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AGRICULTURE PRODUCER RESPONSES TO GOVERNMENT-FUNDED CONSERVATION PROGRAMS TO ADDRESS WATER QUALITY

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Objectives

The Kentucky Division of Water 2004 Kentucky Pollutant Discharge Elimination System (KPDES) Report to Congress on Water Quality (305[b] Report) shows that there are 1477.2 river miles within the Kentucky River Watershed affected by agricultural sources of discharge (nonpoint source—NPS). In order to mitigate the pollution in U.S. waterways including the Kentucky River Watershed, U.S. government conservation programs provide financial incentives for farmers' participation in voluntary pollution control. These programs are also commonly referred to as cost-share programs. Information about the adoption of these programs and best management practices (BMPs) will be important to the achievement of more stringent standards and/or further cost reductions in water quality improvements. Several studies have found that in general, higher levels of education attainment and higher cost-share percentages offered for each BMP correlate with the higher rates of adoption (Paudel et al., 2008; Suter et al., 2008). Higher cost-share percentages offered for BMPs may be one solution for additional adoption of conservation practices. In this study, the adoption of public conservation programs within the Kentucky River Watershed is examined.

Procedures

Data used in this study come from two sources: secondary data collected through various sources of publicly available databases and primary data collected by a producer surveys conducted by the researchers. In the Kentucky River Watershed, there are three main conservation programs: EQIP (Environmental Quality Incentives Program), WHIP (Wildlife Habitat Incentives Program), and CRP (Conservation Research Program). All three programs are administered by the National Resources Conservation Service (NRCS) under the USDA. Information about adoption of these cost-share programs at the county level is available from the NRCS. In addition to the secondary data, the research team conducted a survey to collect producers' BMP practices, farm characteristics, farm operator characteristics, as well as producers' willingness to consider additional BMPs given additional cost incentives. Producers were identified according to their residence county. A system of three fixed-effects regressions can be performed to analyze factors contributing to producers' adoption of conservation programs. The dependent variables of the system of three equations were the amount of cost share incentives received by each farm. The dependent variables included farm and operator characteristics as well as

demographic nature of the various counties producers reside. Since the incentives producers receive were truncated at below at zero. A generalized Tobit model was adopted to estimate all three equations (one equation for each program) simultaneously while considering the fixed effects of producers.

Results

Results generated so far show that the average numbers of farms per county and average farm size per county of the study region have a positive relationship with participation in the CRP. Holding all other factors constant, a county with one additional farm within its border is likely to receive $44.80 more in CRP program payment. This is an expected result as the payment is awarded to a specific farm. The larger number farms indicate larger number of candidates to receive the payment holding other factors unchanged. In addition to the number of farms, holding all other independent variables fixed, if the average farm size of a farm increases by one acre, the CRP payment is projected to increase by $300.92 per year. Thus, counties with more farms and larger farms tend to collect more CRP incentives. Land use type is found to be insignificant for CRP participation. The coefficient estimates for the EQIP and WHIP programs did not show as many significant results as those used to explain CRP. Results also show that farm operators' characteristics may have significant impact on their decisions to participate in government cost share programs.

Summary

The voluntary nature of farmer and landowner participation in conservation programs requires studying the factors that may lead to this participation. Based on the findings from the literature, this study tested the relationships between participation in U.S. government cost share programs and a number of farm and farm operator characteristics in the Kentucky River watershed. Results show that counties with more farms and larger farms will probably have more participation in these programs. Adoption and funding could depend on land characteristics of individual plots of land such as slope and vicinity to water. Although this study comes from the U.S., it also offers an example for other countries or regions to conduct a similar research. In many developing countries, the tension between agriculture and the environment is often a protruding issue facing policy makers. For these countries, how to use an incentive-based program to mitigate the problem and how constituents may respond to such a program can be a discussion involving the experience from many countries in the world.

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ABATEMENT COSTS FOR AGRICULTURAL NON-POINT SOURCE POLLUTERS

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This research estimates the costs of implementing riparian buffer strips on agricultural land in the Kentucky River watershed. These cost estimates are used in analyzing the feasibility of a water quality trading program in that watershed.

Background

Water quality trading (WQT) programs are advocated as an important means to cost-effectively pursue water quality goals (USEPA 2003) and have been introduced in several states (Breetz et al 2004). Although agricultural non-point source (NPS) polluters are generally exempt from federal regulation, some trading programs allow point source (PS) polluters to meet their requirements by purchasing offset credits that reflect reductions in NPS discharges to the same waters (USEPA 2004).

The inclusion of agriculture in a trading program offers two potential benefits. First, since PS pollution is heavily regulated while agricultural NPS pollution is not, significant differences in marginal abatement costs can exist and the inclusion of agriculture can lower the overall expense of achieving water quality levels. Second, water quality targets under the Clean Water Act have not been met in many areas, and a growing share of such impairment is attributed to agricultural runoff (USEPA 2002). Meeting these targets will likely require reducing the impacts of agricultural runoff, and the use of offset credits in a WQT program is a politically feasible approach.

In a WQT setting, agricultural producers receive offset credits, which they can sell to PS polluters, when they implement best management practices (BMPs) that reduce nutrient loads. Producers a expected to undertake such BMPs when the value of the offset credits is sufficiently lower than the BMP cost. Among available BMPs, riparian buffer strips have proven effective in mitigating the movement of nutrients into surface waters (Qiu et al 2006), so estimates of riparian buffer costs would be useful in setting WQT policy.

Methods and Data

We select six counties within the watershed that are characterized by a high proportion of nutrient-impaired waterways and for which a total maximum daily load (TMDL) of pollutants is approved or under development. These characteristics indicate that NPS offset credits might be in demand if a WQT program were implemented.

To estimate costs, we adapt the methodology used by Roberts et al (2009). Potential buffer strip areas are geographically located and their land uses are identified using National Land Cover Data and ArcGIS software. The cost of riparian buffers on cropland includes the opportunity cost of forgone production, as well as the costs of establishing and maintaining the buffer strips. Forgone production returns are determined from cropping practices and soil fertility, using spatially disaggregated data from the Web Soil Survey Database. The cost of riparian buffers on pasture land is derived from average rental rates and the cost of exclusion (fencing), as well as establishment and maintenance expenses. These costs are aggregated to form a supply curve of the buffer strip area that would be supplied at various prices.

Discussion

The results indicate that land currently used for pasture and hay production, as opposed to row crops, is the most important factor in potential agricultural participation in a WQT program. Pasture and hay land accounts for the vast majority of potential riparian buffer area and also possesses much lower opportunity costs. Annualized costs for an acre of riparian buffer are estimated to range from approximately $100/acre to $600/acre and. are highly sensitive to the prices of agricultural commodities.

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POINT SOURCE POLLUTERS IN THE KENTUCKY RIVER WATERSHED AND THE POTENTIAL FOR WATER QUALITY TRADING

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This research provides a profile of point-source (PS) polluters in the Kentucky River watershed. To analyze the feasibility of a water quality trading (WQT) program, the characteristics of the watershed's PS are compared with factors believed to encourage the success of such a program.

Background

Since the enactment of the 1972 Clean Water Act (CWA), point-source polluters (e.g., municipal wastewater treatment plants) have been required to obtain permits and comply with effluent restrictions under the National Pollutant Discharge Elimination System (NPDES). Although significant progress has been made, substantial challenges remain. Reports indicate that up to 64% of assessed surface water bodies remain impaired, unable to support their designated uses (EPA, 2009). The Environmental Protection Agency (EPA), charged with administering regulations under the CWA, supports the use of water quality trading (WQT) programs as a means to address current water quality problems (EPA, 2003).

It is widely held that the marginal abatement costs are lower for non-point source (NPS) polluters than for the heavily regulated PS polluters, so that WQT has the potential to significantly lower the costs of achieving a given level of water quality (Faeth, 2000). However, cost-reduction can occur even when trading takes place among PS with heterogeneous cost structures (e.g., due to differences in age or type of equipment, economies of scale, nature of influents) without participation by NPS. WQT programs also have the potential to increase flexibility and availability of different options for improving water quality and to encourage innovation in related technology. Similar programs related to control of air quality have enjoyed substantial success (Stavins, 1998).

Data and Methodology

The Kentucky Division of Water (KDOW) provided us with PS data regarding NPDES permits and compliance. We build upon the methodologies of Roberts, et al (2008), Kieser & Associates (2004), and Rowles (2005) to delineate potential WQT markets and analyze PS characteristics. We investigate five major components for a successful WTQ

market: environmental suitability, availability of participants, economic incentives, regulatory incentives, geospatial orientation. Particular attention is paid to characteristics related to the objectives and requirements of WQT specified by EPA policy (EPA, 2003). Thus, we focus on nutrient-related impairments, examine PS locations relative to potential NPS participants, analyze potential trading areas corresponding to receiving waters and TMDL boundaries, and allow for non-degradation constraints for individual segments. We also examine alternative regulatory scenarios, to compare trading feasibility under different conditions. In addition, we use GIS software to examine the geospatial connections among PS, NPS, and impaired waters.

Results

Current findings show that PS are non-compliant with total nitrogen as ammonia (TNA) and total phosphorus (TP) requirements in their permits throughout the year, creating potential for water quality trading for these two nutrients on a monthly level. Stricter regulation of TP and TNA point sources, as states try to comply with water quality-based standards, will create more potential for WQT as a mechanism for decreasing the costs of such compliance.

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POINT SOURCE ABATEMENT COSTS AND PREFERENCES FOR TRADING MARKET MECHANISMS IN THE KENTUCKY RIVER WATERSHED

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Objectives

This study aims to understand the current cost structure and preferences for market structures among municipal sewage treatment facilities along the Kentucky River basin in the context of a potential water quality trading (WQT) market. These facilities are Point Source polluters (PS) and may soon be facing stricter regulations in terms of targeted allocated TMDLs which will be set in place by the National Pollutant Discharge Elimination System (NPDES). In order to avoid steep penalties, various PS may need to invest in new equipment to reduce their levels of pollution (Breetz et al. 2005). The first objective in our study is to find out the methods these facilities may be implementing to meet the new requirements, either in the form of purchasing new equipment or by improving the biological/chemical treatment processes. The second goal is to understand the costs, both currently and in the past, for controlling water quality in the Kentucky River. Thirdly, this study attempts to gain an understanding of what market trading mechanisms, given their different implementation schemes and market implications, PS would prefer to take part in. Knowing the methodology used to control water quality, the costs associated, and the preferred market trading mechanism will have direct contribution to assessing the feasibility of WQT.

Background

In Kentucky, The NPDES is establishing a permit program that will be overseen by the Kentucky Department of Water (KDOW) that will limit the allowable amount of pollutants in wastewater. The WQT market is made up of buyers (over-polluters: typically PS) and sellers (underpolluters: typically NPS) who may trade pollution rights. Failure to meet the requirements for a target TMDL will be the driving force behind demand for additional water quality credits by PS. So long as the maximum cost for attaining an additional credit is less than the minimum marginal cost of implementing new technologies, there will be a net gain for PS participating in WQT (USEPA 2004).

In the past, multiple studies have addressed issues involving PS in the context of WQT. However, none has examined PS preferences for potential trading mechanisms. Given the different transaction costs or organizational implications of various trading schemes, PS preferences will likely contribute to the success of WQT.

Data and Methods

This study uses a survey conducted among PS in the Kentucky River watershed. PS addresses and contact information were obtained from the KYDOW. The survey included three main sections. The first section of the survey was designed to get a profile of PS such as their size and service history. The second section of the survey asked for information on the current and historical technology used for water quality control and the associated costs. The third and final section of the survey gathered PS preferences between four potential market mechanisms: Seller/Buyer Negotiations, Government Facilitation, Market Exchange, and lastly Sole-Source Offset. Detailed information about these market mechanisms are presented in the survey using language pre-tested by PS.

Results

The survey is currently in its final stage of completion (completion in four weeks is expected). Preliminary results indicate that in the Kentucky River Watershed, roughly one third of all PS are considered by the EPA as major sources. Depending on the size and location of the PS, they use different pollution reduction methods and the costs involved in implementing these practices vary greatly between facilities. Opinions about preferred market trading mechanisms differ across facilities and even across different managerial personnel within the same facility. These results suggest that there is much more to be understood about PS including their role and preferences in a potential WQT market. Our study will contribute to this discussion.

Discussion

Our study adds to the discussion of establishing tradable water markets to reduce water pollution. Pollutants entering the Kentucky River watershed are discharged into the larger Ohio River watershed which will inevitably contribute to the formation of the hypoxic zone in the Northern Gulf of Mexico which is eradicating aquatic life. This study applies the Coase Theorem and measures the economic feasibility of a WQT market in the Kentucky River watershed from the perspective of PS. Using a survey-based approach, this study will generate discussion both in the theoretical and practical fronts of WQT.

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