Market Incentives and Nonpoint Sources: An Application of Tradable Credits to Urban Stormwater Management

Introduction

Excess stormwater runoff is a serious problem in a large number of urban areas, causing flooding, water pollution, groundwater recharge deficits and ecological damage to urban streams. Solutions currently proposed to deal with this problem often involve large centralized infrastructure and high expense. This research investigates the use of a tradable credit system which relies on market incentives to promote dispersed placement of smaller-scale best management practices for water detention to control excess runoff. We are examining potential cost-savings with this approach, as well as possible market designs.

Background

Excess stormwater flow off impervious surface in a watershed can lead to stream degradation, habitat alteration, low base flows and toxic loading. Researchers at EPA show that a properly designed tradable runoff credit (TRC) system creates economic incentives for landowners to employ best management practices (BMPs) to maintain a waterway "in regime."

The effects of stormwater runoff (SWR) on stream ecosystems are exacerbated by urbanization and the coincident increase in impervious surface in a watershed. Proliferation of impervious surface allows more stormwater from rain events to reach a stream faster causing higher peak flows that can lead to stream alteration and habitat degradation. Furthermore, where impervious surface prevents rainfall from infiltrating the soil, less water is available for groundwater recharge, which reduces stream base flow. Also, depending upon the land use in the watershed, nutrients and toxics can be scrubbed off roadways and parking lots and transported overland and through storm drains into waterways causing toxic loading of the stream.

Methodology

Using individual property level data (such as land use, soil type and BMP cost information) for the 453 parcels in the Shepherd Creek subwatershed in Cincinnati, OH, the researchers demonstrate the TRC methodology with an ArcView GIS-based decision support tool. The TRC methodology uses the USDA - NRCS "hydrologic curve number" system (TR-55) to calculate SWR volume on a property-by-property basis under constraints on stream power and development. Mathematical representation of the property owner's cost minimizing objective is implemented in Excel. Property owners minimize the cost of required SWR abatement responsibility by choosing the least-cost BMP technology suitable to their parcel or by purchasing credits. Those for whom building detention capacity is relatively expensive will purchase storage capacity (or credits) from those for whom BMPs are relatively cheap.

Analysis

The economic aspect of the parcel owner's decision is incorporated thus: Cost functions for the appropriate BMP technology (based on land use and soil type) are assigned to a given parcel in its attribute table in the Excel spreadsheet. A simple algorithm is used to minimize the parcel owner's costs given a credit price and BMP cost function.
At a given per-unit credit price, some parcel owners will desire to build BMPs and some will desire to buy credits (or waivers) as demonstrated in the following figure. The credit trading ratios and credit prices can be varied to analyze different plausible policy scenarios and their effect on the stream.

Tradable Credits — Impacts

- EPA research suggests that a tradable runoff credit system (in some cases on its own, and in some cases in concert with a large-scale engineering solution for control of excess stormwater flow) could lower the cost per ft3 of runoff detention given certain credit prices.

- It suggests that tradable runoff credits can create incentives for the construction of dispersed BMPs. This promotes a stormwater runoff detention strategy more like that found naturally in an undeveloped watershed.

- This study utilizes spatially explicit analysis to transform what was traditionally a non-point source pollution problem to a point source problem.

- This methodology could be generalized for application in other areas of the country to examine options in stormwater management.

Conclusions

Depicted below in ArcView GIS format are parcel-owners that buy, and parcel-owners that choose to sell credits when the price is $8.00 per credit (one credit allows one ft^3 of runoff). At this credit price, in our case study area, 118,100ft^3 of water is detained (96% of the total excess stormwater runoff) at a cost per ft^3 of dispersed storage of $4.97. This compares favorably with our case-study calculations of per-unit cost for either command-and-control ($5.40/$ft^3$) or a large centralized infrastructural solution ($8.93/$ft^3$ - $11.90/$ft^3$).

For more information, contact Pati Schultz at Schultz.Patricia@epa.gov@epa.gov.