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Allocating reforestation areas for sediment flow minimization: an integer programming formulation and a heuristic solution method

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Abstract

Policy and decision makers dealing with environmental conservation and land use planning often require identifying potential sites for contributing to minimize sediment flow reaching riverbeds. This is the case of reforestation initiatives, which can have sediment flow minimization among their objectives. This paper proposes an Integer Programming (IP) formulation and a Heuristic solution method for selecting a predefined number of locations to be reforested in order to minimize sediment load at a given outlet in a watershed. Although the core structure of both methods can be applied for different sorts of flow, the formulations are targeted to minimization of sediment delivery. The proposed approaches make use of a Single Flow Direction (SFD) raster map covering the watershed in order to construct a tree structure so that the outlet cell corresponds to the root node in the tree. The results obtained with both approaches are in agreement with expert assessments of erosion levels, slopes and distances to the riverbeds, which in turn allows concluding that this approach is suitable for minimizing sediment flow. Since the results obtained with the IP formulation are the same as the ones obtained with the Heuristic approach, an optimality proof is included in the present work. Taking into consideration that the heuristic requires much less computation time, this solution method is more suitable to be applied in large sized problems.

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