I-10 Project Status Report
Mississippi State University

NCRST-E
Advisory Board Meeting
Fall 2001

National Consortium on Remote Sensing in Transportation - Environmental Assessment
MSU Project Efforts

In the year two research plan, MSU is identified as the lead in the following efforts:

- Consortium Management and Data Brokering
- MS Gulf Coast (I-10) Assessment
- Consortia Outreach, Support, and International Programs Development
- Application Development and Cookbooks Development
- Development of a Center of Excellence
MSU Project Efforts

Of the efforts listed, all are discussed in the NCRST-E Strategic Direction presentation except for a full reporting on the status of the MS Gulf Coast (I-10) Assessment.
The National Consortium on Remote Sensing in Transportation – Environmental Assessment (NCRST-E) is conducting an assessment of land cover and land use change in the Mississippi coastal corridor with the purpose of identifying changes due to transportation and land development.
Initial exploratory comparative analysis of existing land cover classification data (non-spectral data analysis) for the area compiled at various times over the past 30 years provided results that were not adequate for the identification of development trends or for spatially characterizing land cover and land use change.
I-10: Non-Spectral Analyses
GIRAS, MARIS, and MRLC

GIRAS
(Level 1 Classification)

MARIS
(Level 1 Classification)

MRLC
(Level 1 Classification)

GIRAS data for the land-cover classification of coastal counties was collected from NASA high-altitude aerial photographs, earlier land use maps and field surveys from 1977 to early 1986. The classification was done by the U.S.G.S.

LEGEND

Class | Acres
--- | ---
Agriculture | 105973
Barren | 21049
Forest | 1099372
Urban | 75424
Water | 159813
Wetland | 28026

MARIS data for the land-cover classification of coastal counties was collected from Landsat TM on October 14, 1992. The classification was done by the Mississippi Automated Resource Information System (MARISS).

LEGEND

Class | Acres
--- | ---
Agriculture | 120897
Barren | 6994
Forest | 113161
Urban | 68536
Water | 511788
Wetland | 202049

MRLC data for the Multi-resolution land characteristics for the United States. The data for the three Mississippi coastal counties was collected from Landsat TM imagery taken on September 29, 1991 and February 1, 1992. The spatial resolution for this map is 30 meters.

LEGEND

Class | Acres
--- | ---
Agriculture | 170046
Barren | 400306
Forest | 904498
Urban | 31333
Water | 508338
Wetland | 255951
MS Gulf Coast (I-10) Assessment

Image and change detection analyses performed on satellite images scenes acquired for the area for the past 30 years 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.
MS Gulf Coast (I-10) Assessment

The image processing and analyses performed included image co-registration, radiometric normalization, NDVI and tasseled cap transformation, supervised and unsupervised classification of the entire area of interest, and the use of transformation analysis data products to provide analysis masks for supervised or unsupervised classification of portions of the area of interest.
I-10 Data Preparation
Co-Registered, Cataloged, and Documented
MS Gulf Coast (I-10) Assessment

Through the use of a combination of image processing and analysis techniques it was possible to identify and spatially quantify areas of land use development, areas where forestry practices have periodically altered the land cover, areas of growth in the vicinity of major transportation corridors, patterns and trends in development and growth, natural and man made barriers to growth, and areas where ongoing development may eventually stress sensitive coastal habitat areas.
MS Gulf Coast (I-10) Assessment

The image processing and analyses performed included image co-registration, radiometric normalization, NDVI and tasseled cap transformation, supervised and unsupervised classification of the entire area of interest, and the use of transformation analysis data products to provide analysis masks for supervised or unsupervised classification of portions of the area of interest.
I-10: Normalization and Exploratory Analyses

The satellite image scenes were normalized and exploratory analyses were conducted. The analyses resulted in the extraction of specific content or themes of data such as areas of water cover within the area of interest.
The major analysis phases of the effort can be seen in the table to the right. Each major phase included several processing components, the intermediate products of many of which will be presented in the following foils.

- Data Analysis
  - Data Preparation
  - Radiometric Normalization
  - Exploratory Analysis
  - Spectral Classification
  - Radiometric Analysis
  - Accuracy Assessment
  - Change Detection Analysis
  - Visualization and Tabulation of Change
  - Analysis of Patterns and Trends
I-10: Elevation Enhanced Visualization of Coastal Corridor Imagery

Elevation data is used for many purposes in transportation planning. Used range from calculation of grades to determination of cut and fill amounts for highway construction. In the environmental assessment of transportation projects, elevation data are useful for efforts that range from watershed delineation to the visualization of the landscape.

Most readily available digital elevation model (DEM) data provide a "bare-earth" depiction of the landscape in which trees and other naturally occurring vegetation cover is removed from the landscape. Also, DEMs do not typically show man-made structures. In contrast, digital surfaces that are available through InterSpace's Synthetic Aperture Radar (ISAR) provide a landscape surface that includes the texture of the vegetation cover as well as the shapes of man-made structures. Therefore, the use of ISAR digital surface models (DSMs) such as those provided by InterSpace's G1.2 data can provide an enhanced visualization by improving the ability to assess vegetation cover and the urban landscape.
Land Use/Land Cover Classification

Mississippi Coastal Classification 2000

The generation of a land use/land cover (LULC) classification map required a combination of classification methodologies and data sources. LandSat 7 data and digital ortho-quarter-meter (DOQ) maps were the primary data sources from which the LULC maps were produced. Normalized Difference Vegetation Index (NDVI) and the Land Cap Transform algorithms were run on the LandSat data to help highlight specific land cover classes. Supervised and unsupervised classification methods were used to separate the LULC classes.

Two classification maps following a modified Andersen (1973) classification scheme were shown. These maps were produced from a LandSat 7 scene taken on July 2, 2000 (PATH: 223/305). The first map is a level 1 classification map that includes the following classes: urban/builtup, non-forested vegetation, forested vegetation, water, marsh, and barren. The second map is similar to the first with the exception of the urban/builtup and barren classes. These classes were further broken down into residential, minor roads, major transportation, industrial/commercial, forest, and non-coastal land cover classes.

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I-10: MS Coastal Classification 1990

The generation of a land use/land cover (LULC) classification map required a combination of classification methodologies and data sources. Landsat 5 data and digital ortho-quadrangle (DOQ) images were the data sources which the LULC map was produced. Normalized Difference Vegetation Index (NDVI) and the Textural Detecton algorithm were run on the Landsat data to help highlight specific land cover classes. Supervised and unsupervised classification methods were used to separate the LULC classes.

Two classification maps following a modified Anderson (1976) classification scheme are shown. Each map was produced by using a combination of Landsat 5 images taken on August 22, 1990 and February 14, 1991 (Path 21, Row 39). The first map is a level 1 classification map that includes the following classes: urban/built-up, non-forested vegetation, forested vegetation, water, roads, and bare. The second map is similar to the first with the exception of the urban/built-up and barren classes. These classes were further broken down into urban/built-up roads, major transportation, industrial/commercial, and institutional level 2 classes.

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An accuracy assessment is being conducted for the classified data. Random points have been sampled for determining the overall accuracy of the classification of the multispectral satellite image data.
I-10 Assessment of Change

The analysis of change for the I-10 effort has comprised assessments of change in:

- Radiometric values from normalized image data
- Classification change from spectrally classified image data
- Vegetative and developed lands change from exploratory analysis data derivatives
A comparative change analysis is being performed to determine the degree of agreement between different change detection methods used. Additionally, normalized increases or decreases in vegetative cover (NDVI values) will be compared to changes in tasseled cap greenness and brightness values to assess the agreement and sensitivity of these exploratory data analysis methods.
I-10: Vegetative Analyses (NDVI)

Normalized Difference Vegetation Index (NDVI)

The NDVI is a ratio of the reflected energy in the near infrared (NIR) and red portions of the electromagnetic spectrum. It is used to measure the health and density of vegetation. A NDVI value of 1 indicates healthy vegetation, while values close to 0 indicate little or no vegetation.

The NDVI can be calculated using the following formula:

\[ \text{NDVI} = \frac{\text{NIR} - \text{R}}{\text{NIR} + \text{R}} \]

Where NIR is the energy reflected in the near infrared portion of the electromagnetic spectrum and R is the energy reflected in the visible red portion of the electromagnetic spectrum. The NDVI values range from -1 to 1. Values close to 1 indicate healthy vegetation, while values close to 0 indicate little or no vegetation.

Normalized Difference Vegetation Index

Mississippi Coastal NDVI 2000

The NDVI values range from -1 to 1, with 1 being healthy vegetation and 0 indicating no vegetation. The NDVI values are shown in different colors, with higher values in green and lower values in red.

EXPLANATION

0.85 - 1.00
0.71 - 0.85
0.55 - 0.70
0.41 - 0.55
0.21 - 0.40
0.11 - 0.25
0.03 - 0.10
-0.01 - 0.00
-0.10 - -0.05
-0.20 - -0.10
-0.30 - -0.20
-0.50 - -0.40
-0.70 - -0.60
-0.85 - -0.90
-1.00 - -0.86

Technical Assistance:
The National Consortium on Remote Sensing in Transportation-Environmental Assessment (NCRST-E) provides technical assistance for this project.

Additional Resources:
- National Center for Geographic Information and Analysis (NCGIA)
- National Geophysical Data Center (NGDC)
- National Aeronautics and Space Administration (NASA)
- National Oceanic and Atmospheric Administration (NOAA)

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Map prepared by the Center for Geographic Information and Analysis (CGIA)

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Computational Geospatial Technologies Center
National Consortium on Remote Sensing in Transportation - Environmental Assessment
I-10: Tasseled Cap Transformation

Tasseled Cap Transformation is one of the available methods for enhancing spectral information content of Landsat TM data. Tasseled Cap transformation especially optimizes data viewing for vegetation studies. Tasseled Cap index was calculated from data of the related TM bands. Three of the six tasseled cap transform bands are often used:

- Band 1 (brightness, moisture of soil)
- Band 2 (greenness, measure of vegetation)
- Band 3 (wetness, interrelationship of soil and water moisture)

The Tasseled Cap Transformation for LandSat satellite imagery is calculated with the following coefficients:

\[
\begin{align*}
\text{Brightness} &= 0.25152/NDVI + 0.74807/NDVI + 0.47807/NDVI \\
\text{Greenness} &= 0.2605/NDVI - 0.2405/NDVI - 0.340/NDVI \\
\text{Wetness} &= 0.150/NDVI + 0.197/NDVI + 0.027/NDVI
\end{align*}
\]

Tasseled cap results and change in tasseled cap values between images will be used to assess changes to the environment. These changes will be compared and contrasted to changes in radiometric values, NDVI values, and classification.

References:

I-10 Tabulation and Trends

Tabulation of change are being compiled and assessments of trends in change are being conducted. These final analyses will be completed shortly and final results will be available for the December TRB Remote Sensing forum.
I-10 Products and Deliverables

Many of the results of the I-10 effort will be included in a Master’s Thesis of one of our graduate students (Adam Johnson). The effort will also be documented in a Technology Guideline and in a paper to be presented at the Annual AAG meeting in March, 2002. These results are in large part due to the efforts of Adam and John Cartwright of the new Computational GIS/RS Lab at the MSU ERC.
The next phase of work related to the Mississippi I-10 Coastal Corridor will include the following components:

- Analysis of high-resolution hyperspectral data for improving the assessment of urbanization and development trends in selected areas of the Mississippi I-10 Coastal Corridor.
- Hydrologic and habitat assessments of the I-10 Corridor
- Providing as needed support to the Mississippi I-10 Coastal Corridor EIS efforts.
- Developing a GeoLibrary and web interface for the Mississippi I-10 Coastal Corridor