 (showing traditional approaches did not result in significant decreases of pollution).

again accounting for project risk.[199] My intent in that analysis was not to argue that public funding is necessarily the best approach to agricultural pollution control, but if we are going to continue to spend large amounts of public funds in that effort—particularly during a time of federal fiscal crisis—we certainly should do so more effectively and with more accountability. There is some indication that interest in the public auction approach is building, as Pennsylvania is considering legislation to adopt an auction model[200] as part of its implementation of the EPA's interstate Chesapeake Bay TMDL discussed above.[201]

This same strategy might also help us to identify and prioritize funding for solutions to agricultural water pollution in ways that also help agricultural producers adapt to the disruptive effects of climate change. One thing seems reasonably clear in this effort: Neither farmers nor governments can solve the reframed problems laid out earlier on their own. It needs to be a partnership. And it is equally clear that, despite rhetorical claims about the independent nature of small rural farmers, agriculture has been a private-public partnership in the United States since at least the 1930s. The federal government has assisted farmers through direct subsidies, price supports, subsidized crop insurance, international trade policies, and otherwise. Since Congress adopted the original New Deal agricultural programs, the real question has been about the specific nature and terms of the public-private partnership, which has evolved considerably throughout its history,[202] as opposed to whether it should exist at all.

Although certainly not the only option, a reverse auction approach might help us to use climate change as an (admittedly counter-intuitive) opportunity to make this public-private partnership work more effectively to reduce the water quality and other adverse environmental effects of agriculture while also helping with climate change adaptation. To explore that option, we first need to consider accountability metrics equivalent to dollars per ton of salt (or nitrogen or phosphorus) that address multiple, hopefully consistent, goals. Although more difficult and more complex than programs designed to address individual pollutants like salt or nutrients, it is quite possible to conceive of metrics that might be suitable. The following examples are presented simply as preliminary possibilities to

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199. *See id.* at 803–05, 807 (proposing that auction approach would be more cost effective and reduce pollution).

200. S.B. 1263, 2011 Sess., Gen. Assemb. (Pa. 2011).

201. *See supra* note 136 and accompanying text.

202. *See generally* HISTORY OF AGRICULTURAL PRICE-SUPPORT & ADJUSTMENT PROGRAMS, *supra* note 91.

illustrate the idea. All would require considerably more refinement and are in no way intended to be exclusive.

In a region facing expected reductions in precipitation and runoff, we might rank public investments based on predicted crop production per unit of water used (e.g., tons of wheat per acre-foot of water applied). In this case, the mutually aligned goals would be to increase production efficiency while preserving scarce water resources in increasingly arid areas. The accountability metric would provide incentives to develop more water-efficient production methods, while making public funds available to make the necessary investments in the most cost-effective irrigation methods, crop changes, or other innovations.

Similarly, in a region facing increasing weed growth or increased risks from insects or other pests, we could rank public investments by crop production per unit of herbicide or pesticide use, perhaps weighted by the toxicity and mobility of each chemical in the environment. The mutually aligned goals would be to maintain production while reducing input costs and reducing adverse effects on water quality and human health. Producers would have incentives to innovate weed control and pest control methods that either used lower quantities of chemicals, or chemicals that were either less toxic or less likely to contaminate surface water, ground water, or other resources.

Last, in a region in which crops are facing natural temperature limits, we might rank investments based on which new crops or varieties can produce best in that region with lowest water quality or other environmental impacts. The mutually aligned goals would be to promote and support crop shifts that maintain or improve production levels with lower environmental impacts, even if that means that different crops would be produced in different regions. Producers would have incentives either to develop or change to crops or crop varieties better suited to changing weather conditions, or even to change production locations. Some of those solutions could be expensive, making the partnership and public funding approach particularly desirable.

One interesting advantage of using accountability metrics based on *production* relative to some relevant measure of environmental harm, as opposed to dollars per unit of pollution reduction, as is used for the salinity control program and proposed for the Chesapeake Bay TMDL, is that it potentially opens up a wider scope of federal funding mechanisms. As a matter of basic domestic farm policy, it may no longer be feasible from a fiscal, food supply, *or* environmental perspective to continue to subsidize inefficient production of large amounts of commodity crops, either for domestic consumption or for export. Rather than basing only certain targeted provisions of the Farm Bill on water quality and other resource protection goals, as well as any funding under the CWA or other federal and state environmental programs, this strategy could be used to direct all agricultural subsidies, or at least a larger percentage of them, to production changes designed simultaneously to help farmers adapt to climate change and to meet water quality and other environmental goals.

A particularly challenging problem inherent in this approach, however, is that so many different accountability metrics might be relevant in determining the sustainability of agricultural production in the face of climate change, and some of those metrics might be internally inconsistent and subject to different value preferences or policy judgments. As just one example, if one measures production relative to pesticide use as a way to avoid or reduce the likelihood that farmers will adapt to increased pest risks by using more, or more toxic, pesticides, that might provide an incentive to shift to genetically modified organisms. Some may believe that to be a positive trend, while others may fear that it exposes humans, or the environment, to currently unknown or poorly understood risks. On the other hand, framing the question in this way may force us to make the choices among competing values that will be inevitable in deciding how to maintain or increase agricultural productivity in the face of climate change without aggravating already serious water quality and other environmental problems.

V. CONCLUSION

Agricultural water pollution remains a serious problem that has not been mitigated on a nationwide scale despite four decades or more of effort. It has also been an intractable problem, in part due to the longstanding policy impasse about whether the best approach to the problem is to regulate farming practices more rigorously or to continue to encourage farmers to minimize their environmental impacts through education, public funding, and other voluntary programs.

Climate change is likely to exacerbate the water quality effects of a range of agricultural practices and to increase other associated environmental problems as well. At the same time, climate change is likely to hurt U.S. agriculture itself, in ways both related to and entirely independent of environmental issues.

As unsettling as those dual realizations may be, if we integrate the two issues, they provide an interesting opportunity to reframe the agricultural water pollution problem in a way that brings about an alignment of—rather than a conflict between—traditional agricultural and environmental interests. Some of the same strategies that will help farmers to withstand the production challenges presented by climate change, such as better pest management techniques, simultaneously could reduce the water pollution effects of those activities. Accordingly, reframing the agricultural water pollution issue from a climate-integrated perspective may increase our chance of finding viable solutions and overcoming the longstanding policy impasse in this area.