Decision Support for Coastal Science and Management

Lidar Vegetation Mapping in National Parks: Gulf Coast Network

Airborne lidar (Light Detection and Ranging) is an active remote sensing technique used to collect accurate elevation data over large areas. Lidar provides an extremely high level of regional topographic detail, which makes this technology an essential component of U.S. Geological Survey (USGS) science strategy. The USGS Coastal and Marine Geology Program (CMGP) has collaborated with the National Aeronautics and Space Administration (NASA) and the National Park Service (NPS) to acquire dense topographic lidar data in a variety of coastal environments.

EAARL Technology

The Experimental Advanced Airborne Research Lidar (EAARL) is an airborne lidar system that provides unique capabilities to survey coral reefs, nearshore benthic habitats, coastal vegetation, and sandy beaches (Wright and Brock, 2002). Operating in the blue-green portion of the electromagnetic spectrum, the EAARL is specifically designed to measure submerged topography and adjacent coastal land elevation in a single scan of transmitted laser pulses (Nayegandhi and others, 2009).

Effective coastal management plans need accurate and detailed representation of the horizontal and vertical structure of plant communities, also called canopy structure. EAARL is a full-waveform digitizing lidar. It records backscattered laser energy above a very low time interval, creating a data record that is highly sensitive to minor changes in vegetation structure. These “small-footprint” EAARL waveforms can be used to generate accurate estimates of the spatial arrangement in coastal vegetation communities.

To describe the vertical structure of a vegetation canopy, several individual small-footprint laser pulses are combined to create a composite “large-footprint” waveform that defines a larger horizontal area (fig. 1). This process is called composite waveform analysis. The size of this composite footprint can be determined in post-flight processing software, unlike large-footprint lidar systems, whose footprint size is constrained by hardware prior to data acquisition. The size of the composite footprint depends on the density of the lidar data, the nature of the forested terrain, and the desired horizontal resolution of the end product.

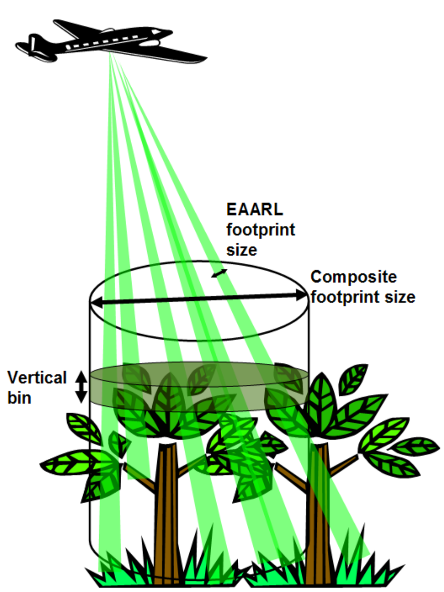

Figure 1. EAARL lidar waveforms can be combined to create a composite waveform.

Coastal Applications

The National Park Service (NPS) has been mandated to improve park management through greater reliance on scientific knowledge, and it achieves this goal through its Inventory and Monitoring (I&M) Program. EAARL lidar data were acquired by the USGS in collaboration with the NPS I&M Program to document and interpret vegetated habitats along coastal areas in the NPS Gulf Coast Network (GULN). This network extends from the western third of Florida through Mississippi and Louisiana to the southeastern quarter of Texas and extends northward to Nashville, Tennessee.

EAARL-derived vegetation measurements are being used to provide reliable and consistent quantitative information on the structural

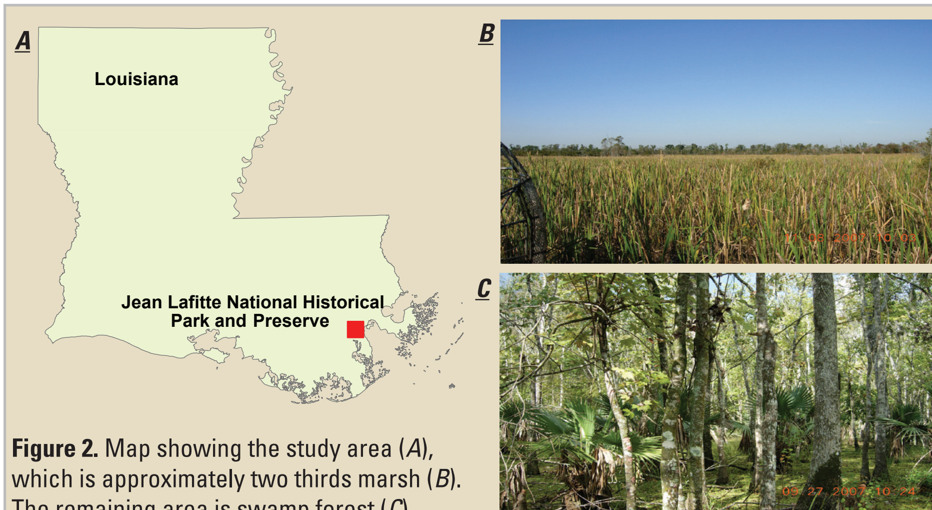

Figure 2. Map showing the study area (*A*), which is approximately two thirds marsh (*B*). The remaining area is swamp forest (*C*).

characteristics of park vegetation resources at both small and large scales. One recent study evaluates the capabilities of EAARL technology in predicting the presence or absence of coastal vegetation communities in Barataria Preserve at Jean Lafitte National Historical Park and Preserve, Louisiana (JELA) (fig. 2; Palaseanu-Lovejoy and others, 2009). Bare-earth elevation, canopy height, canopy reflection ratio, and the height of median energy are examples of metrics that can be derived from EAARL composite-footprint waveforms (fig. 3). In coastal communities, bare-earth elevations can be used to model the hydrology of areas and therefore be helpful in predicting water availability to plant communities. Canopy height is a long-established indicator of site quality in forestry applications. Canopy reflection ratio is a relative measure of canopy cover, and height of median energy has been found to be a good predictor of biomass and structural attributes in tropical forests. Applied in a similar manner to coastal vegetation communities, height of median energy could be used to help identify structural changes across environmental gradients and perhaps assess damage to forests from storms and parasite infestations.

Maps generated from lidar-based vegetation measurements are used extensively for conservation, land management applications, and decision support systems. These maps can also be used in change analysis and assessment of extreme storm impact on different vegetation communities.

In addition to the research efforts taking place in the GULN, the USGS also collaborates with two other NPS I&M Program Networks, the South Florida Caribbean Network and the Northeast Coastal and Barrier Network. Lidar data have been collected using EAARL technology in all three NPS networks to document and interpret marine benthic communities, barrier island geomorphology, and vegetated habitats in coastal areas.

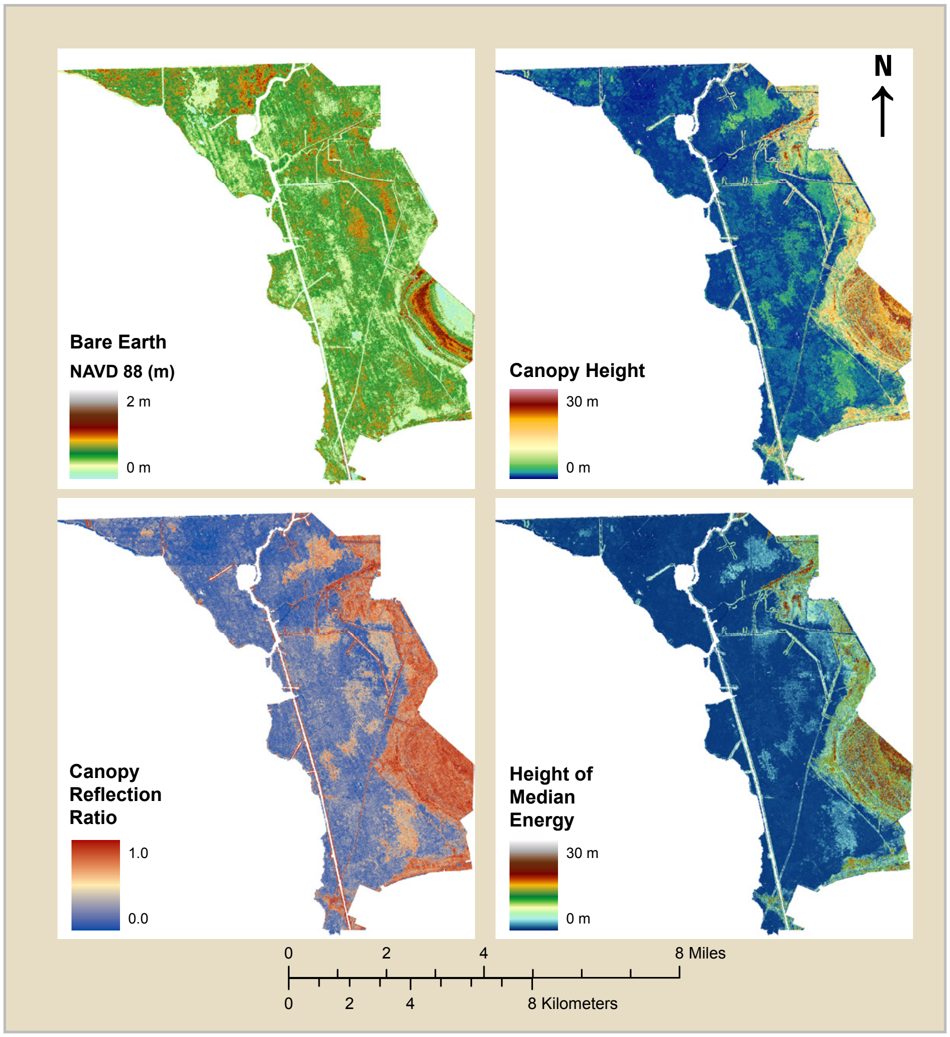

Figure 3. Examples of EAARL measurements from Jean Lafitte National Historical Park and Preserve, Louisiana. Abbreviation: m, meter.

References Cited

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Contact Information

John C. Brock
Coastal and Marine Geology Program
USGS National Center, Mail Stop 915–B
12201 Sunrise Valley Drive
Reston, VA 20192
jbrock@usgs.gov

Monica Palaseau-Lovejoy
U.S. Geological Survey
St. Petersburg Coastal and Marine Science Center
600 4th Street South
St. Petersburg, FL 33701
mpal@usgs.gov

Martha Segura
Gulf Coast Network
National Park Service
Lafayette, LA 70506
Martha_Segura@nps.gov

http://ngom.usgs.gov/dsp