Airborne Sensor Fusion for Coastal Environmental Applications

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US Army Corps of Engineers
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USACE National Coastal Mapping Program (NCMP)

- Funded by HQ
- Initiated in FY2004
- Collect lidar elevation and imagery data to support regional sediment management/navigation
- 5-year national cycle
- Focus on sandy shorelines
- Mission planning meetings

CHARTS

Optech SHOALS-1000 Integrated Laser System

DuncanTech-4000 RGB camera

Itres CASI-1500 Hyperspectral Imager

Bottom Aircraft Port

System II Specifications

1,000 Hz Pulse Rate (hydro)

10,000 Hz Pulse Rate (topo)

1 Hz Digital camera (~20 cm pixel)

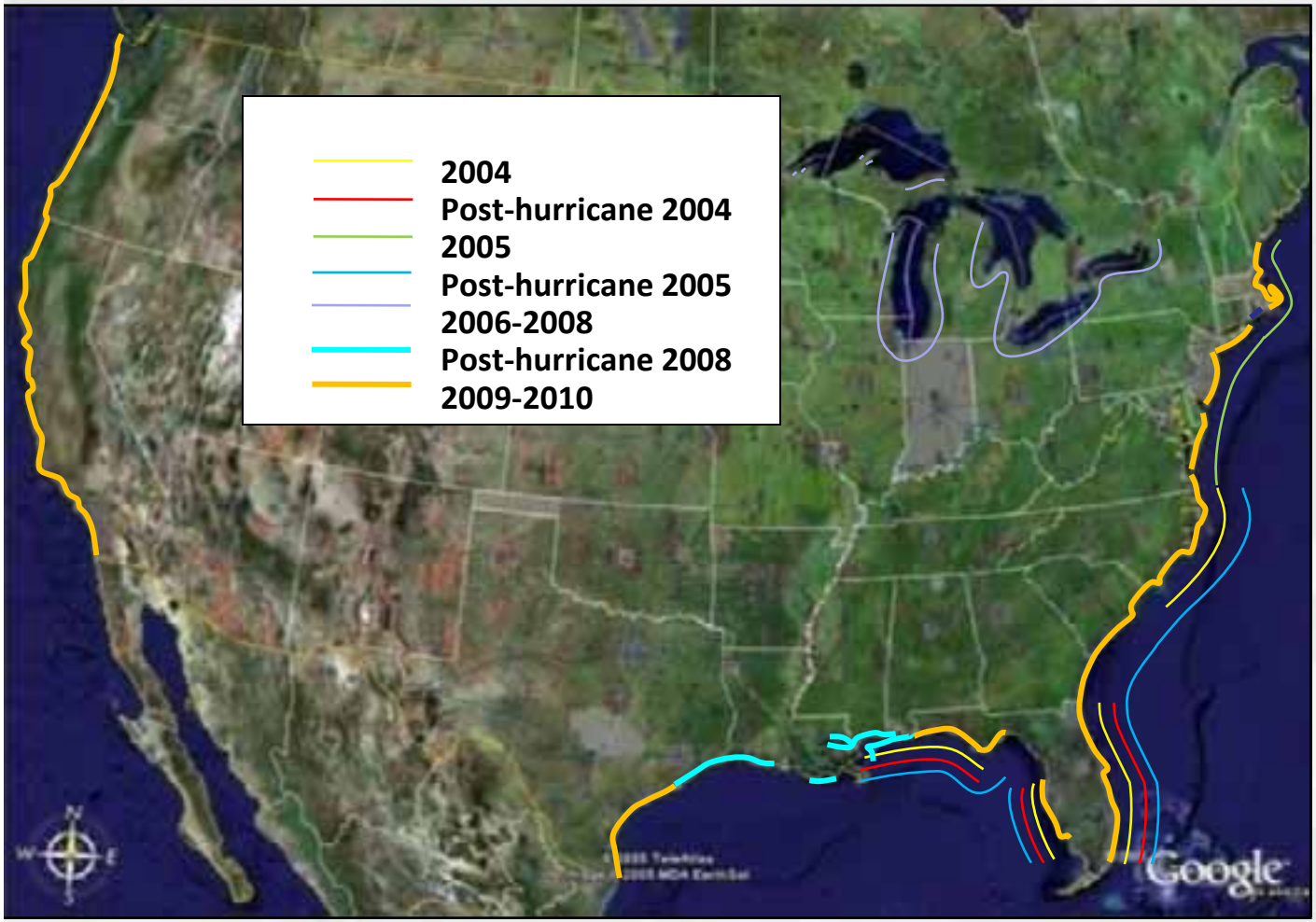
CASI-1500 Hyperspectral Imager

1500 cross-track pixels

380 – 1050 nm wavelength

1 m pixel w/ 36 spectral bands

USACE NCMP Surveys and Products



Available data products:

- ASCII xyz
- RGB mosaics
- Zero contour
- 1-m bathy/topo DEMs
- LAS format topo
- 1-m bathy/topo bare earth DEMs
- Hyperspectral mosaics
- Laser reflectance
- Basic landcover classification

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EL and JALBTCX

- EL has teamed up with JALBTCX to assist with the development and expansion of environmental data products
- GOAL: identify/expand environmental data products, utilizing (1) imagery resources of JALBTCX and (2) environmental expertise in EL to address environmental/geospatial needs of the coastal districts.

Environmental Systems Branch (EL)

- **MISSION:** Identification, mapping, and modeling of environmental conditions in support of diverse military and civil requirements. Development of environmental sensing, characterization, and monitoring capabilities necessary to quantify environmental site conditions. Model development for the prediction and visualization of dynamic environmental characteristics for civil and military applications.

Tasks and Objectives

- Target features spectrally with hyperspectral and structurally with lidar through image fusion
- Brief the coastal districts during mission planning
  - Increase awareness
  - Identify needs and priorities
  - Initiate collaborations

Use of Airborne Lidar and Hyperspectral Data to Detect and Discriminate SAV Species at Corps Dredging Sites

Approach: Combine and process bathymetric lidar and hyperspectral data from high resolution airborne platform to determine zero-range spectral reflectance. Use spectral pattern recognition techniques to classify SAV and macroalgae species.

Massachusetts Dept. of Environmental Protection, 1995, 2001 eelgrass surveys and online maps

Project Plan/Methods

Mission Planning:

- CASI spectral bands
- Survey window, September

Ground Truthing: site visit this week!

- Acoustic survey/video imaging
- Bottom sampling
- In-situ spectral measurements
- Water sampling

Image Processing:

- Hyperspectral/lidar post-processing
- Spectral optimization (depth correction)
- Species classification
- Accuracy assessment

Heavy-metal Stamp Sands Migration in Lake Superior

Objectives

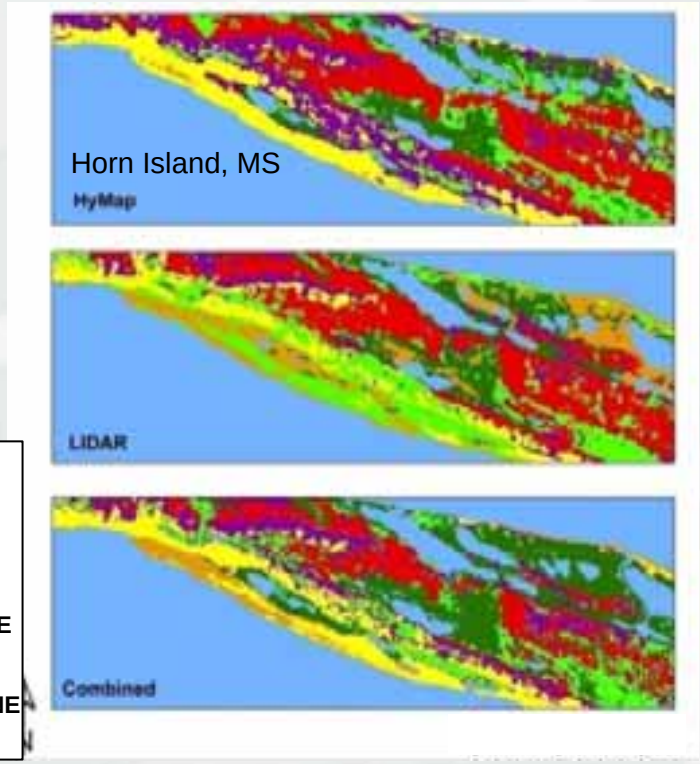
- Map stamp sands distribution above and below water line
- Estimate movement and loss of stamp sands to lake
- Extrapolate consequences of no actions to immobilize sands

Approach

- Register and difference lidar topographic and bathymetric data with archival maps and data
- Classify submersed lake bottom surfaces using passive hyperspectral and lidar bottom reflectance
- Evaluate accuracy using ground truth sediment sampling data

Landuse/Landcover and Species Composition

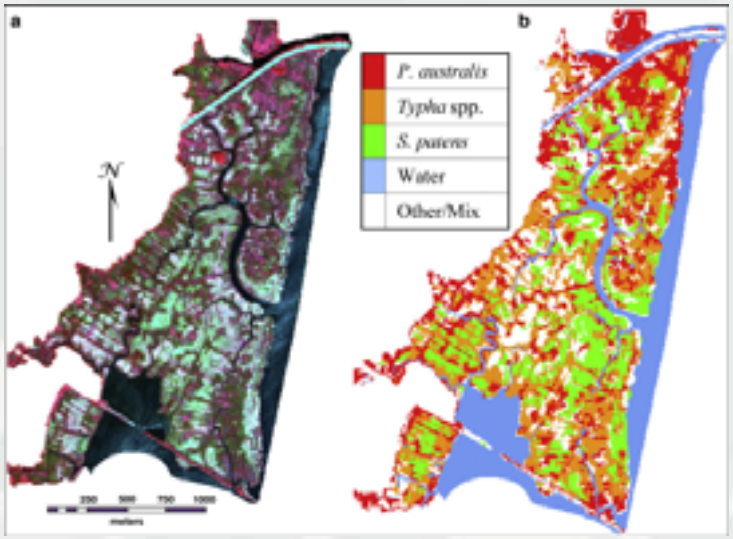
- Landuse/landcover, Species Composition/Distribution, and Habitat Mapping
  - Use standard system such as the National Vegetation Classification System



Lucas and Carter. 2009. Decadal Changes in Habitat-Type Coverage on Horn Island, Mississippi, USA. *Journal of Coastal Research*, In Press.

Invasive Species Detection

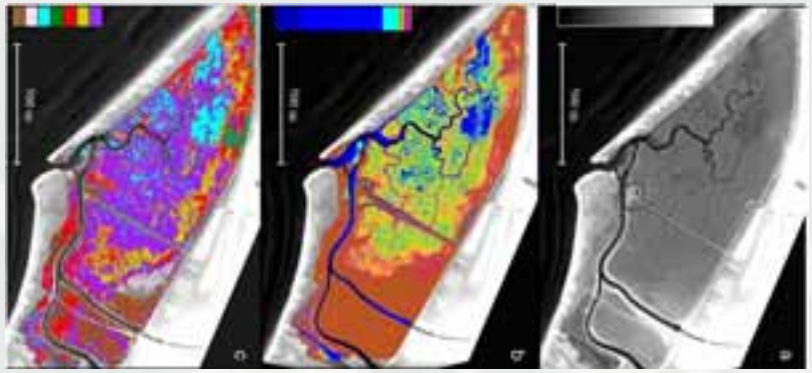
- Mapping Invasive and Indicator Species
  - Spectrally and structurally target species of interest
  - Emphasize changes in composition, structure and function in ecosystems caused by invasives



Gilmore, M.S. et al. 2008. Integrating multi-temporal spectral and structural information to map wetland vegetation in a lower Connecticut River tidal marsh. *Remote Sensing of Environment*. 112:4048-4060.

Wetlands and Beach Characterization

- Mapping Wetland Habitats and Beach Morphology
  - Spectrally and structurally target wetland species
  - Emphasize species pattern characterization and zonation related to elevation gradients
  - Characterize erosion/sedimentation and beach types for monitoring



Sadro, S. et al. 2007. Characterizing patterns of plant distribution in a southern California salt marsh using remotely sensed topographic and hyperspectral data and local tidal fluctuations. *Remote Sensing of Environment*. 110:226-239.

Suitability/Prioritization Modeling

- Ecosystem Modeling with Suitability/Prioritization Ranking
  - Identify unique characteristics in landscape parameters/attributes
  - Model habitat for invasive/threatened/endangered species and restoration/conservation

Potential habitat for
invasive species (Lepidium)