

# EXPERIENCES WITH THE USE OF A DESKTOP GIS FOR ANALYSIS OF SELECTED WATER RESOURCE PROBLEMS

Kathy N. Watts, Research Associate  
and David H. Moreau, Director  
Water Resources Research Institute of the  
University of North Carolina

The purpose of this paper is to report on our recent experience with the use of a desktop GIS system and related data sets for the analysis of selected water resource problems. Four different problems are discussed, all of interest to state and local governments in North Carolina. They are:

- 1) evaluating the impacts of North Carolina's proposed regulations for protecting water sheds for public water supplies;
- 2) counting housing units and population served by geographic areas in a study of urban water conservation;
- 3) estimating spatial patterns of water use for the analysis of a water distribution system;
- 4) preparation of watershed management plans for a regional water supply.

Among the principal data sets used for addressing these problems were the TIGER/Line Precensus Files, datapoint files for the P.L. 94-171 census data for 1990, and water utility customer files.

This paper briefly describes each of the problems, methods and data sets used for analysis, and any significant difficulties or limitations encountered in the process. A few general conclusions about desktop GIS and the datasets are also offered.

The Water Resources Research Institute of the University of North Carolina (WRI-UNC) has been exploring the use of mapping and GIS software for several years. A number of very useful products are on the market, but the Institute chose to limit its choices to those that satisfied the following criteria:

- 1) the software must be capable of performing certain basic operations for the analysis of geographic information;
- 2) extensive training in computer software is not necessary for a computer literate person;
- 3) the software must be able to import and export geographic and data files in a format that is readily adaptable to other software; and
- 4) it must operate on a general purpose personal computer and be priced at no more than \$5,000.

The experience reported here is based on the use of Atlas GIS, a software package that satisfies the above criteria. Other packages may be equally powerful and competitively priced; this report does not constitute an endorsement of a particular product. Experiences cited here are based on the use of an IBM AT upgraded to a 4 MB of RAM, a 386 SX chip and a memory manager.

## Applications

### Analysis of Watershed Protection Policy

In 1989, the legislature of North Carolina passed the Watershed Protection Act to limit urban encroachment on watersheds that drain to public water supplies. Rules adopted pursuant to that legislation provided for density and impervious surface limitations within water supply watersheds. Four classes of watersheds were proposed in the rules where each watershed was to be classified largely on the basis of existing residential densities. Among the issues raised in the public debate over the rules was: would the rules put the

brakes on home building and economic growth due to limits on the supply of land? WRII undertook a study to address this issue. Development densities were calculated for each of the 415 designated water supply watersheds. Those densities were then compared to densities permitted by the rules.

Existing development densities were found through basic GIS operations on pre-existing digital data sets. A digital file of polygonal representations of watershed boundaries was purchased from the N.C. Center for Geographic Information and Analysis (NCCGIA). The geographic file of watershed boundaries was in ARCINFO export format in N.C. State Plane coordinates. The watershed polygon files were about 5 MB. Atlas GIS allows the user to convert files into other coordinate systems, and that feature was used to convert the coordinates of the polygons to latitude and longitude to match the data file described below.

A file of block level 1990 census data for the state was obtained from the Institute for Research in Social Science, University of North Carolina at Chapel Hill. The data file contained 1990 counts of housing and population and the latitude and longitude of the centroid of the approximately 225,000 census blocks in North Carolina. ASCII files that contained this data were quite large, about 12 MB. Data was moved from one machine to another on 3.5-inch diskettes, using BACKUP and RESTORE commands.

A standard point in polygon operation was used to total the population and housing within each of the 415 watersheds as illustrated in Figure 1 for selected counties. Areas of polygons are automatically calculated by Atlas GIS, and all attributes can be manipulated using any dBase III+ compatible expression. Areas were converted into appropriate units and divided into housing and population totals to produce existing housing densities. A similar operation was used to find population and housing densities over counties using a grid of 1.0-square-mile cells.

In a separate operation, an attempt was made

to estimate that portion of each county that was covered by each of the four classes of watersheds. A digital boundary file for the 100 counties in North Carolina was obtained from NCCGIA. The operation of splitting the 100-county layer with the watershed layer proved to be too complex a task for the software. Selected counties were split one at a time by the watershed layer.

Results showed that with the proposed densities, there was not a significant constraint on the supply of land for development. In fact, without the density bonuses that the rules tied to use of stormwater controls, the watersheds could hold more than three times the population of North Carolina.

### **Water Conservation**

The desktop GIS also proved to be of value in a study of water conservation in Durham, N.C. Two particular needs in that study were well-satisfied through use of GIS. First, like most water and sewer utilities, the city of Durham has very good records on customers, but the customer records do not include information about the number of people, not even the number of housing units that are served by a given meter. Information of that kind is essential to any evaluation of water use. For Durham these numbers were found in a manner similar to that described previously. Block-level census counts for housing and population in 1990 were captured for the Durham service area using the point-in-polygon operation.

That study also included an examination of potential reductions in capital investments in wastewater treatment facilities that might result from water conservation and elimination of excess inflow and infiltration into sewer systems. Baseflow calculations for that analysis required population and housing counts for each of Durham's five sewersheds. A polygon was digitized for each sewershed, and the point in polygon operation was used to total housing and population for all blocks whose centroids fell within each of those polygons. Some of the results are illustrated in Figure 2.

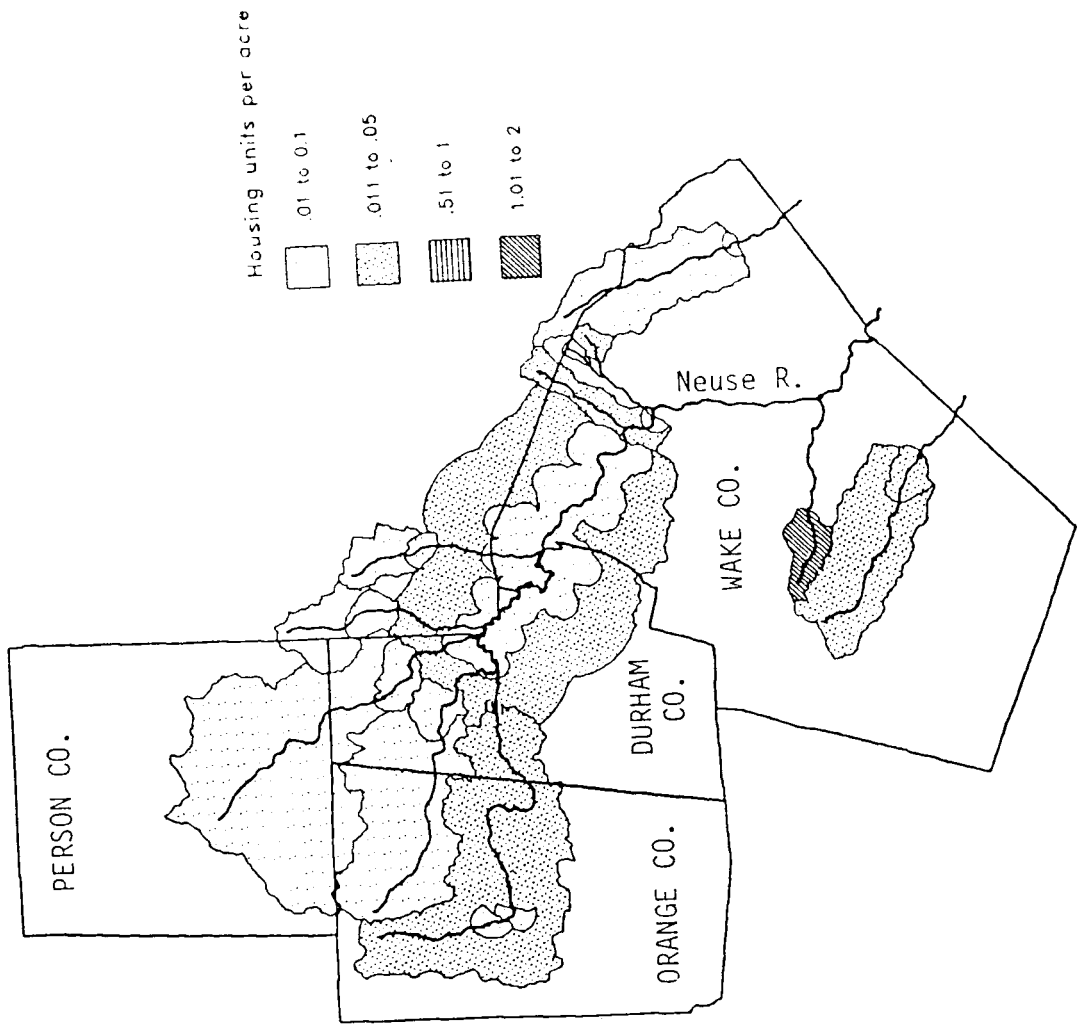


Figure 1-b. Densities of Housing in Selected Watersheds in North Carolina

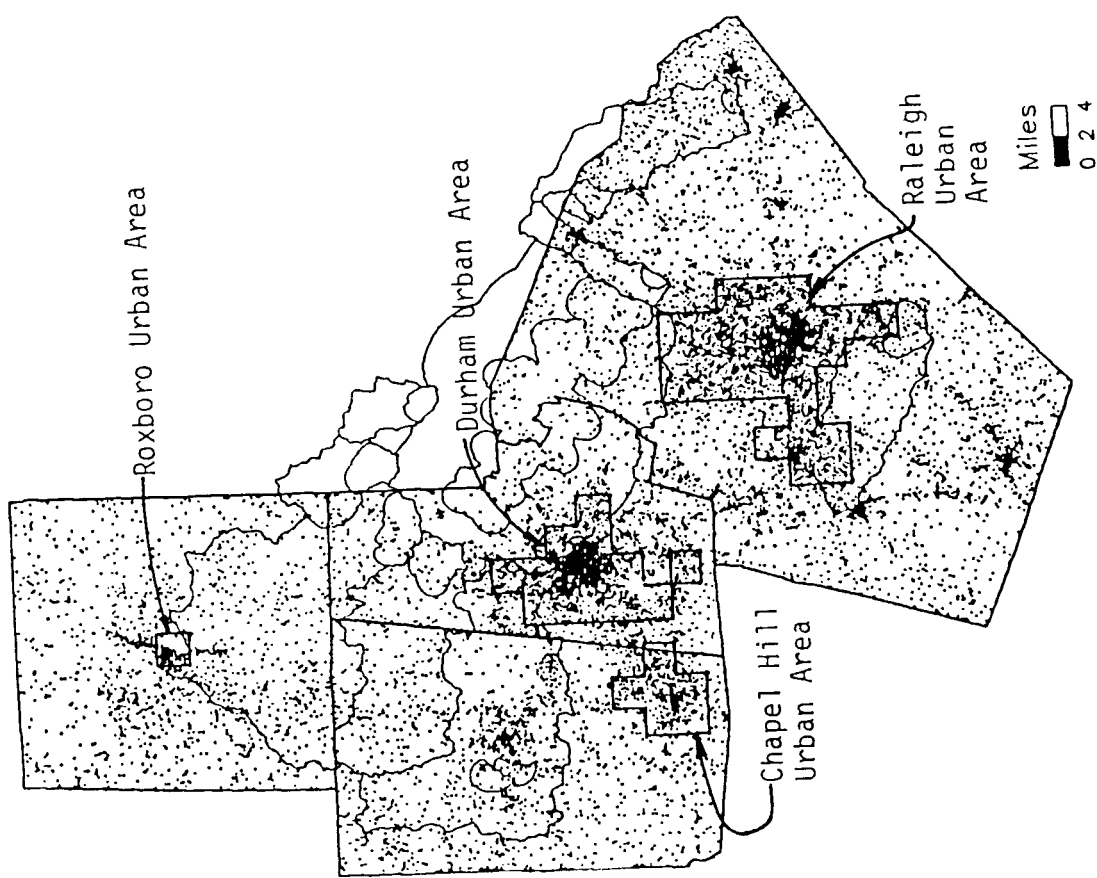


Figure 1-a. Centroids for Census Blocks in Selected Counties and Watersheds in North Carolina

