



# Reducing Nutrient Losses From Cropland in the Mississippi/Atchafalaya River Basin: Cost Efficiency and Regional Distribution

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## What Is the Issue?

Every summer, a large area forms in the northern Gulf of Mexico where dissolved oxygen becomes too low for many aquatic species to survive. This “hypoxic zone” is fueled by nutrient (nitrogen and phosphorus) losses from the Mississippi/Atchafalaya River Basin (MARB), a region containing about 70 percent of U.S. cropland. Research has established that nitrogen (N) and phosphorus (P) loadings into the Gulf originate largely from cropland, with agriculture contributing about 60 percent of N and nearly half of P. The Mississippi River Gulf of Mexico Watershed Nutrient Task Force, comprised of State and Federal agencies and led by the U.S. Environmental Protection Agency (EPA), established a goal to reduce the average size of the summer hypoxic zone from 5,236 square miles (current 30-year average) to 1,931. Achieving this goal could require a reduction in nutrient loads to the Gulf by 45 percent or more, which could have significant economic impacts on producers and consumers.

## What Did the Study Find?

We modeled changes that would achieve a 45-percent reduction in N and P loads from cropland to the Gulf at least cost to producers and consumers. The analysis considers two policy implementation scenarios. One focused only on reducing overall nutrient loads to the Gulf, regardless of where those nutrients originated (“Gulf Constraints”). Another met this same goal by requiring a 45-percent reduction in N and P loadings from each of 135 subregions (REAP model production regions) within the Mississippi/Atchafalaya watershed (“Regional Constraints”), thereby potentially addressing both Gulf and local water quality objectives.

- ***The most cost-effective method to meet the Gulf goal focuses nutrient-reduction efforts in the Lower Mississippi sub-basin.*** While the largest baseline contributors to nitrogen deliveries to the Gulf are the Ohio and Upper Mississippi Basins, with more than 60 percent of baseline nitrogen loadings, the Lower Mississippi accounts for more than 43 percent of N and P load reductions to the Gulf under a cost-effective strategy for hypoxia control. Costs per unit of nutrient reduction are lower here than in other regions, in part because of proximity to the Gulf and less opportunity for instream removals of N and P as nutrients flow to the Gulf.
- ***Addressing both Gulf and local water quality objectives would spread the conservation effort more evenly among sub-basins.*** The total cost of reducing nutrient discharge to the

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Gulf would be higher as more treatment occurs in areas with higher nutrient-reduction costs. However, local water quality benefits (beyond reducing Gulf hypoxia) would likely occur as total nutrient discharges decline across the basin.

- ***Providing incentives for the reduction of a single nutrient (N or P) results in some reduction of the other nutrient.*** The strength of the association varies regionally, and the effect is greater when N is the targeted nutrient.
- ***Implementing nutrient-reduction measures to meet Gulf hypoxia goals would reduce commodity production and increase commodity prices.*** MARB cropland in production would decline by 4.4 percent under the Gulf constraints and 10.9 percent under the regional constraints. As a result, the prices of most crops would rise, with some major crops growing up to 10 percent costlier under the Regional Constraints scenario. Higher prices would partially offset the costs to crop producers of reducing nutrient loads and pass some of the cost on to consumers of agricultural products, including livestock producers, food consumers, and biofuel feedstock users.
- ***Higher commodity prices lead to an intensification of production in regions outside the MARB.*** Without additional constraints on nutrient loadings to water bodies outside the MARB, non-MARB cropland in production expands by 2.1 to 4.0 percent. As a result, nutrient and sediment losses increase 1.2 to 5.0 percent across non-MARB regions.
- ***The least-cost strategy for nutrient reduction within the MARB involves a mix of on-field and off-field conservation practices.*** Optimally placed wetlands and buffers generally provided the most cost-effective nitrogen reductions to the Gulf. Drainage water management, nutrient management, and cover crops, when used with structural erosion controls, were also generally relatively cost effective.

Financial incentives to farmers would likely be required to achieve the range of conservation practices and the scale of nutrient reduction necessary to meet Gulf hypoxia goals, particularly where the benefits of the nutrient-reduction practices occur primarily off the farm. An analysis supplemental to the REAP analysis explores how a nutrient-compliance policy for USDA farm program benefits could incentivize farmers with excess nitrogen applications to implement improved nutrient management. Farms with the highest excess application rates tend to receive the most program payments per acre, suggesting that a nutrient-compliance policy could effectively reduce nutrient runoff. However, nutrient management is most likely to be adopted in sub-basins that contribute fewer nutrients to the Gulf, reducing the overall impact on Gulf water quality from this policy alone.

## **How Was the Study Conducted?**

The study used the ERS Regional Environment and Agriculture Programming (REAP) model to identify the combination of conservation practices, crop rotations, tillage, irrigation, and land-use change that meets nutrient-reduction goals at least cost. Data from USDA's Conservation Effects Assessment Project (CEAP) were used to evaluate the environmental and economic impacts of applying conservation practices on agricultural lands. Nutrient-delivery coefficients developed by USDA's Agricultural Research Service (ARS) were used to estimate the share of edge-of-field nutrient losses from across the MARB that reaches the Gulf. ERS researchers used the REAP model to estimate the mix of conservation strategies and farm production changes across the MARB region that would reduce nitrogen and phosphorus loads from agriculture to the Gulf of Mexico by at least 45 percent at the lowest total cost to producers and consumers. Additional nutrient compliance scenarios draw on data from the 2012 Census of Agriculture and from USDA conservation, commodity, insurance, and disaster programs to estimate excess nutrient use (above crop needs) and program benefits at the farm level.