Investigating the Scale Effect of Watershed Delineation on Local Multi-Criteria Method for Land Use Evaluation

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Land use evaluation for semi-natural habitats is a land performance process involving careful consideration of several environmental factors to balance the preservation of nature and wildlife while considering the need for agricultural production.Sincemultiple criteria are involved in the evaluation process, and many areas are subject to high heterogeneity of land characteristics (criteria), local multi-criteria evaluation (MCE) is a suitable approach to solving this decision making problem. As opposed to global MCE, the local approach explicitly accounts for the local variability in evaluation criteria within defined local units of analysis (subregions). Moreover, criteria weights are also assumed non-stationary and are standardized based on the local extreme values within these subregions. In a study of local MCE presented here, watershed delineations are selected for the local unit of analysis, since they reflect the hydrologic principles and are widely applied as a logical unit of land management. The sub-watershed delineations, however, influence how differences in expected decision option outcomes at a large scale (small area) impact the solution of a local model as compared to a global model. Additionally, the quality of the decision support relying on MCE output can be significantly improved by assessing the uncertainty associated with the decision problem. The interaction between the decision model input and output is key information for establishing the level of confidence in the evaluation outcome. Especially, the reliability of outcomes becomesa crucial requirement when the model output is used for decision making affecting environmental sustainability.

An integrated approach to uncertainty and sensitivity analysis (iUSA) can help uncover the sources of uncertainty through the analysis and visualization of input-output relationships captured by sensitivity analysis. This research reports on a study of a local MCE approach followed by uncertainty and

sensitivity analysis of land prioritization model for conservation practices. The relationship between the results of uncertainty-sensitivity analysis and different scales of analysis units is investigated in the local MCE model. The comparison of suitability and uncertainty maps for each scale of land unit is made using the coefficient of variation values per parcel and the relative change in the overall rank. Finally, sensitivity maps are combined into dominance maps by using output variability (first-order) and interaction (total-order) maps. The overview of the implementation is illustrated in Figure 1.

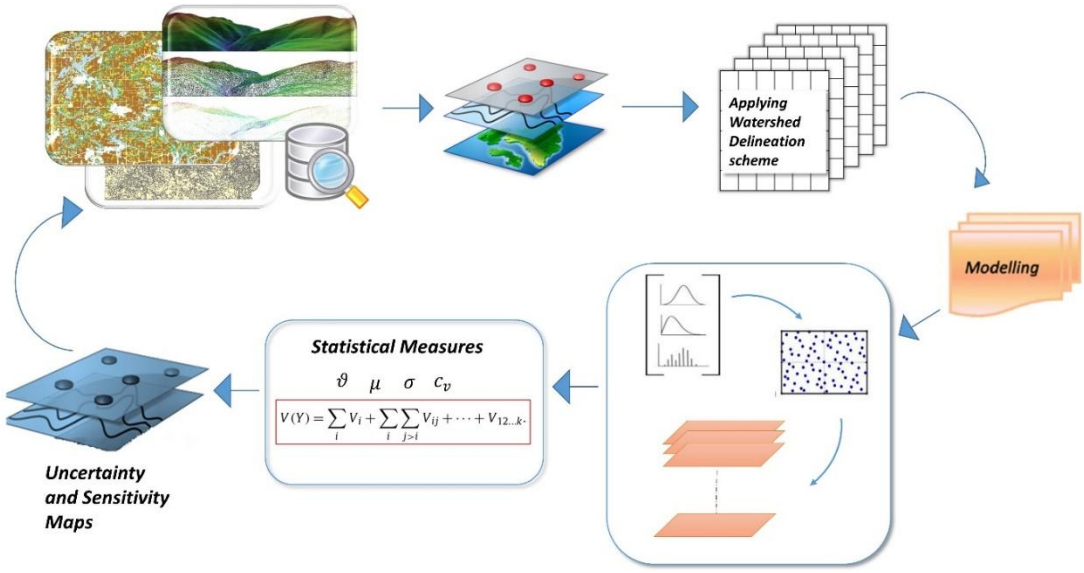

Figure 1. Graphical Abstract of the Framework

The iUSAapproach goes beyond the conventional practice of one-at-a-time (OAT) sensitivity analysis by providing spatial uncertainty and sensitivity maps. Moreover, two different granularity levels of delineations for local MCE used to calculate land parcel suitability show that it is insightful to examine the effect of scale on the stability of MCE model output. A potential practical application of the presentedapproachis the improved analytical support for land suitability evaluation requiring an explicit consideration of multiple decision alternatives.

Keywords: GIS, Local Multi-Criteria Evaluation, Uncertainty Analysis, Global Sensitivity Analysis, Scale Effect