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OPTIMIZATION MODELLING FOR THE SELECTION OF AN ABATEMENT PROGRAM FOR DIFFUSE AGRICULTURAL POLLUTANTS

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Agricultural nonpoint source nutrient loadings are characterized by the difficulty and cost for their control, the large areas involved and the variable characteristics of these areas. In order to identify a least-cost remedial measures scheme from the wide variety of abatement measures available for agricultural watersheds, an efficient selection scheme is required.

In this research, a general linear programming (LP) model is presented which can aid in the selection of a cost-effective agricultural nonpoint source nutrient abatement program. A large number of remedial measures can be analyzed within the LP framework and a least-cost program of a combination of these measures is selected such that specified instream nutrient concentration criteria are satisfied. The selected abatement strategies considered in the modelling include:

(i) sound management practices
(ii) strip-cropping
(iii) vegetative buffer strip
(iv) winter cover crops
(v) delay plowing until spring
(vi) urban nonpoint source control - level 1
(vii) urban nonpoint source control - level 2
(viii) contour plowing
(ix) no-tillage cultivation
(x) change continuous corn to a corn-hay rotation
(xi) change silage corn to grain corn
(xii) change corn to permanent pasture
(xiii) use of slow release fertilizer
(xiv) plow under fertilizer

The model isspecially formulated to identify the optimal implementation of remedial measures within specified subareas of the watershed. Special consideration is also given to the interactions between decision variables (e.g. both (ix) no-tillage cultivation and (xiv) plow under fertilizer cannot be applied simultaneously); these concerns normally require the use of a nonlinear optimization technique.

An application of the LP model to a small agricultural watershed in Southern Ontario is presented. A least-cost nutrient abatement scheme was selected for several different levels of constraint on instream concentrations of phosphorus and nitrogen. The remedial strategy was selected from fourteen nonpoint source abatement measures and an option for point source loading

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reductions at a municipal wastewater treatment plant located within the basin. The nonpoint source measures included agricultural management practices such as contour plowing, strip-cropping, zero-tillage and the use of buffer zones.

A multi-objective analysis is considered for the study watershed to assess a hypothetical case of government subsidies for application of four of the nonpoint source remedial measures. Results showed that the abatement strategy selected may be changed substantially when government-sponsored alternatives are included in the analysis.

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