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Nutrient farming: The business of environmental management

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Abstract

Restored wetlands could be used successfully to address our recurring problems of excess nutrients (and sediments) and flood damages along U.S. rivers. Credit markets for flood storage, nitrogen, phosphorous, carbon, atrazine, sediment, and many other constituents would economically motivate landowners to restore wetlands. The resulting high-quality open space would provide for recreation, wildlife habitat, and biodiversity. By instigating the market for nitrate-nitrogen, we can jumpstart the entire process of using markets to manage ecosystems. The nitrogen market will create a new land-economics paradigm and new opportunities for landowners, particularly farmers.

Keywords: Nutrient control; Flood control; Restored wetlands; Credit market

1. Introduction

Our nation can address and ameliorate several major ecosystem problems (e.g., flooding, excess nutrients, habitat loss) by restoring wetlands. Restored wetlands can store floodwaters, remove excess nutrients, and provide wildlife habitat. Furthermore, we can finance this restoration by creating nutrient removal credits and selling or trading them to dischargers who need to meet water quality standards. These credits, bought or sold on an open market or through long-term contracts, could offset wetland losses due to agricultural, industrial, commercial, or residential development, while providing high-quality open space for recreation, wildlife habitat and biodiversity. The Wetlands Initiative calls this strategy of creating a marketplace for nutrient credits "Nutrient Farming." In comparison to other credit-based programs that focus on watershed trading opportunities between municipalities (Moore et al., 2000) or point and non-point sources (Johnson et al., 2001), nutrient farming centers on the use of wetlands to remove excess nutrients.

One of the easiest ecosystem commodities to generate, monitor, and manage is aqueous nitrate–nitrogen (NO_3–N). Wetlands do not sequester nitrate; they remove it largely through denitrification (Mitsch and Gosselink, 2000). An anaerobic biological process, denitrification reduces inorganic nitrate (NO_3^-) and nitrite (NO_2^-) to nitrogen gas (N_2). The biological process is dependent on the microbial communities present in the wetlands. Gaseous nitrogen volatilizes, thus ni-

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trogen is eliminated as a water pollutant. Nitrogen gas is relatively inert, so its release to the atmosphere poses no danger; in fact, nitrogen comprises 78% of the atmosphere. To a lesser extent, nitrate is also removed from water by assimilative nitrate reduction, where nitrate is reduced to ammonia, which serves as a nitrogen source for growth by plants, fungi, and bacteria.

A viable nitrogen credit market will readily demonstrate the economic value of land for purposes other than corn production, housing, or commercial development. The nitrogen market will monetize ecosystem services for water quality management. This precedent will facilitate monetizing phosphorous control, flood storage, wildlife management, and many other ecosystem services. The nitrogen market will create a new land-economics paradigm. It will create new financial opportunities for landowners, particularly farmers, and lessen the agricultural community's dependence on government subsidies, while bringing an equitable resolution to the problem of non-point source pollution.

2. Excess nutrients

The modern landscape (e.g., the Upper Mississippi River Basin) suffers from degraded water quality, excessive flood damage, decimated wildlife populations, and declining biodiversity. The impact of landscape modifications in this basin also directly affects other regions. For example, the hypoxic zone in the northern Gulf of Mexico has nearly doubled in size in the past two decades. The hypoxic area averaged 8300 km^2 in 1985–1992 and increased to approximately 16,000 km^2 in 1993–2001 (Rabalais et al., 2002). Explanations for the increased size of the hypoxic zone have varied, but the increase is principally attributed to an almost three-fold increase in nitrogen load to the Upper Mississippi River Basin since 1950 (Goolsby et al., 1999). Hypoxia, or oxygen depletion, is the result of the overenrichment of nitrogen, mainly nitrate–nitrogen, which increases algal production within this aquatic ecosystem. The decomposition of the dead algae leads to the low dissolved oxygen concentrations (<2 mg/L O_2). During the late spring and early summer months, the low dissolved oxygen concentrations force fish and other mobile aquatic organisms to flee the regions of low oxygen, while less mobile organisms are killed. High nitrogen concentrations have been linked to human and ecological health effects, including blue baby syndrome and increased risks of cancer (Weyer et al., 2001). In addition to the excess nitrogen loading, wetland loss and more efficient drainage practices have contributed to the hypoxia problem.

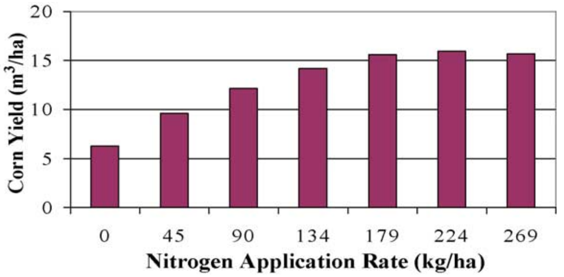

Fig. 1. Effect on corn yield of nitrogen application rate (Hoeft et al., 1999).

Agricultural practices are the principal sources of nitrogen to the basin as the use of commercial fertilizers, the application of manure, and the production of legumes (e.g., soybeans) contribute to the increased nutrient concentrations (Goolsby et al., 1999). In the Mississippi basin, 31% of the nitrogen load to the Gulf of Mexico comes from the fertilizer applied to agricultural lands. Corn yields have increased as nitrogen fertilizer application rates have increased (Fig. 1). Hoeft et al. (1999) found a 2.5 increase in corn yield with application of 224 kg/ha (200 lbs/acre) of nitrogen fertilizer compared to crops with no fertilizer. This increase in yield is not merely theoretical; annual use of nitrogen fertilizer has increased six-fold since 1950 in the Mississippi–Atchafalya River Basin (Fig. 2).

While use of nitrogen-based fertilizers in the basin has increased, so has hydraulic efficiency of the

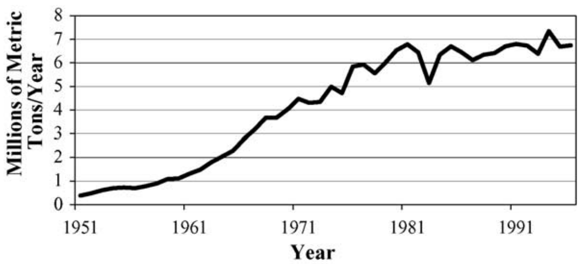

Fig. 2. Annual nitrogen input from fertilizer, Mississippi–Atchafalaya River Basin (Goolsby et al., 1999).