Can integrated ground water vulnerability mapping tool facilitate sensitivity analysis in a spatial domain?

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Modeling ground-water vulnerability reliably and cost effectively from non-point source pollution at a regional scale remains a major challenge. In recent years, Geographic Information Systems (GIS), neural networks and fuzzy logic techniques have been used in several hydrological studies; however, very few of these research studies undertook an extensive sensitivity analysis. Therefore, the overall objective of this research was to examine the sensitivity of neuro-fuzzy models used to predict ground-water vulnerability in a spatial context by integrating GIS and neuro-fuzzy techniques. The specific objectives were to assess the sensitivity of neuro-fuzzy models by varying (i) input parameters and, (ii) training parameters (shape of the fuzzy sets). The research reports a case study of Woodruff County, located in the Mississippi Delta part of Arkansas, US. This County was selected for its extensive agricultural landuse and the presence of underlying sand and gravel (alluvial) aquifer.

The neuro-fuzzy models were developed using NEFCLASS-J software in a JAVA platform and were loosely integrated with a GIS. Various plausible parameters that are critical in transporting contaminants in and through the soil profile to the ground-water included depth to ground water, recharge of the ground water, thickness of the claycap, soil drainage class, soil hydrologic group, depth of the soil profile, soil structure, slope, aquifer media, hydraulic conductivity and landuse. Water quality data from 55 wells were

used for validation of the models. Bentazon was the most commonly found contaminant. In order to validate the model predictions, coincidence reports were generated among model inputs, model predictions and well contamination data for pesticides. A total of 27 neuro-fuzzy models were developed. The sensitivity analysis showed that neuro-fuzzy models were sensitive to the shape of the fuzzy sets used during the training process, and input data layers used in the models. Compared to the bell- and triangular-shaped, the neuro-fuzzy models with the trapezoidal membership function were the least sensitive.

Key Words: GIS, GPS, pesticides, modeling, neuro-fuzzy

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