SYNOPSIS OF THE PROBLEM BEING RESEARCHED

In areas underlain by carbonate rocks, sinkholes can adversely affect the construction and maintenance of roadways and associated hydraulic structures. On topographic maps, sinkholes are identified as closed depressions. Identifying and delineating closed depressions from topographic maps is a difficult and time consuming process. Digital elevation data provide a means to automate the identification of closed depressions on local and regional scales, but simple mathematical analysis of digital elevation data to delineate them typically misidentifies a significant number of features in a given area. Digital filters can reduce the uncertainty in karst-feature identification, but such filters must be evaluated for accuracy before being applied across large areas. Even when these filters are applied correctly, the resolution and accuracy of the karst features are limited by the quality of the elevation data from which they were derived. Topographic analysis of digital elevation data, combined with field-verified digital filters, may provide a means to automate the delineation of karst features while eliminating misidentification due to noise inherent in digital elevation data.

Project Objectives

The objectives of this study are:

1) to process and prepare available 10-meter NED, 3-meter NED, and TN Base Map data as DEMs for use in delineating karst features,
2) to refine and test for accuracy the methods used to identify karst features in Tennessee, and
3) to produce a GIS karst dataset to support the regional and local scale planning and design of civil structures and natural-resources management of karst watersheds.

The project will be completed in the tasks described below.

1) Produce high-resolution DEMs to Identify and Delineate Sinkholes (Karst Features)
   a. Obtain available digital terrain datasets – National Elevation Dataset (NED) 10-meter DEMs, TN Base Map Digital Terrain Models (DTMs), and NED 3-meter DEMs will be obtained from State and Federal Government agencies.
   b. Prepare digital elevation data for analysis – DTMs and DEMs data must be converted into Environmental Studies Research Institute (ESRI) GRID format for GIS analysis. The data will be divided or merged (whichever is applicable) into similar tiles of sufficient size for GIS analysis. The separate datasets will be projected to obtain a common spatial reference, and elevations for all dataset will be converted to feet above mean sea level.

2) Refine and test for accuracy the GIS methods for identifying karst features in Tennessee
   a. Identify various karst settings in the study area – Several areas representing different karst settings in the study area will be chosen for method testing. These areas will most likely be chosen based on physiographic and/or geologic setting.
   b. Test current method in representative areas – Existing GIS methods will be used to identify and delineate closed depressions in each different karst setting chosen above.
c. Identify errors and quantify problems with the method – Results of the tests conducted for each karst setting will be compared to closed depressions in the field for selected areas. Differences between the test results and field data will be examined to quantify problems with the automated method related to the identification of sinkholes and the delineation of karst features.
d. Modify and retest method – GIS techniques will be modified to correct specific problems with the method. Retesting and modification will continue until optimum accuracy is obtained by the method for each karst setting. Although the method accuracy may differ between karst settings and source elevation data, the method will be revised until a satisfactory accuracy level has been reached that is agreeable to both the USGS and TDOT.

3) Creation of a Karst Features Dataset for the Study Area
   a. Prepare digital terrain datasets for study-area-wide application – The entire digital elevation dataset will be converted to ESRI GRID format (if necessary), projected, and tiled into approximately 40 pieces covering the study area to facilitate GIS processing.
b. Run optimized method for each tile in the study area.
c. Combine tiled results – Inconsistencies that exist between the datasets at tile edges will be reconciled. The tiled datasets then will be combined to create the study-area-wide karst dataset.
d. Summarize characteristics of the karst datasets – Analysis will be performed on the karst datasets to understand and describe spatial patterns of characteristics such as closed-depression density, size, and depth for each karst setting chosen in Task 2 and for the entire study area.
e. Provide the cooperator with the new DEMs used in the karst delineation process.
f. Final report describing the automated method and the results of the study will be published.

Status of the Project