REMOTE SENSING/GIS FOR WATER RESOURCE MANAGEMENT APPLICATIONS IN THE SOUTHEAST

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The Center for Remote Sensing and Mapping Science (CRMS) at the University of Georgia (UGA) has been active in a number of projects involving the use of remote sensing and geographic information system (GIS) techniques for solving water resource management problems in the Southeast (Figure 1). These projects include assessments of: 1) non-point source (NPS) pollution; 2) management practices affecting water quality; 3) salt marsh environments; and 4) floodplain disturbances. Each of these projects is briefly summarized in the following paragraphs.

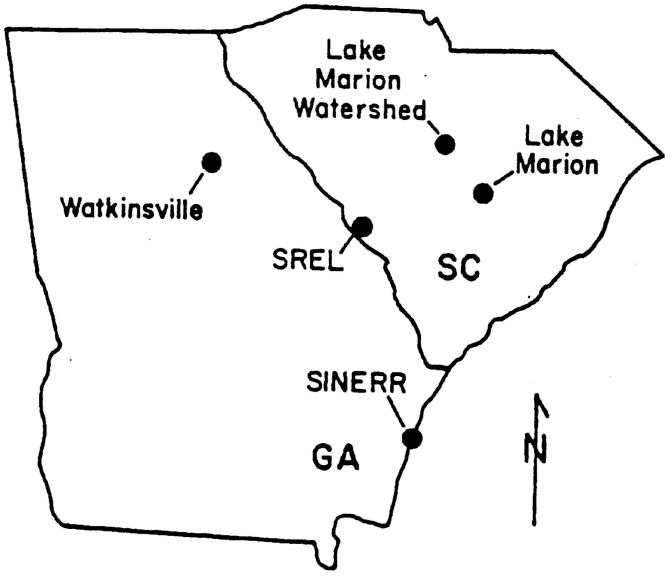

Figure 1. Study Locations of CRMS Projects Involving Water Resource Management Applications

NON-POINT SOURCES OF POLLUTION

Soil erosion from agricultural fields is known to be an important source of NPS, however, estimates based on the Universal Soil Loss Equation (USLE) do not account for soil loss from ephemeral gullies. In a cooperative study between the CRMS and the U.S. Department of Agriculture - Agricultural Research Service (USDA-ARS), gully erosion in fields near Watkinsville, Georgia was measured using large-scale aerial photographs acquired before and after gully changes due to erosion or tillage (Welch *et al.*, 1984; Thomas *et al.*, 1986; Thomas and Welch, 1988). Detailed topographic maps were constructed at 0.15 m contour interval by photogrammetric methods and used to quantify the volume of soil removed by erosion or filled by tillage during the growing season. These data, plus on-site measurements of soils information (e.g., soil type and texture), topographic features, cropping practices and rainfall are presently being used with GIS software to study the erosion processes.

Integrated remote sensing and GIS techniques also have been utilized by the CRMS to identify areas of potential NPS in large watersheds. Information on land use/land cover, soils, topography and rainfall were derived from SPOT satellite image data (20-m resolution), aerial photographs, maps and field studies and incorporated into a digital database. This database, in combination with the ARC/INFO GIS software package, has been employed to rank critical areas of NPS pollution for a 5,000 km^2 watershed area draining into Lake Marion, South Carolina. In addition, a spatial runoff model has been developed by the CRMS that quantifies soil loss as a function of terrain slope and distance from the nearest streams. This model is being used to estimate sediment input to Lake Marion, a contribuing factor to the excessive growth of aquatic macrophytes in the lake.

MANAGEMENT OF AQUATIC VEGETATION

The spread of aquatic macrophytes in Lake Marion necessitated an assessment of the trends in aquatic plant growth and water quality. Maps depicting aquatic vegetation at 1:10,000 and 1:24,000 scale were produced from color infrared aerial photographs recorded on seven dates between 1972 and 1988 (Welch *et al.*, 1988). These map products, along with water depths and herbicide applications were converted to digital format to form a cartographic database

for the 170 km² study area (Figure 2). Statistical data on nutrients, dissolved oxygen, biological oxygen demand and turbidity obtained from the South Carolina Department of Health and Environmental Control and the U.S. Environmental Protection Agency also were added to the database. The ARC/INFO GIS system was then used to: 1) analyze changes in aquatic plant growth over time; 2) assess the effectiveness of herbicide applications for aquatic plant control; and 3) model macrophyte distributions as related to environmental factors influencing their growth (Remillard and Welch, 1991a and 1991b).

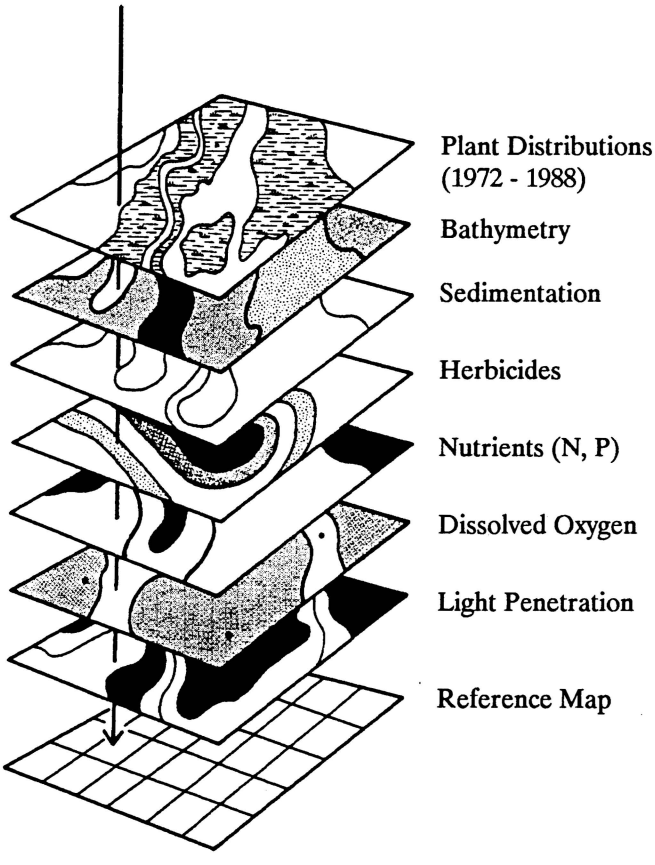

Figure 2. Data Layers in the Lake Marion Digital Database

QUALITY OF THE SALT MARSH

The Duplin River estuary and surrounding marshlands were designated the Sapelo Island National Estuarine Research Reserve (SINERR) to ensure the preservation of some of the last unaltered salt marshes along the East coast. To examine the possible effects of management practices on SINERR marshlands, detailed information is required. Global positioning system (GPS), photogrammetric and GIS techniques in combination with aerial photographs recorded between 1953 and 1989 have been employed by the CRMS and Marine Institute to create an integrated resource database. This database contains information on marsh and upland vegetation, drainage, topography and land use. Analyses of changes in marshland species, upland vegetative cover, drainage creek patterns and management activities such as controlled burning are being conducted with the aid of ARC/INFO overlay procedures. These data are then being used to establish relationships between salt marsh quality (i.e., productivity) and management activities in the surrounding watershed areas.

FLOODPLAIN DISTURBANCES

Water resources in the Savannah River floodplain have been heavily impacted by disturbances such as the release of thermal effluents, river level manipulation and logging practices. The CRMS and the Savannah River Ecology Laboratory (SREL) have used remote sensing and GIS to assess the effects of disturbances on wetland vegetation succession in the Savannah River floodplain. To document current vegetative conditions, a vegetation and disturbances map of the floodplain was constructed from SPOT satellite image data. Historical aerial photographs dating back to 1943 also were examined to produce detailed vegetation succession maps. Overlay procedures were then employed to relate successional changes to disturbances in the Savannah River floodplain.

CONCLUSION

The integration of remote sensing and GIS techniques has enabled assessments of NPS pollution, aquatic vegetation growth, salt marsh quality and floodplain disturbances over time. It is worth emphasizing that the procedures employed for these studies can be extended to many water resource related problems in the Southeast, provided careful consideration is given to source materials, database construction and GIS analysis techniques. Furthermore, with the evolution in small computers and associated mapping, image processing and GIS software, it is now possible for the resource manager to undertake studies in his home office.

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