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Optimal Placement of Conservation Practices Considering both Economic and Water Quality Effects

This research is part of a large Conservation Effects Assessment Project whose overall goal is to integrate economic and water quality modeling capability to study the effects of conservation practices at the watershed scale. In this paper, we study the optimal placement of a set of conservation practices in the Sny Magill watershed in Northeast Iowa. From an economic standpoint, the optimal combination of conservation practices and their location is the spatial configuration of practices that achieves the water quality target at the least possible cost. Unfortunately, studying the least cost solution in this context is more challenging than in many other environmental problems. Due to the unique nature of the biophysical relationship between conservation practices and resulting water quality levels the effectiveness of a given conservation practice on a given field depends on the placement of other conservation practices and cropping systems, in the watershed. Additionally, multiple conservation practices exist for each field in the sense that there are a potentially large number of conservation practices that could be implemented on each field. This means that solving for the least-cost solution requires comparing a very large number of possible land use scenarios. Specifically, if there are “N” conservation practices possible for adoption on each field and there are “F” fields, this implies a total of NF possible configurations to compare. In a watershed with hundreds of fields and more than a couple of conservation practices, this comparison quickly becomes unwieldy. Fortunately, the recent development of genetic algorithms provides a solution strategy for just this sort of problem. Genetic algorithms mimic the process of evolution, which, in effect, is a method of searching for solutions among an enormous amount of possibilities. In this application, we use the water quality model, SWAT, in conjunction with detailed information on conservation practices, to calibrate the water quality model to flow, sediment, and nutrients for the Sny Magill Creek Watershed. The genetic algorithm is applied to the SWAT model to find an allocation of conservation practices that minimizes the costs of achieving a given water quality target. Several water quality targets are studied so that the costs of achieving different water quality standards can be compared. The watershed covers over 9,000 ha; land use in the watershed consists of forest (48.9%), pasture (23.9%), and cropland (25.9%). Sediment lost from the agricultural landscapes has been identified as the primary source of water-quality impairment in the SMCW. Nutrient losses to the stream system are a secondary source of impairment. A data set describing the extent and location of numerous conservation practices for the watershed have been collected at the CLU scale for the Sny Magill watershed. The set of practices include contour farming, field buffers, contour buffers, terraces, reduced tillage, and land

retirement (CRP). Economic data on the costs of these practices have been collected and are used in conjunction with the SWAT model to solve the least cost solution described above.

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