

Evaluating uncertainty of ground-water vulnerability predictions using Latin Hypercube sampling

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Abstract. Many regional ground-water vulnerability assessments have incorporated multivariate logistic regression models within a geographic information system (GIS) to make empirically based predictions of non-point source contamination. However, uncertainties associated with such predictions are rarely addressed. Uncertainty is one measure of confidence surrounding vulnerability predictions and it needs to be defined in order for decision-makers to make informed decisions regarding resource monitoring or remediation. A method for quantifying prediction uncertainty from a logistic regression and GIS model is presented using results from a recent ground-water vulnerability assessment of the High Plains regional aquifer. The prediction uncertainty of this ground-water vulnerability assessment was largely a function of errors from spatial uncertainty of GIS-based explanatory variables and estimated coefficients from the calibrated logistic regression models. These errors were incorporated into vulnerability predictions using Latin Hypercube sampling. This sampling technique was selected over conventional Monte Carlo methods because of a stratified sampling of the input probability distribution that enables a more accurate and faster convergence with fewer iterations. Results of the uncertainty analysis are presented as 95% prediction interval maps and illustrate the spatial variability of prediction uncertainty. An analysis of the relative contribution of uncertainty of the regression coefficients to the total prediction uncertainty is presented, and identifies specific areas of the High Plains regional aquifer where additional monitoring wells should be located to most effectively reduce prediction uncertainty of ground-water vulnerability.

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