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An uncertainty analysis based framework to evaluate and optimize the best management practices

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Best management practices (BMPs) are proven as effective measures to reduce Non-Point Sources (NPS) pollution. The selection and placement of BMPs in a watershed scale are an optimization problem which is highly non-linear, multi-condition constrained, and notably complex. Recent research focuses on the improvement of the optimization techniques for more efficiently approaching the optimal solution sets. However, the uncertainty in the assessment of BMPs effectiveness is often overlooked, which will be propagated into the optimization process and then increases the risk of exceeding the water quality criterion. In this study, four types of BMPs, including measures for source reduction (e.g., fertilizer management), measures relating to upland interception (e.g., terraces and strip cropping), filtering strips (e.g., vegetated strips and grassed waterways), and detention based practices (e.g., sedimentation basins and constructed wetland) are considered. Preliminary selection of BMPs is performed based on underlying surface characteristics and social requirements. A coupled model combining the Hydrological Simulation Program Fortran (HSPF) model, k-C* model, and filter strip model is then developed for the evaluation of the BMPs effectiveness. Then the parameter uncertainty in the evaluation process is identified and quantified to obtained the probability distribution function for individual BMPs. Incorporating the confidence interval and BMPs uncertainty, the Chance constrained goal programming model combined with the NSGA-II method is proposed to optimized the spatial distribution of BMPs in an event-based condition and at the watershed scale. The effectiveness and cost of each BMP are determined as the random variables. The object of the optimization is to minimize the costs of BMPs and the constraints are: 1) the reduction of NPS pollutants is not higher than the water quality criteria under a specific confidence interval; 2) the number of the selected BMPs in each land segment is reasonable. The NSGA-II method is incorporated to search for the optimum solution.