**Evaluating Alternative Options for Managing Nitrogen Losses from Corn Production**

Jing Liu, Thomas Hertel, Laura Bowling, Chris Kucharik, Sadia Jame and Navin Ramankutty, along with other collaborators, as needed

**Introduction**

Deteriorating water quality caused by nonpoint source nutrient pollution leads to wide-ranging impacts include eutrophication, biodiversity loss, and negatively affected human health. A variety of conservation practices have been suggested to abate nutrient loading from farming. However, a growing consensus suggests that no single practice is sufficient to meet the water-quality goals. In this paper, we compare the effectiveness and penalty (in terms of crop yield loss) of combinations of rate reduction, nutrient management, controlled drainage, and wetland restoration. We find that the trade-off between environmental and economic objectives vary considerably across space and among different policies, suggesting the importance of coupling targeted conservation tools to minimize the trade-off.

**Method**

An endogenous nationwide leaching charge is applied to target the 45 percent reduction in total nitrogen loads flowing into the Gulf of Mexico, while implementing various best management practices. Yield and nitrate leaching responses to N fertilizer application provided by an agro-ecosystem model Agro-IBIS are incorporated into a fine-resolution economic model SIMPLE-G-US, such that the profit maximizing farmers decide the optimal N fertilizer use to lessen the penalty from either the leaching charge or crop yield loss. The geographical scope of the conservation practices is guided by the feasibility maps of these practices. Built upon a previous study by Liu et. al (2018), the current paper improves the modeling framework by considering different crop rotations and the seasonality of nitrate removal by controlled drainage and wetlands.

**Preliminary results**

* Leaching reduction outcomes are highly spatially concentrated, suggesting that water quality can be improved by targeting high-contributing parcels.
* Among the four practices studied, rate reduction is requires prohibitive leaching charges. However, when paired with other policies, the leaching charges are greatly diminished.
* Wetland restoration appears to be the most effective policy, followed by controlled drainage.
* Conservation recommendations should be location specific, depending on the marginal productivity of Nitrogen, the marginal rate of leaching reduction, as well as the feasibility of the practice.

**Next steps and extensions**

Future work will be directed to further improving the spatial heterogeneity of the model and addressing the limitations of the present study. The main idea is to introduce a leaching charge that is site-specific instead of uniform. We hypothesize that the penalty induced by the leaching charge should correspond to the marginal damage of pollution. A uniform leaching charge ignoring this linkage decreases the efficiency of the policy. In order to improve assessing the marginal damage by location, we consider the following two extensions:

* + Link pollution damage to the amount of pollutant eventually delivered to the Gulf, rather than the amount leaving the root zone. SIMPLE-G exported root zone leaching will be passed to the InVEST model to quantify the landscape-based delivery from farm land parcels to the nearest stream. Then we rely on the WBM model to simulate the transportation of the pollutant via stream and the final load delivered to the coastal area.
  + Measure pollution damage by the social cost of Nitrogen that varies remarkably across space even given the same nutrient load.