Knee-deep in pluff mud: In 2008, the NOAA Coastal Services Center's lidar team waded into the South Carolina marsh to compare the elevation information they gathered with a GPS survey tool against elevation information collected through lidar.

Keil Schmid

LINKING LIDAR TO COASTAL STEWARDSHIP

The guardians of the nation's coast tap into a NOAA resource to find lidar data, a contract vehicle, technical assistance, and trainings.

BY KITTY FAHEY

The workload just keeps growing for local, state, and federal officials charged with safeguarding the vitality and natural resources of U.S. coastal communities. The nation's population living near the oceans and Great Lakes has grown by 47 percent since 1970, and this rapid growth is placing unprecedented demands on coastal communities.

These communities are also on the front lines of intensifying natural hazards, a point underscored just last month as Hurricane Irene roared up the U.S. coast on a path of destruction from North Carolina to Maine. Coastal professionals need accurate data and information to help communities prepare for hazard threats and to bounce back from storms, flooding, sea level rise, and other impacts.

A lidar collection housed and distributed by the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center is becoming the first stop for a growing number of coastal professionals (see www.csc.noaa.gov/lidar). The collection is featured on the Digital Coast, a national online

initiative led by the Center that gives communities the data and information they need to address coastal conservation, hazard resilience, marine spatial planning, and climate change.

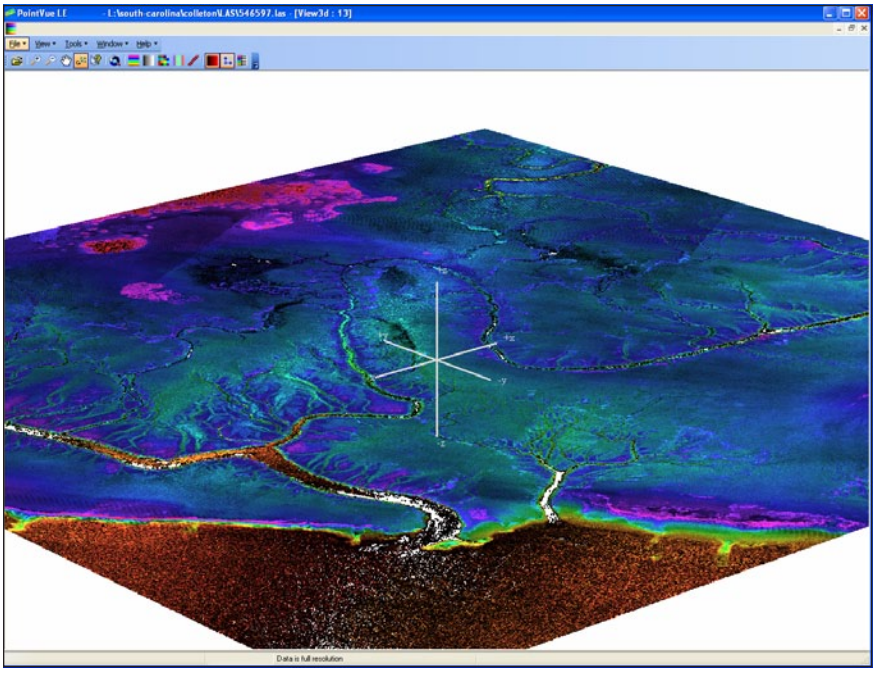
"Since 1996 we've been working to get lidar data out to coastal managers," says Kirk Waters, the Center's program manager for coastal remote sensing. "We have nearly 20 terabytes of downloadable lidar data from every coastal state featured on the site, collected by NOAA programs, other federal agencies, state and local government, academic institutions, and private firms."

The Center also provides a vehicle that enables local and state officials to contract the flying and processing of lidar, using contractors with proven past performance who have already undergone a stringent, competitive contracting process.

"Once the Center contracts out the funds to fly the lidar, we provide contract management services to ensure that the data will meet the customer's needs and relieve them from day-to-day worries about the project," says Waters. "We may also agree to help with technical issues, examine the data, supply extra information on the data, and provide quality assurance or else have quality assurance performed by an independent, third-party contractor. Once the data is gathered, approved, and delivered to the customer, it gets put on the Digital Coast website and can be used by anybody."

Ill Wind Stirs Lidar Need

In September of 1999, Hurricane Floyd caused the evacuation of more than 2 million people from five states and wrought devastation in eastern North Carolina, whose residents suffered 35



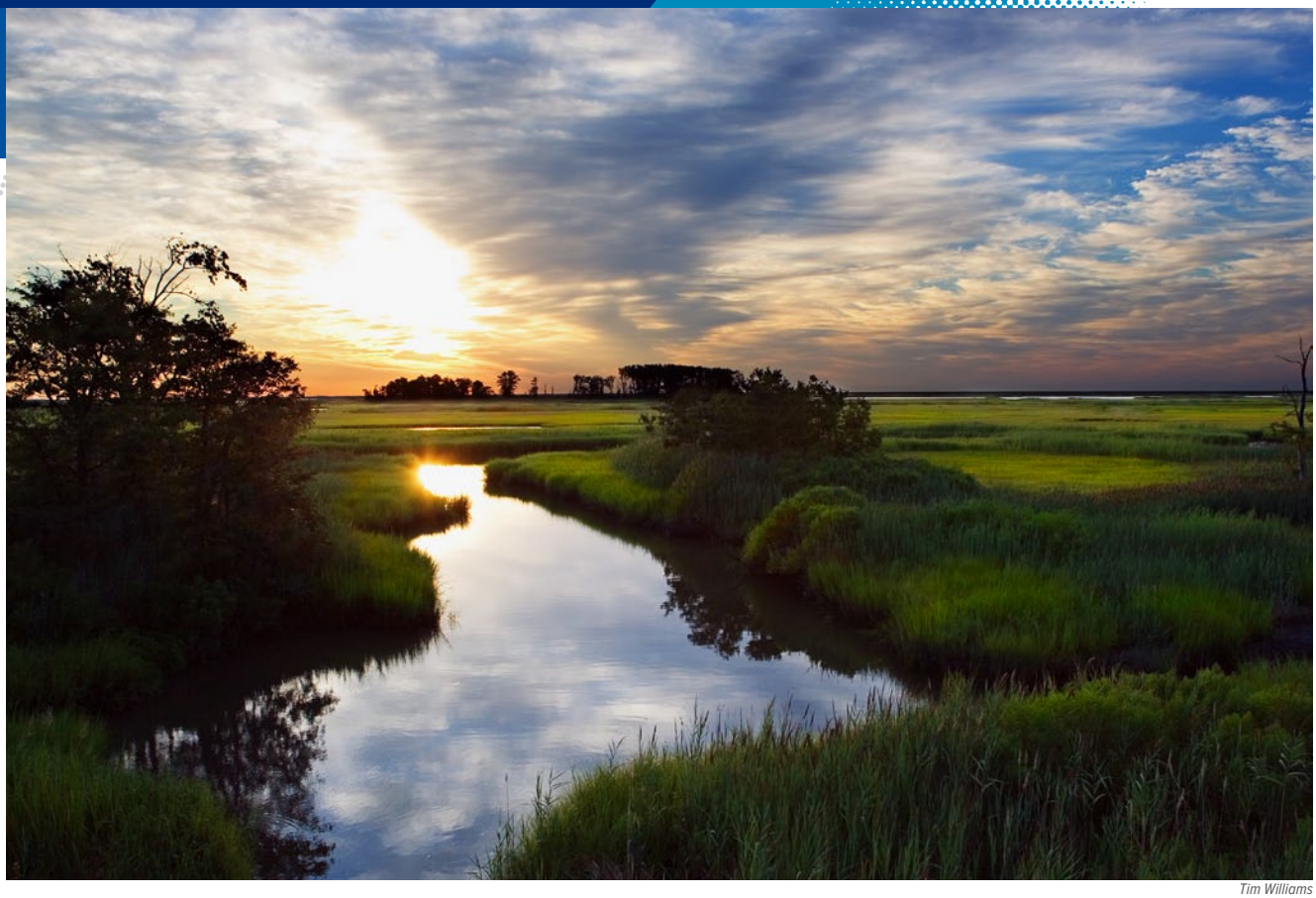
This coastal lidar image captured two aspects—elevation and intensity—so that coastal managers will understand more about a marsh's subtle variations in elevation and plants.

A POPULAR FAVORITE: SHORELINE CHANGE DATA

In 2004, the NOAA Coastal Services Center agreed to help the U.S. Army Corps of Engineers (USACE) distribute its high-resolution topographic and bathymetric lidar elevation data of U.S. sandy shorelines. The USACE National Coastal Mapping Program (NCMP) provides the data, which includes true-color and hyperspectral imagery, on a five-year recurring basis. The data is used by a wide variety of researchers in government, academia, and industry to detect coastal changes, manage sediment concerns, and to make land use plans.

The combined lidar data and imagery are the most frequently downloaded lidar data sets on the Digital Coast website (see www.csc.noaa.gov/digitalcoast/data/chartstopobathy).

"Leveraging the Digital Coast's data distribution capabilities expands our audience and reduces the need to physically ship data files," says Chris Macon, the NCMP technical lead. "Data users draw their area of interest on the Digital Coast's online map, select their desired data format and download the data onto their computer system. In this way, users are getting high-resolution elevation data in a format that works best for their software application of choice."



Tim Williams

In 2011, lidar was flown over the Bombay Hook National Wildlife Refuge in Delaware (shown here) to help coastal managers understand why marsh areas are diminishing.

THE ELLIPSOIDAL EQUATION

The NOAA Coastal Services Center stores lidar data in ellipsoidal heights, and later uses geoid models to transform ellipsoidal heights into orthometric heights. Kirk Waters, the NOAA Coastal Services Center's program manager for remote sensing, explains why.

"The ellipsoid is a mathematical surface used in Global Positioning Systems and is a suitable reference for lidar measurements to maintain data integrity. But nobody working on management issues wants data in ellipsoid heights, they want orthometric heights," explains Waters. "By starting with ellipsoidal heights and transforming later into orthometric heights, we're better positioned to keep our data consistent and accurate, while the National Geodetic Survey continues the process of refining the geoid models every several years."

fatalities on the day of the storm, billions of dollars in damage, and ecological harm to rivers and sounds because of massive stormwater runoff.

The maps that had been used to prepare for Floyd were, in some cases, decades old and lacked the accurate elevation data and current applications so important to making flood-related decisions. A national outcry motivated Congress to allot millions of dollars to the Federal Emergency Management Agency (FEMA) for modernizing floodplain maps.

In the meantime, the Center realized the importance of expanding its lidar collection beyond a narrow strip of shoreline, to meet the floodplain mapping needs of coastal resource managers. But floodplain mapping is not the only concern of coastal resource managers.

"Sea level rise is driving lots of requests for our lidar contract vehicle," says Waters. Using lidar to address sea level rise requires more stringent specifications than does mapping the floodplain using FEMA's guidelines. "Our customers figure they'll get more bang for their buck if they contract for lidar with sea level rise in mind, because the data will help them deal with floods, too."

The Power of Lidar Partnerships

In 2007, Chris Chalmers was the GIS director of Georgia's Coastal Regional Commission when he was approached by the U.S. Geological Survey (USGS) about spearheading a multi-county agreement to purchase lidar. (Chalmers now works as a senior project manager at Woolpert, one of the Center's contractors for flying lidar data.)

"At that time, Georgia needed new lidar data because we didn't have flood maps or storm surge maps covering the entire coast," notes Chalmers. However, he had his doubts about

Woolpert

This image shows a developed coastal area in Massachusetts and illustrates the strength of lidar pulse energy after striking an object and returning to the sensor. The lighter the hue, the greater the intensity of features captured.

LIDAR TRAININGS

Two online trainings are available from the NOAA Coastal Services Center:

Introduction to Lidar

www.csc.noaa.gov/digitalcoast/training/intro-lidar

Introduces fundamental lidar concepts and demonstrates how lidar-derived elevation data supports natural resource and emergency management applications.

Understanding Map Projections, Datums, and Coordinate Systems

www.csc.noaa.gov/digitalcoast/training/datums

Teaches the fundamental concepts of map projections, datums, and coordinate systems.

whether the project would get off the ground. "FEMA would only provide us with funding if counties matched the amount, and some people's concern was, 'How are you going to get all those counties to agree to that?'"

After talking with Center staff members, Chalmers decided to use the lidar contract vehicle. "The great advantage of the Center's qualification-based contracting process is that it satisfies our state competition laws on contracting. I also liked the fact that the Center would treat me like a client, managing the funds and giving me updates on the project," adds Chalmers.

Chalmers visited county after county, telling officials about the lidar opportunity. Surprisingly, 13 counties, six of which were coastal, signed on and contributed funds for the FEMA match. "Not only does the state now have modernized floodplain and storm surge maps," notes Chalmers, "but the State of Georgia points to this project as a model for multi-county collaboration."

For Bob Scarborough, a senior scientist with the Delaware Coastal Programs, the Center's contract vehicle enabled the state to acquire new lidar and digital imagery to accomplish many coastal management goals.

"The manager of our two national wildlife refuges located in Delaware has a lot of concerns about marsh loss. Some marshes are turning into mudflats or open water, which could lead to further sediment loss and is also bad news for waterfowl and aquatic habitat. We have some theories about why this is happening, but we needed to fly lidar at a low spring tide to learn more," says Scarborough.

The Delaware Coastal Programs used the Center's lidar contract vehicle earlier this year, which "saved us a lot of work and time," says Scarborough. The programs are beginning to analyze the lidar data and digital imagery, and after additional sediment sampling and modeling, will know more about why marsh loss is happening.

"This data is not just helping the refuges," says Scarborough. "The Delaware Division of Fish and Wildlife is going to use it to learn more about their wildlife impoundments, and the lidar will be used by the Delaware National Estuarine Research Reserve to help analyze the early environmental impacts of climate change."

Kitty Fahey is a writer with I.M. Systems Group at the NOAA Coastal Services Center. The mission of the Center is to support the environmental, social, and economic well-being of the coast by linking people, information, and technology.