Evaluating Management Options: Simulating Wetland Processes and Performance of Nutrient Reduction by Use of a Water Quality Algorithm

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My first trip to Purdue was for a job interview with the Radiological & Environmental Management (REM) department, where I would have the opportunity to bring my field experience in hydrogeology to assist the university with environmental compliance issues. I quickly learned that Purdue has a breadth of diversity in many aspects, and I wanted to expand that knowledge through ESE. Over the course of more than three years of working with the university and developing my research I have had the privilege to learn from and work with outstanding Faculty and Staff in science, engineering, and computer technology. We have brought these disciplines together to help bridge gaps through communication and create environmental awareness, which I feel accurately represent the tools you obtain in the ESE program.

The effects of nutrient overloading have been well identified in areas such as the Gulf of Mexico, where agricultural drainage from the Midwest is considered a main contributor to the hypoxic zone. Amongst the suite of agricultural Best Management Practices (BMPs), managed wetlands may present a more cost effective approach to assimilate pollutants and improve water quality at the scale of small watersheds. However, previous research has yielded varying results. Mathematical models have become a tool used to characterize components and predict behaviors of a given process. Model results can then be used to analyze multiple management options, improve decision making, and potentially reduce costs. This research evaluates multiple management options at a natural wetland by developing and implementing a wetland water quality algorithm within the Variable Infiltration Capacity (VIC) model.

The successful implementation of the water quality algorithm enabled the following management options to be further explored for nitrate and soluble reactive phosphorous (SRP) reduction: 1) establishing plant variety within the wetland, 2) management of water level to increase water storage, and 3) water storage and reuse for crop irrigation. Model simulation results revealed that water storage and reuse for irrigation is the best management option for nitrate reduction with a decrease in load of -38.8%. Though caution should be taken during its operation to appropriately manage desorption processes increasing SRP concentration, and ensuring pumping rates are set at a sustainable level to avoid reducing the hydroperiod and causing potential harm to the surrounding wetland ecosystem. The best management option for SRP reduction was the implementation of wetland species with high plant uptake values similar to that of the Iris pseudacorus L. (paleyellow iris), which decreased the SRP load by -2.46%. The overall best management option is water storage and reuse for crop irrigation which provides both environmental and economic benefits.