Abstract: Contamination of ground water has been a major environmental concern in recent years. The potential for ground-water contamination by pesticides depends on porous media, solute, and hydrologic parameters. Although sophisticated deterministic computer models are available for assessing aquifer-contamination potential on a site-by-site basis, most deterministic models are too complex for vulnerability assessment on a regional scale because they require input data that are spatially and temporally variable, and which may not be available at this scale. Therefore, development of an affordable model that is robust under conditions of uncertainty at the watershed scale with minimum input of field data becomes a useful ground-water management tool. The purpose of this study was to examine the usefulness of fuzzy rule-based techniques in predicting aquifer vulnerability to pesticides at the regional scale. The objectives were to (1) develop fuzzy rule-based models using the same input parameters contained in an index-based model (i.e., the modified DRASTIC model), (2) determine the sensitivity of fuzzy rule model predictions, (3) compare the outputs of the fuzzy rule-based models with those of the modified DRASTIC model and with the results of aquifer water-quality analyses, and (4) examine the spatial variability of field parameters around contaminated wells of the Alluvial aquifer in Woodruff County Arkansas. The fuzzy rule-based model for objective (1) was developed using similar parameter weights and ratings as the modified DRASTIC model. For objective (2), fuzzy rule-based models were created using fewer parameters than the modified DRASTIC model. Sensitivity of the fuzzy rule-based models was determined using different combinations of weights of the four input parameters in DRASTIC. It was found that variations in the weights of the input parameters and number of fuzzy sets influenced the location of the aquifer-vulnerability categories as well as the area within each fuzzy category. The fuzzy rule models tended to predict somewhat higher vulnerabilities of the Alluvial aquifer than the modified DRASTIC model. The fuzzy rule base that had the soil-leaching index (S) as the highest weight was chosen as the best fuzzy rule model in predicting potential contamination by pesticides of the aquifer. In general, the fuzzy rule models tended to overestimate the vulnerability of the aquifer in the study area.

Keywords: Geographic Information Systems (GIS); Simulation modeling; Pesticides; Fuzzy logic, Water quality