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A spatial optimization approach to watershed water quality management in the Opequon Watershed, WV

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Abstract Text:

The main objective of this study is to develop an integrated spatial optimization model for water quality by integrating optimization techniques and GIS. The integrated model consists of three submodels; a cost-minimization model, water quality modeling at the sub-watershed level, and a water flow network model at the watershed level. The research will analyze sub-watershed prioritization for nutrient (Nitrogen and Phosphate) pollution at minimum cost and recommend best management practices (BMPs). Local communities' perspectives and aspirations will be incorporated in the GIS analysis and the management of the watershed.

The study area is the Opequon watershed located in northern Virginia and the eastern panhandle of West Virginia. Throughout the watershed, rapid growth and development is being experienced (especially the Washington-Baltimore Metropolitan Area) causing additional strains on the environmental resources. The watershed has mixed land uses of urban areas, agriculture lands and a significant forest cover. High levels of bacteria, benthic and biologic impairment has resulted in several creeks in the watershed not meeting state water quality standards (WVDEP, 2005). Consequently, a Total Maximum Daily Load (TMDL) plan has been developed and is in the process of being implemented in the Opequon watershed.

Data for the study will combine households and stakeholders' surveys, Nitrogen and phosphate pollution monitoring data and conventional GIS data (land use, hydrology, infrastructure, soils and elevation). The expected key outcome of this research will be an integrated spatial optimization model for watershed nutrient reduction and management. The model can be extended to total maximum daily loads (TMDL) implementation strategies at a minimum cost.

Impact Statement:

The research contributes to advancing knowledge in water quality management and can be used in formulating strategies to improve water quality and for watershed policy reform.