Laser Mapping Helps Archaeologists and City Planners

LiDAR technology can be used to predict natural disasters

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Caracol, the site of an ancient Mayan city, is the largest archeological site in Belize, and has been a focus of scientific exploration for decades. Until recently, however, the only way researchers could uncover its wonders was to slowly and laboriously hack their way through the dense jungle overgrowth with machetes and other tools.

But nearly three years ago, researchers tried a new approach, flying over the area with laser technology that can penetrate through the tiniest openings in the rainforest canopy, for the first time allowing archaeologists an unencumbered--and unprecedented--three dimensional view of a vast expanse of this early urban civilization.

"The archaeologists were able to learn things they hadn't known before, for example, that the settlement was much larger than they had seen earlier, with the remains of previously undiscovered structures and more extensive agricultural fields," says William Carter, senior engineer for the National Center For Airborne Laser Mapping (NCALM), which has made major contributions to the development and application of the technology during the past decade.

"Essentially, we can remove the vegetation from the terrain so you can see what's below it," he adds. "It enables scientists and others to see what the actual bare earth is beneath the vegetation. In this case, it helps provide information about a past civilization."

Airborne light detection and ranging (LiDAR) technology, which combines sophisticated laser surveying instruments and GPS, allows scientists to create bare earth maps of thousands of square kilometers with decimeter resolution in a matter of days, regardless of the extent of forests or other vegetation.

More recently, the center also purchased a high pulse rate 'green' laser (which refers to the color of its light) LiDAR unit with the ability to penetrate shallow water.

In addition to its applications in the field of archaeology, information generated by their work holds benefits in predicting as well as coping with the aftermath of landslides, earthquakes, river and coastal flooding, and beach erosion, among other things.

"The data will help in planning for, responding to, and mitigating the impacts of disasters, both from natural and human causes," Carter says.

Ultimately, the researchers hope to develop ways to transfer the laser technology to small unpiloted aerial vehicles, or UAVs. Although they are not yet available, they could prove especially valuable during or after future natural disasters.

"We could launch one immediately after an earthquake, or during a hurricane, for example, when it still isn't safe for a pilot to be up there," Carter says. "Instead of trying to locate an airport to operate from in an area struggling to recover from a disaster, we could send out one of these UAVs. With no need for local support, we could collect the data, and send it back in near real time, so we could analyze it and provide information to responders on the most heavily damaged areas."

The center traces its origins to a University of Florida research group formed by Carter and Ramesh Shrestha, a civil and environmental engineer during the latter half of the 1990s. The actual center began in 2002, in collaboration with Bill Dietrich, a professor in the earth and planetary science department at the University of California at Berkeley. Today, the NCALM operations center is located at the University of Houston, where Shrestha leads a geo-sensing systems engineering program and serves as center director.

The National Science Foundation funds the center with about $1 million annually, as well as providing additional financial resources--sometimes more than $1 million a year--to support research projects using the technology.

For example, "using data we collected, a researcher discovered that a landslide blocked the Eel river, in northern California, 22,500 years ago, forming a lake and blocking the trout breeding runs up to the higher areas, apparently resulting in two different types of trout interbreeding to create a new breed peculiar to that river today," Carter says.

The state-of-the-art laser instruments have, in the past, produced updated and accurate maps of potential flood zones in Florida's Pinellas County, resulting in an estimated $25 million of savings annually in flood insurance costs. More recently, the technology mapped all the major fault lines in California, a template that will serve as a baseline for recording changes that occur after future earthquakes.