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EXPLORING NON-TRADITIONAL PARTICIPATION AS AN APPROACH TO MAKE WATER QUALITY TRADING MARKETS MORE EFFECTIVE

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Abstract

Water quality trading (WQT) has potential to be a low-cost means for achieving water quality goals. WQT allows regulated wastewater treatment plants (WWTPs) facing discharge limits the flexibility to either reduce their own discharge or purchase pollution control from other WWTPs or nonpoint sources (NPSs) such as agricultural producers. Under this limited scope, programs with NPSs have been largely unsuccessful at meeting water quality goals. The decision to participate in trading depends on many factors including the pollution control costs, uncertainty in pollution control, and discharge limits. Current research that focuses on making WQT work tends to identify how to increase participation by traditional traders such as WWTPs and agricultural producers. As an alternative, but complementary approach, we consider whether augmenting WQT markets with non-traditional participants would help increase the number of trades. Determining the economic incentives for these potential participants requires the development of novel benefit functions requiring not only economic considerations, but also accounting for ecological and engineering processes. Existing literature on non-traditional participants in environmental markets tends to center on air quality and only increasing citizen participation as buyers. Here, we consider the issues for broadening participation (both buyers and sellers) in WQT and outline a multidisciplinary approach to begin evaluating feasibility.

Keywords

Water quality trading; Nonpoint source pollution; Non-traditional participants; Nutrients; Water quality economics

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INTRODUCTION

Because excess nitrogen and phosphorus (nutrient pollution) continue to cause major water quality problems like low levels of dissolved oxygen in waterways or increased algal growth that can often produce toxins, federal agencies, states, tribes, and communities are looking for flexible, less expensive ways to mitigate and protect water quality. For years, water quality trading (WQT) has been proposed as a cost-effective approach for achieving water quality goals at watershed scales, especially for reducing nutrient pollution (USEPA 2003; Heberling 2011; National Network on WQT 2015). WQT under the Clean Water Act (CWA) is a compliance option for point source (PS) dischargers, like wastewater treatment plants (WWTPs), to meet their regulatory requirements for pollutant discharge (USEPA 2007; GAO 2017). Nonpoint sources (NPSs) of nutrient pollution, like agricultural producers, are not regulated under the CWA. Therefore, these NPSs do not have requirements for pollutant discharge and nutrient pollution abatement tends to be voluntary (Ribaudo and Gottlieb 2011; GAO 2017). Focusing nutrient pollution regulation only on PSs has led to high costs of abatement and results in limited success towards reaching water quality targets (Wainger and Shortle 2013; Shortle 2017).

In a WQT program, PSs facing discharge limits may reduce their own pollutant discharge by upgrading to a more advanced treatment process or by purchasing credits generated from nutrient pollution abatement (in terms of kilograms of nitrogen or phosphorus controlled) from other upstream PSs or NPSs (USEPA 2003, 2004, 2007). Credits generated from agricultural sources may come from the adoption of best management practices (BMPs) such as cover cropping or adding filter strips. Pollution abatement from such BMPs typically comes at a lower cost per kilogram nutrient removed compared to WWTP upgrades; therefore, PSs have the opportunity to meet their discharge limits at a lower cost. WQT is sometimes referred to as a market-based approach because it allows buyers and sellers to trade credits (creates a demand for and supply of credits). The dashed box in Figure 1 illustrates a WQT market where a WWTP (demand side) purchases credits from an agricultural source (supply side).

The idea of encouraging reduction of nutrient runoff from unregulated NPSs drives much of the interest for WQT (Horan and Shortle 2011; Ribaudo and Gottlieb 2011). However, successful examples of WQT remain limited to groups of PSs with enforceable permit limits (point-to-point trading). There are also examples of trades between a single PS buyer and a small number of NPS sellers that enabled nutrient reduction goals to be met at lower costs (Woodward 2003; Ribaudo and Gottlieb 2011; Fisher-Vanden and Olmstead 2013; GAO 2017). In most cases, even with support from some federal and state agencies, trading with the goal of including NPSs as sellers has not made for a successful compliance option (Selman et al. 2009; Ribaudo and Gottlieb 2011; Stephenson and Shabman 2011).

The reasons that few trades are taking place between PSs and NPSs include high transaction costs, lack of liability transfer, inability to accurately measure NPS abatement, and discharge limits that can be met through on-site PS technology (King 2005; Shabman and Stephenson 2007; Ribaudo and Gottlieb 2011; Ribaudo et al. 2014; GAO 2017; Shortle 2017). Hoag et al. (2017) reason that WQT programs cannot be successful without ideal physical, economic, and institutional environments--finding very few watersheds that fit these necessary conditions.

One solution is to increase demand and supply which will help to increase the number of trades and reduce average transaction costs (Rostek and Weretka 2008). To increase demand or supply, most research has focused on increasing participation of traditional PSs and NPSs, which makes sense given that WQT is a compliance option for PSs. Areas of focus have included improving trust among participants, reducing transaction costs, and considering additional incentives to encourage NPS participation (Breetz et al. 2005; Heberling et al. 2010; Gasper et al. 2012; Shortle et al. 2012; Lentz et al. 2014; DeBoe and Stephenson 2016).

Even these areas have not worked well to improve WQT. As previously mentioned, Hoag et al. (2017) find few watersheds appropriate for trading, so they suggest modifying and adapting programs to work in local conditions. The research we propose does this by going outside of the U.S. Environmental Protection Agency's (USEPA's) traditional framework for WQT (USEPA 2003, 2004, 2007). Having described WQT, its barriers to success, and the largely unsuccessful solutions that have been tried to date, we provide background on an alternative approach for encouraging a broader group of market participants (what we generally refer to as non-traditional participants). We propose specific steps administrators can take to consider broader market participation as a way to increase credit trading, with the goal of more nutrient abatement at watershed scales. These steps are: 1) carefully identifying the make-up of potential market participants, 2) estimating incentives for participants, and 3) addressing common procedural barriers. These steps would comprise a comprehensive and formal WQT feasibility analysis. The analysis must go beyond economic considerations to scientifically support non-traditional participants.

BACKGROUND ON BROAD PARTICIPATION

Encouraging broad participation in environmental markets can be traced back to the original idea of using markets to meet pollution goals (Rousse and Sévi 2013). In fact, Dales (2002: pp. 95–96), who first proposed the idea of markets for water pollution rights in 1968, stated that anyone should be allowed to participate including conservation groups and speculators. However, much of the literature related to broad participation comes from air quality markets (AQMs), and focuses on the participation of citizens, households, or those represented by non-governmental organizations (NGOs) as buyers (Joskow et al. 1998; Malueg and Yates 2006; Israel 2007). AQMs, sometimes called cap-and-trade, differ from WQT in the unit of trade, which is an allowance (Joskow et al. 1998; Shortle 2012). An allowance represents a specified amount of a pollutant that a PS can emit during a year (a tonne of emissions emitted). The number of allowances available in the AQM is set equal to the cap on emissions. With only PSs involved in AQMs, an allowance can be accurately measured as opposed to estimating nutrient reduction from NPSs in WQT.

The retirement of allowances (meaning PSs have fewer to purchase) can help correct excess pollution from an overestimated cap or too many allowances available in the market (Shrestha 1998; Smith and Yates 2003a, 2003b). However, problems such as high transaction costs, uncertainty of damages, and free-riding can limit the participation of citizens. It is well documented that transaction costs can be high and many citizens lack information about how AQMs work, about the prices of allowances, or about the damages from air pollutants (Joskow et al. 1998; Israel 2007; Rousse and Sévi 2013). Free-riding occurs because individuals or firms cannot be excluded from enjoying the benefits of improved environmental quality. Citizens could wait to see what happens in the market, and choose to not participate, but benefit nonetheless. Unlike citizens, PSs do not free-ride in environmental markets because they are regulated (Marshall and Selman 2010).

The fact that citizens participate in AQMs and not in WQT leads to many questions. In addition to high transaction costs and free-riding, part of the reason for non-participation could be that non-traditional participants do not have incentives for purchasing credits (e.g., Heberling et al. 2015). Another reason could be credits produced by NPSs are estimated and have a higher uncertainty than allowances which are measured. The uncertainty about credits could be an issue with non-traditional participants in WQT. Unlike purchasing and retiring allowances, which reduce the enforceable cap in the AQMs, purchasing NPS credits does not affect the individual discharge limits set for PSs in WQT. Purchases of NPS credits by non-traditional participants would effectively increase the abatement at the watershed scale.

Few studies mention the idea of broader participation in the WQT literature. In addition to Dales (2002), Greenhalgh and Selman (2012: p. 121) refer to this as “broadening the scope” by considering urban sources or protecting drinking water sources. The National Network on WQT (2015) identifies conservation groups and corporate buyers as potential outside participants. EPRI (2014) has promoted selling “stewardship credits” to corporate buyers in the Ohio River Basin Trading Program. Fisher-Vanden and Olmstead (2013) looked at existing participants in WQT programs and found only one program that includes an NPS other than agricultural sources (the Neuse River Basin Trading Program that includes the Wetland Restoration Fund as a supplier of credits). Based on the literature, little evidence can be gleaned about the feasibility for WQT.

ADDRESSING THE PROBLEM

We consider broader participation in WQT of both buyers and sellers of credits. Non-traditional sellers can help address limited participation by agricultural sources and non-traditional buyers may be relevant when PSs do not require many credits for compliance. If we want to open up the possibility of non-traditional participants, we must work through important steps that require a multidisciplinary approach and advanced analytical considerations such as applying statistical methods used by economists (econometrics), using watershed and water quality models that account for ecological processes, and understanding engineering principles applied to water treatment or water quality monitoring.

Step 1 - Better Identification of Potential Participants

To begin, we must understand who or what is causing the nutrient pollution and who or what is impacted by the change in water quality. Knowing the sources of nutrients, their relative contributions, and spatial distribution at the watershed scale, we can possibly expand the supply of abatement. This is accomplished by integrating water quality monitoring data with watershed modeling tools, a complex analysis. Identifying the impacted groups and their potential benefits from reducing nutrients can possibly expand demand (Figure 1). This initial step can help find potential participants, but the information is not always easy to acquire or estimate accurately (Howarth et al. 2002; Dodds et al. 2009; USEPA 2015).

The idea of identifying non-agriculture credit sellers such as septic system owners and urban green infrastructure to control stormwater runoff is not new. Woodward (2003), writing about Colorado's Lake Dillon trading program, describes how disconnecting homes from septic systems and connecting them to a WWTP was a way to reduce phosphorus in the watershed and reduce costs for a developer who wanted to expand housing. Other studies, unrelated to improving WQT, have shown homeowners are willing to participate in incentive programs through implementation of stormwater BMPs on their properties (Thurston et al. 2003, 2010).

Identifying new sellers of credits may help to address limited participation of NPSs when there are issues of trust or concerns about privacy--what Motallebi et al. (2016: p. 2) calls “hurdles to implementation” for agricultural producers. Including non-traditional sellers complicates WQT if characterizing the uncertainty of management practices on water quality is difficult. For example, houses on septic systems tend not to be modeled for their impact on water quality (Gassman et al. 2014; Sowah et al. 2014). Characterizing the uncertainty around the abatement and estimating the control costs will improve our understanding of the potential for non-traditional sellers.

For new buyers, by studying previously ignored beneficiaries of improved water quality, we may increase the demand-side of the market. While non-traditional buyers might complicate the market because of the information needed to estimate their benefits for participation, this idea closely resembles incentive-based mechanisms such as payments for watershed services or voluntary markets (Wunder 2005; FAO 2007; Jack et al. 2008; Bennett et al. 2014). Voluntary markets may or may not require regulations for initiation (Pearce 2004; Kline et al. 2009), as people participate in voluntary markets because there is some perceived benefit from paying for protection or abatement (Segerson 2013). We refer to this as a “market development strategy” where new uses are found for nutrient credits (Kardes et al. 2015).

Several non-traditional buyers, including drinking water treatment plants (DWTPs), recreationists, and NGOs, have unique, but compelling reasons to participate. DWTPs might find that protecting their source water is less costly than engineering changes to treatment processes. Recreational users who face human health risks posed by harmful algal blooms or property owners that live near waterbodies impacted by excessive nutrient loadings may be willing to pay to purchase nutrient reduction from upstream sources. Economic studies show these potential participants are willing to pay for improved water quality or to avoid damages (Egan et al. 2009; Walsh and Milon 2016), but it is unclear if other factors such as transaction costs or uncertainty about improvement will prevent their participation. Third parties that represent citizens, such as NGOs (e.g., Trout Unlimited), corporations, or local governments, might purchase credits in order to retire them and further reduce the amount of pollutants for their members, customers, or constituencies (National Network on WQT 2015). Interest in purchasing NPS credits might increase if these potential buyers know what the credits will provide them in terms of benefits from improved water quality. Understanding and accounting for these benefits leads us to the second step.

Step 2 - Estimate Incentives for Participants

After identification, the economic incentive for participation has to be estimated. We have found it is not safe to assume that one exists without analysis (Heberling et al. 2015). We recognize that having the appropriate incentives is only one condition needed for successful implementation (Segerson 2013), but we want to ensure that we do not unintentionally increase the complexity of WQT (Shortle 2012). This is particularly true for non-traditional buyers.

In the process of analyzing the incentives for a DWTP to purchase nutrient credits in an Ohio watershed, Heberling et al. (2015) highlighted a need for an ecologically-informed statistical translation between the amount of phosphorus abated at the watershed scale for the source water of the DWTP and the plant-scale treatment costs related to turbidity. For different non-traditional buyers, we need to translate what reductions in nutrients mean to changes in endpoints that matter to them such as treatment costs for DWTPs, beach closings for recreationists, or water clarity for property owners (Griffiths et al. 2012; Keeler et al. 2012; Heberling et al. 2015). These translation steps provide the economic, ecological, and water quality information needed to make informed decisions, but can be quite complex and require a multidisciplinary approach to complete. Because WQT involves the exchange of credits that are measured in, say kilograms, these additional participants will need to translate what a kilogram of nutrient abatement means to them. Heberling et al. (2015) outline the analytical framework used to determine the cost effectiveness of credit purchases for a DWTP. Similar analytical rigor will be necessary for other non-traditional participants, such as those interested in improving ecosystem services (de Vries and Hanley 2016; Uchida et al. 2018).

Once we have the translation and the benefit estimation for a reduction in watershed loadings, we need to calculate the cost of nutrient credits to meet the reduction (e.g., produced through BMPs on agricultural land or by non-traditional sellers). The comparison of these two estimates quantifies the incentives for the non-traditional participants (determine if benefits of improved water quality are greater or equal to the cost of credits). Of all the potential non-traditional buyers for credits, the incentives for corporations or governments may be the most difficult to estimate. Following the steps described above may not help to estimate the incentives for these third parties. Studying EPRI's (2014) approach for including corporate buyers might help. Programs like the Northern Everglades Payment for Environmental Services, where the buyer was a state agency, may provide insight for the use of public funds (Lynch and Shabman 2011). Although estimating incentives can be quite difficult, we find it necessary before moving forward to the final step.

Step 3 – Fix Common Procedural Barriers

Should incentives exist for non-traditional participants, we need to estimate the change in the market and identify why these groups are not currently participating in existing WQT programs. Calculating the change in the market, based on aggregating individual demand and supply, will help determine if trades will increase and by how much.

Assuming there are no legal constraints on participation, we focus on two commonly cited barriers: transaction costs and free-riding. High transaction costs could make broader participation cost prohibitive (limiting or preventing trades). Modifying existing WQT programs may reduce startup transaction costs because nutrient credits already are defined and trading rules have been established (Alston et al. 2013; DeBoe and Stephenson 2016). However, disseminating information about the market or what a credit means, coordinating among new participants, and developing monitoring and enforcement strategies for non-traditional participants must be addressed—meaning additional transaction costs. To get a better idea of the magnitude of these transaction costs, some studies have used in-person interviews (Peterson et al. 2015; DeBoe and Stephenson 2016; Motallebi et al. 2016). Regardless of the methods, quantifying the transaction costs can be complicated, but will be necessary to estimate a more realistic change in the market.

Free-riding could also be a barrier to participation, especially when PSs are major contributors of nutrient pollution in a watershed and must meet discharge limits whether trading occurs or not. This would be less of a barrier when NPS runoff far exceeds PS discharges because NPSs do not have requirements for discharges.

Within larger groups of non-traditional buyers, like homeowners or recreationists, we would expect to see more free-riding because there is no obligation to participate. Some homeowners or recreationists may wait and benefit from the purchases of others. So, we must consider mechanisms that encourage their participation (Engel et al. 2008). One possible solution could be third party representatives. Newburn and Woodward (2012) found that third party representatives, like soil and water conservation district agents, were useful in assisting farmers with WQT and increasing their participation. Government, as a third party, could collect user fees from recreationists or environmental service fees from homeowners, which could force participation (Hoffman et al. 2006; Engel et al. 2008). Requiring a minimum amount of funding or participation from buyers before credits are purchased, called provision point mechanisms, may also help to avoid some free-riding (Segerson 2013; Uchida et al. 2018). Bottom line, these barriers need to be considered and strategies developed to avoid futile attempts at increasing trades.

CONCLUSIONS

WQT programs that involve NPSs continue to have few credit exchanges. We recommend considering the feasibility of non-traditional participants as one strategy to address this problem. The analysis has to be multidisciplinary and done with rigor to avoid preconceived assumptions that incentives exist. Just because we want it to work does not mean that it will; the incentives have to be appropriately characterized. Proposed research will have to cross the spectrum of different water bodies, sources of pollutants, and impacted individuals or businesses. Previous studies have focused on air pollution, which involves a broader geographic scale with more participants, not limited by watershed boundaries. We have presented a work flow for considering broader participation in WQT whose conditions are different from AQMs, making the lessons learned from AQMs informative but not conclusive.

We have made recommendations for moving forward that consist of identifying potential participants, estimating the incentives for participation, and addressing barriers should incentives exist. Relatively speaking, the first step of identification is the easiest, requiring a rational thought exercise and background data and modeling. The next steps are not trivial and require application of analyses from economics, ecology, and, in certain cases, engineering disciplines. Clearly, these are not the only research needs, but many of the same issues studied for traditional participants could be examined for non-traditional participants. Studying these issues concurrently will potentially reduce the research costs and further improve the assessment of whether non-traditional participants can help make WQT markets more effective.

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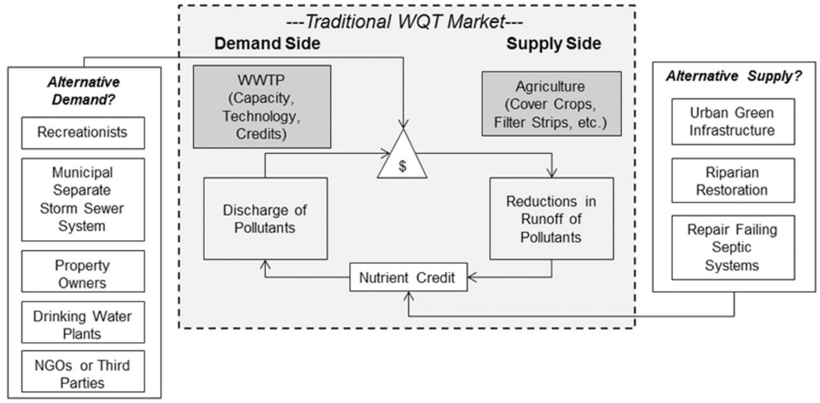

Figure 1.

Conceptual model for augmenting water quality trading (WQT) programs with non-traditional participants. In a traditional WQT program, a wastewater treatment plant (WWTP) has the option to increase its capacity, change its technology, or purchase nutrient credits to meet a discharge limit. An agricultural producer has a variety of best management practices like cover crops, filter strips, or nutrient management to produce nutrient credits. We propose alternative suppliers like urban green infrastructure, riparian restoration, or fixing failing septic systems. If the WQT program does not have enough demand, alternative buyers of credits might be recreationists, municipal separate storm sewer systems (MS4s), property owners, drinking water treatment plants, nongovernment organizations (NGOs), or other third parties that represent groups of citizens or firms.