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Development of a multi-objective optimization tool for the selection and placement of BMPs for pesticide control

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Abstract:

Best management practices (BMPs) have been proven to effectively reduce the nonpoint source (NPS) pollution loads from agricultural areas. Pesticides (particularly atrazine used in corn fields) are one of the common causes of water contamination in many of the water bodies in the Midwestern USA, sometimes exceeding the 3 ppb threshold for drinking water during the cropping season. Candidate BMPs that could effectively control the movement of atrazine include buffer strips and land management practices such as tillage operations. However, selection and placement of BMPs in watersheds to achieve an ecologically effective and economically feasible solution is a daunting task. BMP placement decisions under such complex conditions require a multi-objective optimization algorithm that would search for a number of feasible solutions that satisfy the given objectives. Genetic algorithms (GA) have been the most popular optimization algorithms for the BMP section and placement problem. However, most previous work has considered the two objectives, i.e., minimization of pollutant load and related net cost of BMP implementation, individually during the optimization process by introducing a constraint on the other objective, therefore decreasing the degrees of freedom to find the solution. Most optimization models also used a dynamic linkage with the water quality model, which increased the computational time considerably, thus restricting application to field scales or relatively small (11 or 14 digit HUC) watersheds. In the present work, the optimization for atrazine reduction is performed by considering the two objectives simultaneously using a multi-objective genetic algorithm (NSGA-II). The model was used for the selection and placement of BMPs in the Wildcat Creek Watershed (USGS 8 digit [05120107] HUC), Indiana, for atrazine reduction. The most ecologically effective solution from the model had an atrazine concentration reduction of 30% from the base scenario with a BMP implementation cost of $10 million in the watershed. The pareto-optimal fronts generated between the two optimized objective functions can be used to achieve desired water quality goals with minimum BMP implementation cost for the watershed.

Impact Statement:

The project has developed an innovative BMP optimization tool that can be used to efficiently optimize selection and placement of BMPs in agricultural watersheds to maximize water quality improvement with minimum BMP cost.

Category: Agricultural BMPs
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