INTRODUCTION

PROJECT STRATEGY

Developing statewide pesticide vulnerability assessments and producing ground-water aquifer sensitivity maps for New Mexico are expected to be a long-term effort due to budget and time constraints. Hence, it was necessary to develop, test, and apply the system to a pilot area, and design a priority system that guides available resources to areas of the state where the potential for contamination is greatest and where sufficient information is available.

With the exception of man-made impacts on ground water within relatively localized urban and rural areas, ground water in New Mexico typically is of good quality. A significant part of the state's ground water contains less than 5000 parts per million (ppm) of total dissolved solids (TDS), a common measurement of the relative quality of ground water for domestic, livestock, and agricultural use. Ground-water quality frequently varies locally due to its depth, distance from recharge areas, type of aquifer in which it occurs, and its proximity to mineralized zones and ore bodies.

New Mexico's ground water is used for domestic, municipal, industrial and agricultural purposes. Shallow alluvial aquifers, typically most sensitive to contamination, are extensively utilized for domestic and agricultural purposes. Urban, oil refining and industrial activities have contributed petroleum hydrocarbons, hazardous materials, nitrates, and other toxic pollutants to ground water. Waste-disposal sites have added metals as well as organic and inorganic contaminants to ground water. Irrigated agriculture, weed and pest control activities, mining, oil refining, underground storage tanks, and the disposal of industrial and commercial wastes also have impacted ground-water quality within the state by adding pesticides and nitrates. In localized areas, mineral extraction has increased ground-water salinity and added radionuclides, cyanide, metals, and/or toxic pollutants.

Aquifer susceptibility to influx of these chemicals is dependent upon the character of the overlying soils and sediments, the aquifer's chemical and physical properties, and the configuration of the water table. All these characteristics interact and must be considered holistically to determine the relative natural sensitivity of each aquifer to contamination. Many other factors can affect the vulnerability of ground water to contamination, for example, current and prior land use, irrigation practices, and others.

Ground-water contamination generally exists within fairly localized areas of the state, although all rural and municipal drinking water supplies could be impacted in the future if appropriate contaminant source management practices are not established and implemented. This project did not directly determine where problems exist by sampling and testing ground-water quality, but was an attempt to identify sensitive areas where ground-water contamination currently may be a problem or likely could become a problem in the future.

Ground-water resources within the state's farming areas are susceptible to contamination from applied agricultural chemicals. This is due to some ground-water aquifers being located relatively near the soil surface, farmlands being intensively cultivated, and irrigation acutely practiced. Therefore, leaching of applied agricultural chemicals could be the main route through which ground water is contaminated. This project would develop an assessment of the sensitivity of ground-water aquifers and evaluate current and recommended BMPs for farming operations in protecting these ground-water aquifers.

PILOT STUDY AREA

The majority of agricultural cropland in the pilot area is located in the Mesilla Valley. In this valley, the Rio Grande has a complex meandering and flooding history. As a result, a diverse and intricate pattern of soil types occur. The soils have textures ranging from clay to sand and often have stratified profiles. Thus the pilot area represents one of the more complex areas in the state and was expected to challenge the project methodology.

The USDA and National Cooperative Soil Survey have mapped the Mesilla Valley soils twice. In 1914, a general soil survey of the Mesilla Valley was produced (Nelson and Holmes 1914) at a scale of 1:63,360. In 1980, after the adoption of Soil Taxonomy (USDA 1975), the Doña Ana soils survey was published (Bulloch and Neher 1980). The survey, which produced a detailed soil map of the floodplain, was published at a scale of 1:24,000. This information was made available to the project in digital form. It was considered preliminary, but sufficiently processed for project purposes. In addition, soils surrounding the floodplain of the Mesilla Valley have also been studied extensively as part of the USDA Soil-Geomorphic Desert Project (Hawley 1975; Gile and Grossman 1979, Gile et al. 1981).

Geologic mapping of both bedrock and surficial geology in Doña Ana County has been produced (Dane and Bachman 1965). Hydrogeologic investigations in the area have continued (Hawley and Lozinsky 1992).

Depth-to-water table information had been collected for a number of years in an extensive network of wells by the US Geological Survey in a cooperative state program. This information was available in digital form.

TECHNOLOGICAL SOLUTION

The most efficient approach to assessing ground-water aquifer sensitivity is to employ a regional Geographic Information System (GIS) to determine and map the relative sensitivity of aquifers to contamination sources. The National Water Well Association (Aller et al. 1985) developed the DRASTIC model to assess aquifer sensitivity by combining data sets that describe the depth-to-ground water, recharge rates, aquifer material, soils composition, land slope, vadose zone materials, and saturated hydraulic conductivity. DRASTIC has been the most commonly used aquifer sensitivity assessment method, however, it is not intended to predict the occurrence of ground-water contamination (USEPA 1993). Recent work has further improved upon this method, evolving the method beyond a simple rating of sensitivity, to a descriptive approach identifying areas with similar hydrogeologic characteristics (i.e., hydrologic setting) and assessing individually these areas' ground-water susceptibility to potential contamination (Hearne et al. 1992). This type of analysis is much more useful to local decision makers. An understanding of the hydrogeologic setting which determines the basic processes under which ground-water contamination occurs must be incorporated into the process of designing alternative management strategies. This project incorporated such information and techniques. It also required that data be gathered at appropriate scales and with sufficient map accuracy.

GIS is a technological tool used to integrate and analyze spatial data to assist in decision making. Using computer processing techniques, GIS can integrate a vast array of data, answer "what if" questions, and produce either maps, tables, or diagrams in a form useful to a decision maker. This effort complements the state's current and future endeavors utilizing GIS in identifying and prioritizing ground-water areas which may require additional protection from both urban and rural pollution sources.

DATA MANAGEMENT

The WRRI maintains a Water Resources Data System (WRDS). This system consists of not only hardware, software, and various data files, but also cooperative agreements for access to many state, federal, and other data sources. The State of New Mexico provides WRRI base funding to maintain the WRDS. It is expected that the map coverages and databases developed under this project will be integrated into the WRDS and will be accessible to various local, state and federal agencies.

To ensure map accuracy and position registration, base maps that had known control points from the National Geodetic Survey were utilized. As additional coverages were digitized or otherwise incorporated into the GIS, the control points were identified and verified. This reduced the amount of error generated by map distortion or projection transformation. Additionally, through each step in the map overlay process, map boundaries were inspected to ensure edge matching between base maps.

Utilization of ARC/INFO software ensured accessibility and compatibility of the data system with a variety of other national and state databases.

COOPERATION AND PARTICIPATING AGENCIES

An agreement was established with the USDA Natural Resources Conservation Service (NRCS) to facilitate the timely delivery of the digital soil data needed for the natural sensitivity assessment. The project employed a student intern who was assigned to the Albuquerque Office of the NRCS during part of the summer of 1995 and 1996 to assist in their GIS laboratory section. In addition, the NM Environment Department agreed to conduct pesticide sampling at selected sites in the pilot study area at the request of the project team should there be indications from the modeling effort of detectible pesticide concentrations.

A project advisory committee was established to provide guidance and recommendations to the project team as well as assist with access to information. Meetings generally were held on a monthly basis to inform the committee of project progress and to review procedures and findings.