REVERSING THE PROPERTY RIGHTS:

A PRACTICE-BASED TRADING APPROACH FOR CONTROLLING AGRICULTURAL NONPOINT-SOURCE WATER POLLUTION

Sergey S. Rabotyagov

Assistant Professor
School of Environmental and Forest Sciences
University of Washington
Box 352100
Seattle, WA 98195-2100
rabotyag@uw.edu
(206) 685-3159

Adriana Valcu

Research Assistant
Iowa State University
573 Heady Hall
Ames, IA 50011
amvalcu@iastate.edu
(515) 6357-5767

C.L. Kling

Professor
Iowa State University
568D Heady Hall
Ames, IA 50011
ckling@iastate.edu
(515) 294-5767

Poster prepared for presentation at the Agricultural & Applied Economics Association's 2012 AAEA Annual Meeting, Seattle, Washington, August 12-14, 2012

Reversing the Property Rights: A Practice-based Trading Approach for Controlling Agricultural Nonpoint-source Water Pollution

Adriana Valcu
Catherine L. Kling
Department of Economics
Iowa State University of Science and Technology
Center for Agricultural and Rural Development CARD

Sergey S. Rabotyagov
School of Environmental and Forest Sciences
University of Washington

Introduction

THE DESIGN OF the efficient programs to address the nonpoint sources (NPS) water quality from agriculture has been on the environmental economists' agenda for decades. A large part of this research has focused on these programs within the context of an existing regulatory structure and the voluntary abatement from agriculture. Despite subsidy programs and the development of nascent water quality trading programs targeting nonpoint source agricultural water pollution, poor water quality pervades much of the U.S. and a large amount of the remaining water quality problems are attributable to nonpoint agricultural sources.

In this paper, we study the efficient design of agricultural water pollution when the regulator is allowed to impose regulations and standards on agricultural non point sources. Furthermore, we carefully address the implications of three types of fundamental difficulties facing by regulators: (1) imperfect information on the abatement costs of individual farms, (2) difficulties in observing pollution or abatement activities at farm level , and (3) imperfect information on the water quality production function.

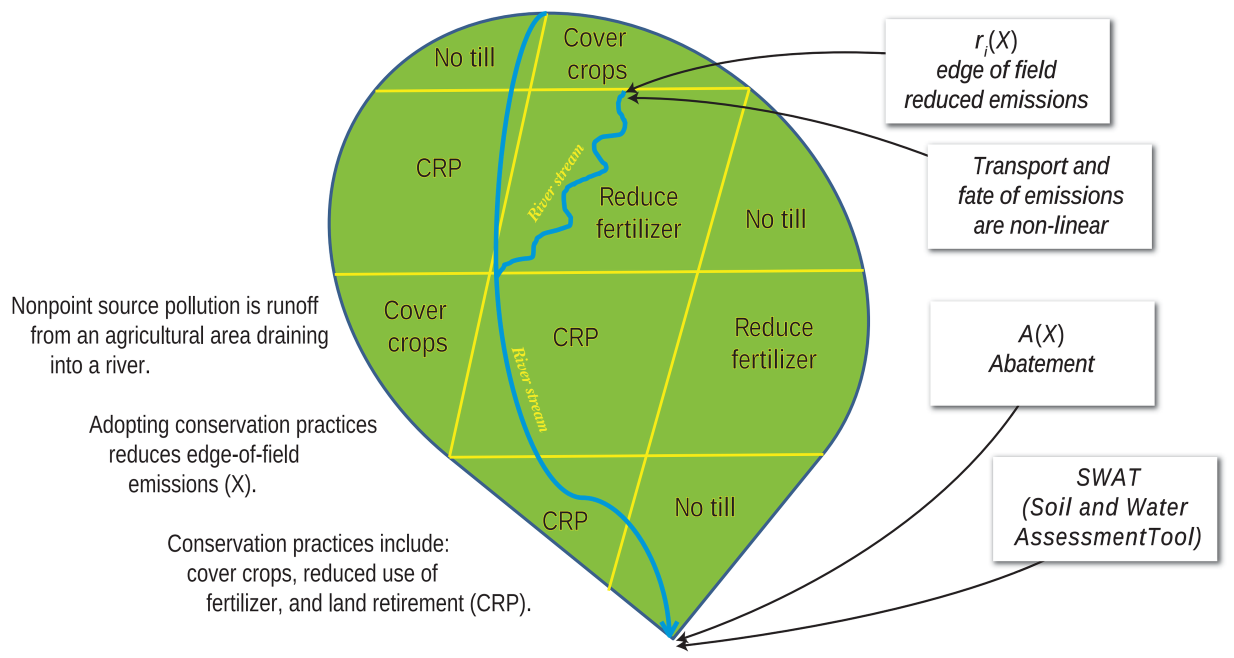


Figure 1

Objective

- Propose a simple approach for regulating emissions from NPS using a point system approach as a proxy for the contribution of each source from the field
  - A regulator is allowed to impose regulations on agricultural NPS;
  - considers abatement actions at the field scale
- Evaluate its ability to achieve water quality goal in a least cost way under different regulatory approaches:
  - A command and control
  - A performance standard
  - A trading setting where initial allocations of abatement actions are assigned just in CAC approach but producers can trade

Abatement Action Permit System (AAPS, Kling 2011)

- Assign each abatement practice point values based on their effectiveness in reducing edge-of-field emissions
- Points associated with a abatement practice vary by the location in the watershed
  - each producer would be required to have an average number of points per acre to satisfy his target requirement
  - Allow farmers to buy/sell points among each

Method

Use a watershed based water quality model to assign points to each abatement practice

- create a sample of 3,000 watershed configurations by randomly assigning conservation practices to each fields (i.e . Assign each field an abatement practice x_{ij})
- simulate the water quality impact of those assignments ($A(r(X))$)

$$A = A(X)$$

- To create the vector of points, a, linearly approximate the abatement function as:

$$A(X) \approx \sum_j a_j \sum_i x_{ij} = X*a$$

- Solve for a, the vector of points

$$\min_a (A - Xa)' (A - Xa)$$

Allocate the points to achieve an abatement goal

- The regulator determines the watershed configuration that achieves $\bar{A}$
- Identifies the total number of points needed to achieve $\bar{A}$
- Determines the number of points for each field using one of the following methods:
  - the regulator's least cost placement solution given the cost information available to her
  - random assignment
  - even assignment
  - others

Empirical estimation

- Estimate a set of 9x30 point estimates
- Level of 40 % abatement from the baseline
- Use 1,000 random draws for cost heterogeneity
- Simulate the abatement level and cost outcomes under the three policy scenarios
- SWAT to estimate the nutrient emission levels

Results

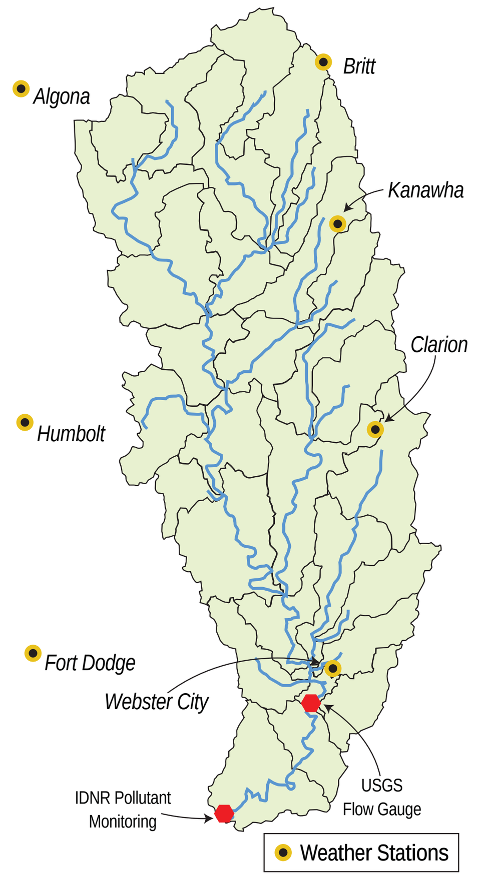
Points estimation and assignment

Agricultural watershed in NW Iowa Land use facts:

- 237,000 ha divided into 30 subbasins and 2,900 homogenous field units
- Corn and soybean cover nearly 90% of the agricultural area

Environmental facts:

- Discharged some of the highest N loads during 2000-2002 amongst analyzed Iowa watersheds
- Use a set of 9 abatement practices

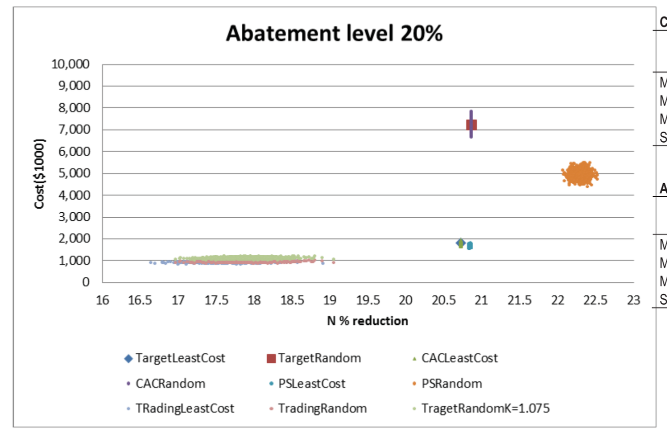


Average values for points estimated for the conservation practices used for Boone River Watershed

Abatement Practice		Point estimate/acre
No till		2.76
Cover Crops		2.42
No till, Cover Crops		4.6
Reduce fertilizer		0.29
Reduced fertilizer, No till		3.34
Reduced fertilizer, cover crops		2.72
Reduced fertilizer, no till, cover crops		5.03
Land retirement		7.52
Total number of points to achieve		
	20%	1231
	30%	13131
	50%	131313

As expected, the conservation practices known to be more aggressive in reduction the agricultural emissions accrue more points.

Empirical Results

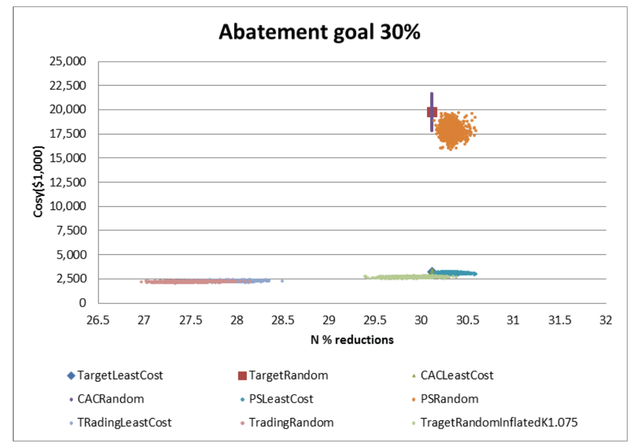


Command and Control and Performance Standard Outcomes

	Least Cost Target			Random Target		
	Cost	N%	CAC cost	Cost	N%	CAC cost
Mean	1,665,199	20.85	1,793,057	4,950,564	22.30	7,231,175
Min	1,820,648	20.86	1,955,425	5,483,399	22.52	7,828,026
Max	1,540,891	20.83	1,663,784	4,392,286	22.07	6,665,245
StdDev	38,090	0.01	38,705	184,403	0.07	200,556

AAPS Trading Outcome

	Least Cost Target		Random Target		Random Target K =1.075	
	Cost	N%	Cost	N%	Cost	N%
Mean	927,373	17.68	950,499	17.92	1,113,597	19.45
Min	1,026,921	18.91	1,051,417	19.05	1,222,170	20.72
Max	839,141	16.65	861,319	16.97	1,012,692	18.43
Std.Dev	29,253	0.30	29,583	0.30	31,850	0.28

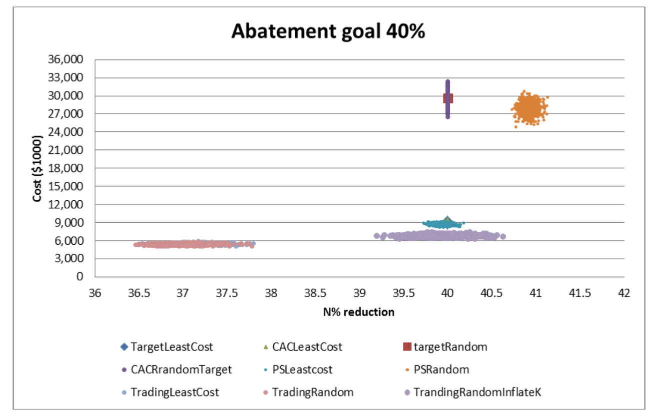


Command and Control and Performance Standard Outcomes

	Cost Informed Target			Random Target		
	Cost	N%	CACcost	Cost	N%	CAC cost
Mean	3,081,106	30.32	3,232,261	27,910,009	40.92	29,573,330
Min	3,240,390	30.60	3,386,230	24,773,870	40.74	26,419,302
Max	2,863,244	30.14	3,002,472	30,669,551	41.14	32,318,543
StdDev	60,465	0.07	59,303	897,480	1.3	900,772

Trading Outcome

	Cost Informed Target		Random Target		Random Target K =1.075	
	Cost	N%	Cost	N%	Cost	N%
Mean	5,377,474	37.09	5,350,838	37.02	6,944,295	39.89
Min	123,255	36.51	4,975,517	36.46	167,598	39.19
Max	5,859,830	37.8	5,823,730	37.79	7,601,899	40.62
StdDev	207,490	0.2	122,218	0.2	274,189	0.22



Command and Control and Performance Standard Outcomes

	Least Cost Target			Random Target		
	Cost	N%	CAC cost	Cost	N%	CAC cost
Mean	8,654,175	39.93	9,010,815	27,910,009	40.92	29,573,330
Min	8,139,097	39.74	8,507,064	24,773,870	40.74	26,419,302
Max	9,212,053	40.18	9,572,124	30,669,551	41.14	32,318,543
StdDev	163,169	0.07	162,446	897,480	1.30	900,772

AAPS Trading Outcome

	Least Cost Target		Random Target		Random Target K =1.075	
	Cost	N%	Cost	N%	Cost	N%
Mean	5,377,474	37.09	5,350,838	37.02	6,944,295	39.89
Min	123,255	36.51	4,975,517	36.46	167,598	39.19
Max	5,859,830	37.80	5,823,730	37.79	7,601,899	40.62
Std.Dev	207,490	0.20	122,218	0.20	274,189	0.22

Conclusions

OUR FINDINGS SHOW a promising performance of the points-based trading system both in terms of reaching the water quality objectives and in terms of cost-efficiency. Our findings suggest that the inefficiencies of the simple points-based trading system may be outweighed by the appeal of capitalizing on established ambient pollution trading theory in a realistic context of agricultural nonpoint-source pollution.