Using ArcScene for GIS visualization and Park Outreach

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Abstract. The South Florida/ Caribbean Network (SFCN) of the National Park Service used lidar imagery to produce 3D visualizations of SFCN monitoring programs at Virgin Islands National Park (VIIS). We acquired high-resolution lidar DEM's through a partnership with NASA and USGS and paired these data with aerial imagery of St. John, USVI using ESRI ArcScene software. The lidar DEM was used to produce 3D imagery of both onshore bald earth topography as well as offshore submerged topography at 1-2 meter resolution. The onshore visualizations use lidar elevation values to define the land surface of the aerial photographs, and the submerged topography visualizations use the lidar DEM as the surface of the ocean floor and the aerial imagery as a semi-transparent water level layer. Using these visualizations the user can explore 3D imagery of the offshore SFCN coral monitoring sites as well as terrestrial monitoring sites managed by NPS and other agencies. This tool may be used both for NPS visualization purposes as well as public outreach and education of our monitoring programs.

Introduction

Virgin Islands National Park is located approximately 1,115 mi offshore of the contiguous United States (Figure 1). The park boundary encompasses 14,695 ac (5,946 ha), of which 5,919 ac (40%) is marine and 8,775 ac (60%) is terrestrial (Figure 1). The task of obtaining high resolution topographical information for a park with both submarine and terrestrial resources was made possible through the use of the NASA Experimental Advanced Airborne Research Lidar (EAARL) sensor.

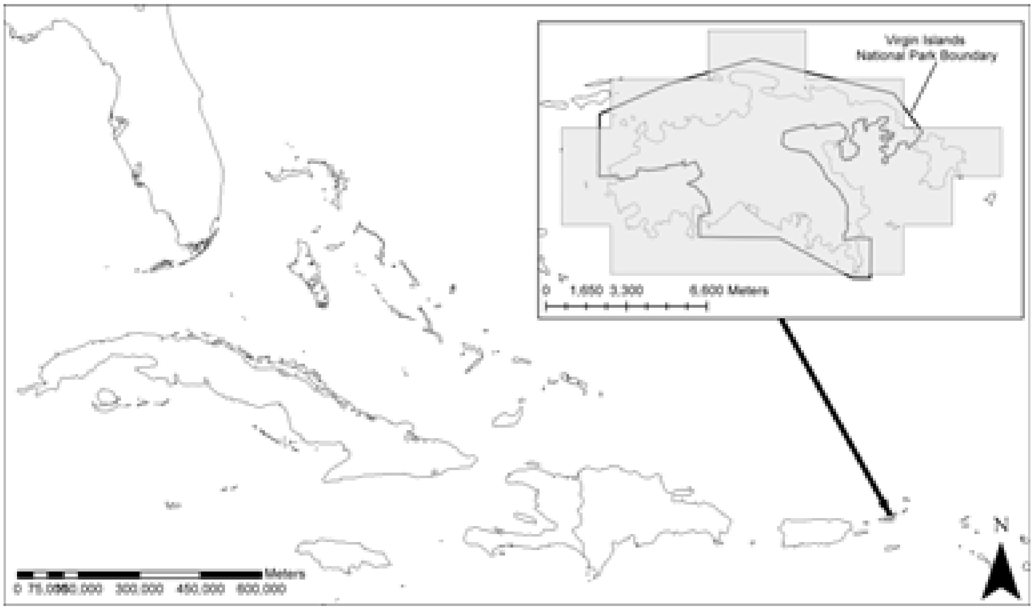

Figure 1. Map showing location of Virgin Islands National Park and lidar extent. Gray transparent overlay indicates extent of lidar data tiles.

The term "lidar" is an acronym that stands for light detection and ranging. Lidar instruments are often flown in small aircraft and utilize an active remote sensing technology. Laser light is pulsed downward, where it interacts with surface or near-surface objects and reflects back to the lidar instrument (Brock et al. 2002). The time between the initial pulse and separate returns provides information on different layers of topography (including tree canopy, bald earth, water level, and submarine topography) (Wright and Brock 2002).

In 2003, a lidar survey was flown over the majority of Virgin Islands National Park in order to obtain both terrestrial and submarine topography data products. In this case, the layers of primary concern from the lidar data were the last surface returns ("bare earth" in terrestrial areas and submarine topography in the marine areas). With overlapping flightlines, the spatial resolution was approximately one laser pulse per square meter, with a vertical accuracy of approximately 15 cm (Brock et al. 2006). The

South Florida/ Caribbean Network (SFCN) of the National Park Service, the USGS, and NASA have collaborated to transform this lidar data into an interpretable product for researchers, park staff, and park visitors. After post-processing and raster editing, these lidar DEM's (Digital Elevation Model) were merged with offshore NOAA bathymetry data to create virtual tours of the park resources for park visitors and other interested members of the population (to be available online).

This tool is useful in the process of increasing public awareness about park-related environmental issues. Past research suggests that the degree of familiarity that the public has towards this remote ecosystem may influence the actual economic value that the public places on *preserving* this resource.

Methods

Data Preparation

The USGS-NASA-NPS partnership that produced these NASA EAARL products involves a different type of data processing for terrestrial versus submarine environments (Brock et al. 2002). Furthermore, the NASA EAARL system can only measure submerged depths up to 25 meters in ideal conditions and 15 meters attainable on most flights (Wright and Brock 2002). For this visualization the LIDAR dataset and a NOAA bathymetry model were merged to create a seamless DEM for the entire area of Virgin Islands National Park and surrounding environment. It was essential that this DEM be seamless with no data holes or anomalies that would affect the appearance of the image. Small anomalies in the DEM would appear as noticeable holes or spikes when displayed in the ArcScene GIS.

The first step in this mosaicing procedure was to create a boundary shapefile along the edge of the “no data” values in the lidar product. These “no data” gaps within the DEM and along the borders were assigned values of -100 during the data processing done by the USGS. As stated, the NASA EAARL instrument can ideally take measurements down to 25 meters in submerged environments under ideal conditions. Therefore, this boundary shapefile was created using a conditional analysis in the raster calculator, where the lidar data was delineated at equal to or greater than -20 meters and all other data values were considered inaccurate or as “no data” holes. The raster was converted to a feature dataset, being sure to deselect the generalize line box within the “Convert Raster dialogue.” This step was essential to creating a seamless DEM as we wanted the polygon lines to follow the pixels of the dataset exactly. Otherwise the pixels would be split in the clipping procedure and we would end up with NODATA slivers. This shapefile was then split into two separate shapefiles along the defined boundary. Both DEM’s were clipped using the Raster Calculator with the analysis mask set at the conversely defined boundaries of the lidar dataset. The cell size for both of these clip operations was set at 1m, which was the cell size of the lidar DEM. Again, this was done so that the pixels of each image would line up perfectly according to the boundary defined by the clipping shapefile. The two DEM’s were then merged using the Raster Calculator, where analysis extent was set to union of inputs, cell size was set to 1, and no analysis mask was set.

Map Preparation

High-resolution aerial photographs were used from the NOAA Puerto Rico and the US Virgin Islands Benthic Mapping Project (1999). This image was added to an

ArcScene project and base heights were set using the mosaiced DEM. Raster resolution was left at 10m until the entire project was completed. The image was set to resample during display using bilinear interpolation for continuous data. All of the feature datasets were added and, where possible, displayed using 3D objects and labels. The scene was recorded using the animation toolbar built into ArcScene with keyframes placed at desired intervals and then the video file was exported in AVI format to reduce file compression. For the video export the raster resolution was set at 5m.

Results

The video product as well as still images have been previewed by park resource management staff and will be made available for public use and exploration. Eventually these products should be available in the park interpretive center and on the Virgin Islands National Park website. This is an ongoing part of a NASA-USGS-NPS partnership that involves gathering and processing LIDAR data for three of the seven National Parks in the South Florida/ Caribbean Network as well as at least nine other parks in the National Park Service system (Table 1).

	Type of Map Publication:		
NPS Unit	Submarine Topography	Bald Earth Land Topography	First Return Land Topography
Biscayne NP	X		
Dry Tortugas	X		
No. FKNMS	X		
FIIS		X	X
Assateague Island National Seashore - Recent Sedimentary Environments			
Assateague Island National Seashore		X	X

Gulf Islands National Seashore (Post-Katrina)	?	X	X
George Washington Birthplace National Monument		X	X
Thomas Stone National Historic Site		X	X
Cape Cod National Seashore		X	X
Colonial National Historic Park		X	X

Padre Island National Seashore	?	X	X
USVI - St.John	X	X	X
USVI - St. Croix	X		
Fire Island National Seashore		X	X
Gateway National Recreation Area		X	X
Gateway National Recreation Area		X	X
George Washington Birthplace National Monument		X	X
Thomas Stone National Historic Site		X	X
Cape Cod National Seashore		X	X
Cape Cod National Seashore		X	X
Colonial National Historic Park			
Gulf Islands National Seashore (Post-Ivan)		X	X
Assateague Island National Seashore		X	X
Parramore Is.		X	X

Table 1. Map queue for LIDAR processing schedule. These datasets will be processed for use in a standard GIS by the SFCN office. Future applications may include 3D visualizations for park outreach.

Currently, the 3D visualizations for Biscayne National Park as well as the visualization discussed in this paper for Virgin Islands National Park are available for public exploration on the SFCN website at http://www1.nature.nps.gov/im/units/sfcn/coral_reef_mon.htm.

Discussion

The use of this tool for public education and park outreach should be further explored in terms of gaining attention for the preservation of these resources. Past research in the valuation of ecosystem services has related the value of natural resources to the sum total of anthropocentric uses that the public can obtain from these resources (Walsh et al. 1984 and Daily 1997). These values depend heavily on the level of familiarity that the public has with the resources. This familiarity can be described as level of education that the public has with the environmental issues (Silberman et al. 1992) as well as past experience through visitation (Sutherland and Walsh 1985). Research also suggests that the overall value of the resources (encompassing "familiarity" and many other factors) decreases and levels off with increasing distance away from the ecosystem of interest (Sutherland and Walsh 1985). Virgin Islands National Park is a United States commonwealth territory and located approximately 1,115 miles offshore from Florida (Figure 1). The majority of the American public will never have the opportunity to have a personal experience in this National Park. Past research in ecosystem valuation suggests that this lack of familiarity negatively affects the value that the general public assigns to preserving the resources within the park. It is a challenge to educate the public on the importance of preserving these out-of-reach resources, but, especially in the case of our degrading coral reefs (Jeffrey et al. 2005 and Field et al. 2002), it is essential that we find new ways to increase public interest and what is called “willingness-to-pay” for the preservation of these parks.

The GIS that was created for these 3D visualizations may be used in the future as a framework from which to build more realistic models, exploratory scenes of future monitoring programs at the park, and hypothetical scenarios of park degradation due to different human uses. This educational tool will increase public attention and future spending towards managing and preserving these and other imperiled National Parks.

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