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SPATIOTEMPORAL ANALYSIS AND VISUALIZATION FOR ENVIRONMENTAL STUDIES

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EXTENDED ABSTRACT

An abundance of information on earth resources is being collected daily such as remotely sensed imagery, Global Positioning System (GPS) surveys, aerial photographs and ground truth data. Interpreted by resource experts and compiled into geographic information system (GIS) digital databases, these data are increasingly available for viewing and distribution over the world wide web. With such a plethora of spatial information, users recognize the need for improved methods of data analysis and visualization in order to make sense of the data at hand.

Researchers at the Center for Remote Sensing and Mapping Science (CRMS), The University of Georgia, have had considerable experience in the construction and analysis of detailed GIS databases for environmental applications. Over time, collaboration with state and federal natural resource agencies has resulted in the compilation of land use/land cover data layers not only over large geographic areas but also spanning time periods of years to decades (see for example, Remillard and Welch 1992, Welch and Remillard, 1996, Welch et al 2001). These databases record changes in land use and vegetation patterns due to human activities, natural disturbances and vegetation succession. In addition to environmental studies, research activities of the CRMS also have focused on image processing techniques such as the development of methodologies for generating digital elevation models (DEMs) using automated stereocorrelation techniques, softcopy photogrammetry and orthoimage production using personal computers (Welch 1989, Welch and Jordan 1996, Welch et al 1998).

The availability of environmental databases, along with DEMs obtained from government agencies such as the U.S. Geological Survey (USGS) or created from stereo image data sources, has resulted in visualization tools that permit drapes of thematic information on DEMs of elevation or other environmental data. Three-dimensional perspective views can aid in the understanding of natural phenomena such as vegetation patterns or animal movement relative to environmental conditions. Animation and time-series displays are also tools of visualization that allow resource managers to analyze changes over time. This paper will present three examples of environmental studies conducted at the CRMS that utilize 3D visualization and time-series displays of spatiotemporal data.

The CRMS is working with the National Park Service (NPS) to create a digital vegetation database for Great Smoky Mountains National Park (GRSM) located in the Appalachian mountains of Tennessee and North Carolina, USA. The GRSM encompasses approximately 2,000 km^2 of rugged terrain with a total relief of about 2000 m. Detailed vegetation mapping of the almost continuous forest cover in the park has required the combined use of GPS, softcopy photogrammetry and GIS procedures with DEMs to construct digital orthophotos and vector-based vegetation databases (Welch et al 2000). Mapping the floristically diverse park also involved the development of a detailed vegetation classification system suitable for interpreting the large-scale color infrared (CIR) aerial photographs. Elevation, slope and aspect of the terrain are all very important environmental factors that determine the type of forest association that will be found in a particular setting. The

relationship between forest classification and terrain will be demonstrated by 3D visualization of draped orthophotos and ortho-corrected vegetation maps onto DEMs.

The CRMS has cooperated with the Southeastern Wildlife Disease Study at the UGA College of Veterinary Medicine to map county-based data on outbreaks of hemorrhagic disease (HD) in white-tailed deer. Surveys conducted from 1989 to 1999 generated a body of tabular data that required mapping to more fully visualize patterns of HD effects on deer populations. County maps of Georgia, Alabama and South Carolina were color-coded to depict various levels of the disease reported over the 20-year period. An animated sequence of the time-series data was created to enhance visualization of the spatiotemporal data.

In a third example of environmental studies conducted by the CRMS, elephant movement was tracked using GPS data collected in Kruger National Park in South Africa. The UGA College of Veterinary Medicine conducted a study of elephant family dynamics as part of their research to develop a contraceptive vaccine for controlling elephant populations. In order to assess if the vaccine was altering normal patterns of elephant movement, GPS receivers were attached to collars worn by selected elephants within a family group. Remotely downloaded tracks of daily movements were transferred to the CRMS for input to a GIS database. The displayed time-series data overlaid on a 3D perspective view of the terrain depicted the movements of two particular elephants. These tracks confirmed that their activities were indeed normal and the vaccine was not disrupting elephant family dynamics.

An overview of these three environmental studies that incorporate 3D visualization and time-series displays will be presented. Results indicate these tools are important components of GIS data analysis and can be used to enhance the interpretation of GIS databases.

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