Application of Neuro-Fuzzy Techniques to predict ground water vulnerability

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ABSTRACT

There is a need to develop new modeling techniques that assess ground water vulnerability with less expensive data and robust when data are uncertain and incomplete. The specific objectives of this research were to (1) develop models using Neuro-fuzzy techniques and GIS to predict ground water vulnerability in a relatively large watershed, (2) examine the sensitivity of the Neuro-fuzzy models by changing model parameters, and (3) determine the effects of the size of the training data sets on model predictions.

The Neuro-fuzzy models were developed in a JAVA platform using four plausible parameters that are critical in transporting contaminants in and through the soil profile including soil hydrologic group, depth of the soil profile, soil structure (pedality points) of the A horizon and landuse. The models were validated using nitrate-N contamination data. The majority of the highly vulnerable areas predicted by the models coincided with agricultural landuse, moderately deep and deep soils, soil hydrologic group C and high pedality points. Compared to the bell- and triangular-shaped membership functions the models with the trapezoidal membership function were less sensitive to the various permutations and combinations of the model/training parameters. Neuro-fuzzy approaches were sensitive to scale/size of the training data set.

From this research it is evident that NEFCLASS-J supports the user but cannot do all the work because a precise and interpretable fuzzy classifier can hardly be found by an automatic learning process. It needs experts' opinion and tuning. Comparisons between well location (point) and vulnerability categories (spatial) should not be used to determine the usefulness of the Neuro-fuzzy models in an absolute sense.

The proposed methodology has potential in facilitating ground water vulnerability modeling at a regional scale and can be used for other regions, but would require incorporation of appropriate input parameters suitable for the region.