A System Dynamics Approach to Changing Perceptions about Thermal Water Quality Trading Markets

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ABSTRACT

Thermal water quality trading markets give point source thermal polluters the option to comply with effluent restrictions by paying nearby landowners to plant shade trees. The shade trees cool the water, offsetting thermal pollution emitted by the point source. Thermal trading has the potential to create greater environmental benefits at a lower cost than traditional regulation, however; only one such program has been implemented to date in the United States. In this regard, a shift in potential stakeholders’ perceptions of these markets could be useful in allowing the markets to spread. This paper explains why system dynamics modeling is a useful tool for creating such a shift in perception, and describes a method of teaching participants about thermal trading. The method begins with a classroom simulation exercise, uses lessons from that exercise to create a model of a thermal trading market, and uses that model to conduct policy design and uncertainty analyses.

Keywords: Classroom Simulation Exercise, Policy Design, System Dynamics Modeling, Thermal Water Quality Trading, Uncertainty Analysis

INTRODUCTION

Thermal water quality trading markets have the potential to create desired water temperature reductions at a much lower cost than conventional policy options. Regardless of this benefit, trading programs have not become widespread. Water quality trading has been used to manage various types of pollution in the United States (Breetz et al., 2004), but only recently was the first thermal trading program created, on the Tualatin River in Oregon (Clean Water Services, 2004).

One of the major obstacles to the propagation of these markets is landowner participation. Three major barriers to landowner participation have been identified, including perceived complexity of the markets, uncertainty about the cost and effectiveness of the markets, and lack of knowledge about how other market participants and stakeholders might behave (Hosterman, 2008). A change in the overall social perception of these markets may help to reduce these barriers, therefore encouraging

DOI: 10.4018/jissc.2010070101
the spread of thermal trading as a cost-effective mechanism for decreasing water temperatures. Models allow low-risk exploration of market dynamics under different scenarios and conditions, and can thus be used to make participants more comfortable with their understanding of potential outcomes of the markets. Models also have the potential to reduce the perceptions of complexity and uncertainty that act as barriers to participation in these markets. This paper explains why system dynamics models can be useful in altering the social perception of thermal water quality trading markets, and also describes an approach that used system dynamics models to teach participants about the potential dynamics of these markets.

This approach began with a classroom simulation, designed to teach participants about thermal water quality trading markets and to allow them to experiment with different trading behaviors and strategies. Debriefing sessions held after the classroom simulations gave insight into how participants made decisions, which informed the creation of a model that simulates trading behavior endogenously. This model was used to explore the dynamics of a thermal water quality trading market under different policy design scenarios. The same model was then used to conduct a simple uncertainty analysis for a thermal water quality trading market. This system dynamics model acted as a system for managing the existing information on these markets, and allowed this information to be used to project the potential dynamics of these complicated systems.

**THERMAL WATER QUALITY TRADING**

Thermal water quality trading is an emerging policy tool for managing water temperature. Temperature trading programs give point source thermal polluters the option to comply with effluent restrictions by paying landowners along the same body of water to plant shade trees. The shade trees cool the water, offsetting the thermal pollution emitted by the point source.

Thermal water quality trading programs are likely to use bilateral negotiations market structures, in which the point source and landowner negotiate directly with each other to make trades (Woodward et al., 2002). These markets are also likely to use trading ratios, which weigh different sources of pollution reduction by applying a multiplier to the value of a credit depending on how it was created. To reduce the likelihood of hotspots caused by trading, these policies may also use upstream-only rules, which require each point source to trade only with landowners that are physically located upstream from that source. These markets may allow landowners to sell credits created by other conservation programs, and will generally require landowners to generate some baseline amount of vegetation before they are allowed to sell credits (CTIC, 2006).

Conventionally, water pollution in the United States has been regulated using a command and control approach, in which point sources are issued permits restricting their discharge of specific pollutants. Thermal water quality trading can easily be set up within this system of water quality regulation, by designing pollutant discharge permits so that they allow point sources to comply with regulation through trading.

Trading provides certain benefits over conventional pollution control strategies that make it an attractive means of regulation. First, since planting shade trees is much cheaper than installing refrigeration units onto point sources, trading has the potential to achieve temperature reduction goals in a more cost-effective manner than conventional regulation. A second benefit of trading is the incorporation of nonpoint sources into pollution-reduction policies. A market can create an incentive for landowners, who have not been strictly regulated under conventional water pollution policy, to improve their practices. Finally, shade trees planted through a trading program not only cool the water, but also enhance other ecosystem services by providing riparian habitat, preventing erosion, decreasing nutrient loading, and providing structural fish habitat, among other benefits.
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