ACCESS NUMBER: 30951-85250

STUDY TITLE: Environmental Sensitivity Index (ESI) Shoreline Classification Using New Remote Sensing Data and Techniques

REPORT TITLE: Feasibility of Using Remote Sensing Techniques for Shoreline Delineation and Coastal Habitat Classification for Environmental Sensitivity Index (ESI) Mapping

CONTRACT NUMBER: 1435-01-99-CA-30951-85250

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Central Gulf of Mexico

FISCAL YEARS OF PROJECT FUNDING: 2003; 2004; 2005

COMPLETION DATE OF REPORT: August 2005

COSTS: FY 2003: $71,022; FY 2004: $29,639; CUMULATIVE PROJECT COST: $100,661

PROJECT MANAGER: D. Braud

AFFILIATION: Louisiana State University, Coastal Studies Institute

ADDRESS: 331 Howe-Russell Geoscience Complex, Baton Rouge, Louisiana 70803

PRINCIPAL INVESTIGATOR: D. Braud

KEY WORDS: Environmental Sensitivity Index, land/water interface, satellite imagery, shoreline types, IKONOS, remote sensing, classification, shoreline delineation, coastal habitat, greenness, vegetation index, tasseled cap, Louisiana coast, Central Gulf

BACKGROUND: Environmental Sensitivity Index (ESI) mapping refers to a shoreline classification and sensitivity ranking system that has been a vital component of oil spill contingency planning and marine environmental assessment programs nation wide for 25 years (Halls et al., 1997). The U.S. Minerals Management Service (MMS) currently uses ESI data and the ESI classification scheme for environmental assessment studies related to Outer Continental Shelf (OCS) activities. Traditional ESI data development includes the interpretation of aerial photographs and mapped observations by coastal geologists during overflights. This method has been applied successfully to the majority of the U.S. coastline. The complex, rapidly changing shoreline of Louisiana, however, has made ESI mapping extremely difficult using traditional techniques. As a result, a coast-wide ESI shoreline classification has never been developed for Louisiana. This represents a major information gap, as oil spill risk and environmental consequences in Louisiana are great.

ACCESS NUMBER: 30951-85250

OBJECTIVES: (1) To develop remote sensing classification procedures supporting ESI mapping efforts in Louisiana and elsewhere; (2) To determine if remote sensing methods are as reliable as traditional methods, more cost effective, and more efficient; (3) To assess the appropriateness of the spectral and spatial resolution of IKONOS satellite imagery for ESI mapping; (4) To substantiate the cost savings of archived imagery; (5) To ascertain if a viable land/water interface can be developed from IKONOS imagery; and (6) To discover if an ESI style product useful for spill response and coastal management can be developed.

DESCRIPTION: The study area comprises the saline regions of the Louisiana coastline from Port Fourchon to Lake Barre. Salinity boundaries were obtained from the 1997 Louisiana Coastal Marsh Vegetative Type Map produced by the Louisiana Department of Wildlife & Fisheries, which includes categories of fresh, brackish, intermediate, saline, and water. These data define saline as salt marsh having typical vegetation of oystergrass (spartina alterniflora), glasswort (avicennia germinans), and saltgrass (distichlis spicata)". This area of coastal Louisiana has experienced high rates of land loss and rapid shoreline change that have made traditional ESI classification techniques difficult. However, the presence of extensive oil and gas infrastructure and highly sensitive habitats and natural resources in this area emphasizes the need for up-to-date maps for oil spill planning and response.

The methodology consisted of satellite image acquisition, land/water interface delineation from the satellite imagery, in situ data collection, satellite image classification, vector shoreline transfer, validation overflights, and accuracy assessment. In contrast, a traditional ESI project methodology consists of identification of existing digital land/water or shoreline, overflight classification on topographic quads, field classification accuracy assessment, and on-screen ESI attributing of the digital shoreline.

SIGNIFICANT CONCLUSIONS: The spatial and spectral resolutions of IKONOS imagery adequately captured four broad habitat classes, but did not extract the same level of detail as traditional ESI mapping methods. The usefulness and applicability of these broad ESI classifications are dependent on the question at hand. For oil spill response, the relatively current imagery provides a valuable base map that is greatly improved over other available maps. This feature is particularly important in coastal areas experiencing rapid shoreline change. One of the biggest challenges of responders in these areas is access to maps that accurately reflect current conditions and shoreline locations so that equipment and personnel can be deployed to appropriate cleanup sites. Currently, responders obtain oblique digital photography during overflights, then print out the photographs to use as base maps for deploying equipment and mapping the distribution of oil. Recent imagery would provide a more uniform base map. A high resolution shoreline vector was also extracted from the imagery and served as the base for shoreline classes. Creation of an actual shoreline is also of value to spill responders, since miles of shoreline oiled is a common metric used to measure the spill impact on linear shoreline types and track cleanup progress.

Both archived and new-collect imagery were used in this study. The average price for archived imagery was \$6.85 per km² whereas the average price for new-collect imagery was \$12.89 per km². The archived imagery is significantly cheaper, however, the seasons and tides cannot be chosen and fieldwork cannot coincide with the collection of the imagery. On the other hand, it is still difficult to predict and plan for new-collect satellite imagery to coincide with the desired seasons, tides and cloud free days, and the small swath width of the IKONOS satellite cannot collect imagery for a large area in a single pass.

General recommendations to improve the classification of all ESI habitat types include the use of more robust sensors, sensors that can extract vertical structures, ancillary elevation data, texture analysis, and an exposure index. The Compact Airborne Spectrographic Imager (CASI and CASI 2) and Light Detecting and Ranging (LiDAR) are robust airborne sensors that have the potential to extract ESI classes with greater detail. Larsen and Erickson (1998) used the CASI sensor to distinguish between substrate types such as course sand, mud, and gravel beaches and man-made features. LiDAR collects elevation data, which may be useful in classifying vertical structures. Applying an exposure index to the shoreline can further define the modified classes into sheltered and exposed.

STUDY RESULTS: Ten ESI habitat types were observed during the field work and overflights. The habitat characteristics were recorded for each type, and the technical performance of the imagery and classifications techniques were documented. Figures illustrate IKONOS imagery of each ESI habitat with a second image depicting the vectorized shoreline attributed with the ESI classification. In addition, an oblique aerial photograph, taken during the overflights, is shown for the same general area of the imagery along with a representative ground photograph of each ESI habitat.

The tide at which the imagery was acquired significantly affected the accuracy of the mud and tidal flat mapping. IKONOS imagery accurately classified mud and tidal flats when the imagery was acquired at low tide. When the imagery was acquired at high tides, few flats were classified. The validation overflights, conducted during low tide, confirmed the extensive areas of mud and tidal flats found within the coastal region of Louisiana.

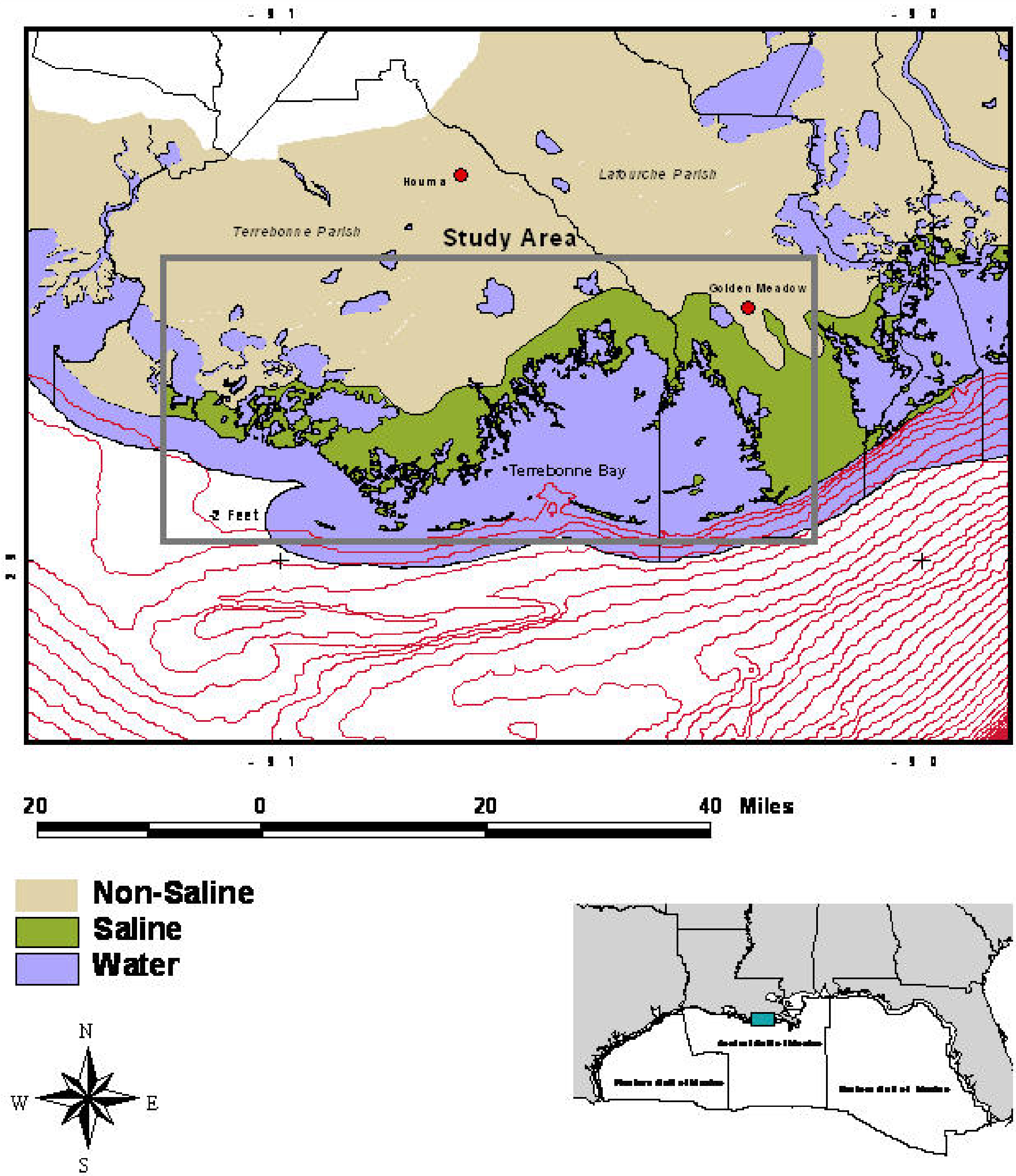
The modified ESI class of beaches and man-made structures was the most difficult and least accurate classification type. The spatial and spectral resolutions of IKONOS imagery are not as effective at distinguishing between spectrally bright features and/or narrow or vertical structures. Gravel and sand beaches, urban infrastructures, riprap, and seawalls all exhibit similar reflectance values within the multi-spectral IKONOS imagery. Suspended sediment in shallow water caused additional problems.

Overall, scrub-shrub habitats were easily identified and classified from the IKONOS imagery, and the classification of salt marsh habitats was successful. Salt marsh was the dominant habitat class found within the study area. Identifying vegetation phenology of the dominant vegetation types may help refine the classification. The classification of broken marsh areas was less accurate than areas of solid salt marsh.

STUDY PRODUCTS: Research Planning, Inc. and Louisiana State University. 2005. Feasibility of Using Remote Sensing Techniques for Shoreline Delineation and Coastal Habitat Classification for Environmental Sensitivity Index (ESI) Mapping. OCS Study Report MMS 2005-047. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Contract No. 1435-01-99-CA-30951-85250. 71 pp.

Geospatial Data: Vectorized shoreline in shapefile format attributed by ESI habitat for saline marsh region of study area. Vectorized polygons in shapefile format of mud flats for saline marsh region of study area. Both GIS layers are supplied with accompanying metadata..

ACCESS NUMBER: 30951-85250



STUDY AREA FOR FEASIBILITY OF USING REMOTE SENSING TECHNIQUES FOR SHORELINE DELINEATION AND COASTAL HABITAT CLASSIFICATION FOR ENVIRONMENTAL SENSITIVITY INDEX (ESI) MAPPING.