REMOTE SENSING AND GEOSPATIAL TECHNOLOGIES APPLICATION FOR DEVELOPING OPTIONS TO RELOCATE CSX RAILROAD FROM MISSISSIPPI GULF COAST TOWNSHIPS

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ABSTRACT

An environmental assessment will be conducted to study the impacts of relocating segments of the CSX railroad out of significant population growth areas along the environmentally sensitive Mississippi Gulf Coast. The environmental assessment project, which is to be jointly managed by the Mississippi DOT and FHWA, will make broad use of remote sensing and geospatial technologies. The project has been awarded and will be supported by the technical and research resources of the National Consortium on Remote Sensing in Transportation (www.ncrst.org).

The National Consortium on Remote Sensing in Transportation (NCRST) comprises four university research consortia sponsored by the US DOT. The consortia conduct research to improve our understanding about how remote sensing and geospatial technologies can provide planners, managers, engineers, and analysts with information resources that can be used to improve multimodal transportation planning, design, operation, and maintenance efforts. Consortia activities also are focused on conducting technical outreach with transportation agencies and organizations to demonstrate how remote sensing and geospatial technologies can be effectively implemented and to improve understanding of where additional research, outreach, and training activities are most needed.

The environmental assessment component of the consortia works with new sources of high resolution data to provide improved information for evaluating options, assessing environmental conditions, screening sensitive areas, optimizing potential alignments, and conducting preliminary planning and design. Research activities have shown that if appropriate remote sensing data are collected early in the project life cycle the benefits of the data include:

- Enhancing transportation planning;
- Improving early design processes;
- Improving the ability to develop and provide informational materials for public access; and
- Better communication and demonstration of benefits of planned transportation service improvements.

Keywords: remote sensing, geospatial, railroad relocation, environmental assessment, Mississippi Gulf Coast.

INTRODUCTION

The three coastal counties in Mississippi (fig.1) Jackson, Hancock, and Harrison, have undergone considerable change in land use, population, wildlife habitat, demographics, and socio-economic conditions in the past 30 years. In that time, Interstate 10 (I-10) has been completed, extensive population growth has occurred, and the coastal counties have changed from being mostly small fishing communities to communities with a complex mixture of residential, commercial, industrial, urban, resort, and relatively unspoiled coastal wilderness areas. The population has gone from around 240,000 in 1970 to over 350,000 in 2000, showing a growth of almost 50 percent (http://www.ncrste.msstate.edu/publications/ncrste_tn003.pdf).

Figure 1. Location of the planned rail relocation EIS.
NCRST research of GIS data, historical satellite imagery, and existing aerial image data to assess changes in the area have provided valuable insight as to development patterns and trends while also indicating areas where future growth patterns may cause potential stress on sensitive wildlife habitat areas. These studies have illustrated the need to update information resources so that improved information will be available to those who must make decisions about future growth and development for the region.

MISSISSIPPI GULF COAST

The Mississippi Gulf Coast is a collection of sensitive environments in a state of rapid change. The coastal landscape comprises a complex mixture of environments including estuaries, marshes, pine savannahs, meander belts traversing wooded river bottomlands, sandy beaches, terraced uplands, and deltaic river outlets. The gulf coast lies mostly within the gently rolling to flat Coastal Pine Meadows physiographic district and moving landward is within the rolling to moderately rugged Long-Leaf Pine Hills district. The geologic materials are mostly fine grained to sandy sediment with coarser grained materials found in upland marine terrace deposits.

A significant portion of the 3-county Gulf Coast area is within National Forest, state parks, wildlife management and refuge areas, conservation areas, or wildlife sanctuaries. The sensitive environmental conditions coupled and a high rate of population growth and land development combine to provide a challenge to develop the region in a manner that is sustainable and preserves the natural environment. NCRST has used available GIS and remote sensing to assess general trends in land cover and land use change and the development of areas along the Mississippi Gulf Coast. Through inspection of existing land cover data (fig. 2 and fig. 3) such as the USGS Multi-Resolution Land Characteristics 1992 (USGS, MRLC 92) data set and the Mississippi Automated Resource Information System land cover data for 2000 (MARIS, LCLU 2000) it is possible to readily observe some aspects of the development trends in the 3 coastal counties. However, different approaches were used to develop these data sets making direct comparison to determine land cover change problematic.
LAND COVER AND LAND USE CHANGES

A significant area of NCRST research has focused on developing approaches for classification and analysis of satellite image data for coastal areas to determine change in regional land cover and land use over time. A series of satellite image data for the area collected over the past 30 years has been processed and analyzed using consistent classification techniques resulting in data that can be more readily compared to assess growth and development patterns for the region. By using similar data, processing methods, and classification schemes, it is possible to improve the consistency of results and with increased assurance assess such factors as growth in developed areas and change in land cover types (fig. 4). It is also possible to evaluate change in land cover and land use as it relates to proximity to new transportation infrastructure or proximity to other spatial features.

Through completed and ongoing NCRST research, regional trends in growth, development, and land cover change have been quantified with the use of Landsat satellite imagery. Landsat satellite imagery (TM, ETM+) provides data with a spatial resolution of 28.5 meters and multiple channels in the spectral range of 0.45 - 12.5 µm. While the resolution of Landsat satellite image scenes provides data sufficient for regional assessment and determination of general trends, the data do not provide sufficient resolution for preliminary transportation corridor designs, planning, or environmental assessment. For planning, design, and environmental assessment, engineers and environmental analyst require data with significantly higher spatial resolutions.

The planned environmental assessment to study the impacts of relocating segments of the CSX railroad out of significant population growth areas along the environmentally sensitive Mississippi Gulf Coast will make extensive use of remote sensing and geospatial technologies. NCRST researchers have technical expertise in the use and application of traditional data sources as well as new higher spectral and spatial resolution remote sensing data and will support the environmental assessment activities in the following general areas:

- Compilation and organization of existing remote sensing and geospatial data and information resources;
- Coordinating and assisting in the acquisition of new remote sensing and geospatial data;
- Assisting with technical outreach to facilitate the use of remote sensing and geospatial data in environmental assessment processes, corridors planning processes, and information product development; and
- Providing information technology for data management, custom data production, and data and information distribution.
NEW GEOSPATIAL DATA TYPES

Rapid advances are being made in remote sensing and geospatial technologies. New systems for collecting aerial remote sensing data include high spatial resolution image data, high spectral resolution multispectral and hyperspectral image data, LIDAR elevation data, and IFSAR elevation data sets provide rich sources of information that can be collected rapidly for large areas, but at considerable cost. New satellite platforms such as Space Imaging’s Ikonos and DigitalGlobe’s QuickBird provide commercial satellite image data with spatial resolutions far higher than have been available in the past. In fact, the spatial resolution of the panchromatic (black and white) data from Quickbird exceed that provided by USGS DOQQ data.

Space Imaging web site:  
http://www.spaceimaging.com/level1/index41.htm

DigitalGlobe web site:  
http://www.digitalglobe.com

NCRST is working to identify sources and providers of existing remote sensing and geospatial data for the region and is working with agencies such as NASA and commercial data providers to identify sources of new high resolution data for the area. Through the Earth Sciences Application Directorate of NASA, a program known as the commercial remote sensing data buy has tasked the acquisition of DigitalGlobe Quickbird data for a significant part of the study area (fig. 5). The Quickbird satellite provides highly accurate, commercial high-resolution panchromatic and multispectral imagery of Earth to support applications ranging from map publishing to land and asset management to insurance risk assessment. Data from the platform has a ground sample distance (GSD) resolution at nadir of

- Panchromatic image data: 61 cm (2 ft)
- Multispectral image data: 2.44 m (8 ft)

It is hoped that these data, among others, can be made available to the environmental assessment effort. NCRST will work to facilitate the availability of these and other data
products for the assessment efforts. Although the selection of specific data types and acquisition details will be determined by the contractor in consultation with the Mississippi DOT and FHWA, who are managing the project, it is likely that the following data types will be used to some extent in the environmental assessment process:

- Historic satellite image data
- Historic land cover and land use data
- Digital elevation data from available data sets
- USGS Digital Raster Graphics of topographic quadrangle maps
- Digital orthophoto quarter quads (DOQQs) from the USGS
- New high spatial resolution aerial image data
- New high spatial resolution multispectral satellite image data
- New high spectral and spatial resolution aerial hyperspectral image data
- New high vertical resolution digital elevation data

**GEOSPATIAL DATA AND INFORMATION SOLUTIONS**

One of the most difficult challenges in transportation and regional planning is data and information management. Providing needed geospatial data to decision makers, planners, engineers, and analysts is a difficult task that is further complicated by the use of large geospatial image data sets that are needed for maps and analysis products. These data sets usually comprise large data files that are difficult to transfer, require significant storage resources, and are time-consuming and complicated to process. The development of computational solutions for the storage, management, custom product creation, and distribution of image data and other geospatial data sets is of vital interest to transportation agencies. To address these challenges, Mississippi State University is developing a computational geospatial data library (geolibrary). One of the first goals for the geolibrary will be serving specific data and information products to MDOT and other EIS project participants for the Mississippi coastal corridor effort.

Traditional image processing and geospatial data workflows typically involve highly skilled analysts who prepare data for use by engineers, planners, and other data users who in turn use the data to create custom maps, perform analyses, and tabulate data. Image analysts usually have expensive graphics workstations, complex software, and access to extensive data storage. Much of the work of these analysts is conducted using complicated image processing and GIS software. One of the most time-consuming set of tasks involves the preparation of image and base map materials that are useful for custom maps and analysis. Tasks such as image registration, orthorectification, coordinate transformation, creating mosaics, creating digital terrain models, and fusing data to produce custom products can be extremely time consuming and labor intensive. Mississippi State University will develop resources to perform many of the “heavy-lifting” tasks of geospatial data management, image processing, custom product development, and product distribution that are an increasingly significant part of transportation planning, environmental assessment, and transportation design.

**APPLICATION OF REMOTE SENSING DATA AND DECISION SUPPORT SYSTEMS**

In conducting the environmental assessment, potential alignments of the relocated rail segment will be developed as well as alignments for a potential new east-west highway corridor. New and existing remote sensing and geospatial data will be used to evaluate the potential alignments’ effects in terms of such factors as (but not limited to):

- Land Use Patterns
- Social Environment
- Transportation
- Public Safety
- Noise Levels
- Air Quality
- Water Resources
- Wetlands, Wildlife and Farmlands
- Coastal Zone Resources
- Public Lands
- Archaeological or Historic Sites

The use of remote sensing and geospatial data in the issues listed is not the extent to which these technologies can be used. The application of these technologies extends to such areas as decision support systems which fall into (but are not limited to) the following general areas:

- Alignment Optimization – Applications that integrate construction information and geospatial data to determine best option alignments which meet constraints, consider environmentally sensitive areas, and consider construction criteria.

- Wetlands Analysis, Assessment, and Mapping – Applications that use geospatial technologies to assess vegetative cover, hydrologic conditions, and soil conditions arriving at estimations for areas likely to meet wetlands criteria as well as areas that are ideal for wetlands mitigation. When combined with potential alignment optimization applications, wetlands assessment applications can be used to design transportation corridors that minimize impacts on wetlands areas and identify ideal mitigation strategies to assure environmental sustainability.
Habitat Analysis, Assessment, and Mapping – Applications that use geospatial technologies to quantitatively assess habitat areas, connectivity, and fragmentation. When combined with potential alignment optimization applications, habitat assessment applications can be used to minimize impacts of transportation on environmentally sensitive areas.

IMPROVING PUBLIC INFORMATION SERVICES

NCRST will provide access to remote sensing and geospatial information for the study area to project participants. Information and materials will also be made available through the on-line geolibrary to the public in an effort to use a remote sensing mapping and information portal to increase levels of public participation and satisfaction with the EIS process in the overall goal of improving the public service and community satisfaction provided by the transportation system.

SUMMARY AND CONCLUSIONS

It is expected that the contract for the EIS will be awarded in the summer or early fall of 2002. NCRST will be prepared to work closely with the EIS team and the public agencies involved. NCRST’s support in acquiring needed data, providing expertise in geospatial data processing and analysis, and providing management and coordination of geospatial data resources for the effort will help assure the successful use of geospatial and remote sensing data and technologies in the transportation planning and assessment effort. The application of remote sensing and geospatial technologies in different aspects of the environmental impact assessment process will be documented as a result of the project. The resulting reports and findings of the Mississippi coastal corridor EIS will provide a wealth of information about how geospatial and remote sensing data can help streamline environmental assessment processes and help to improve the transportation services that are delivered to the general public.

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