

National Coastal Mapping Program Update and Tools

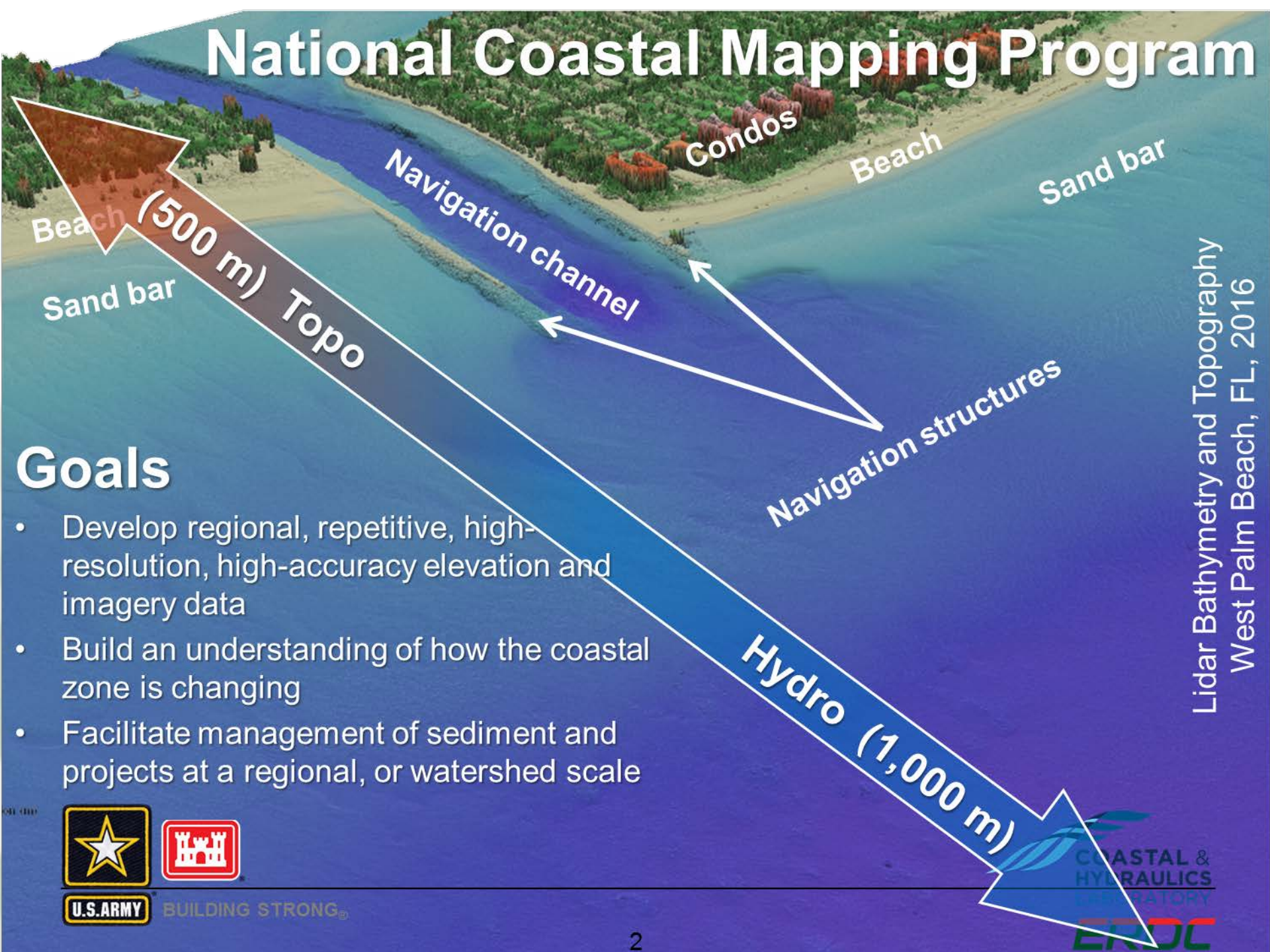
Jennifer M. Wozencraft
Program Manager

16 May 2017
Regional Sediment Management IPR
Portland, OR

Coastal and Hydraulics Laboratory
US Army Engineer R&D Center



National Coastal Mapping Program



Lidar Bathymetry and Topography
West Palm Beach, FL, 2016

Goals

- Develop regional, repetitive, high-resolution, high-accuracy elevation and imagery data
- Build an understanding of how the coastal zone is changing
- Facilitate management of sediment and projects at a regional, or watershed scale



U.S. ARMY

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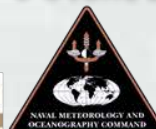
COASTAL &
HYDRAULICS
LABORATORY

ERDC

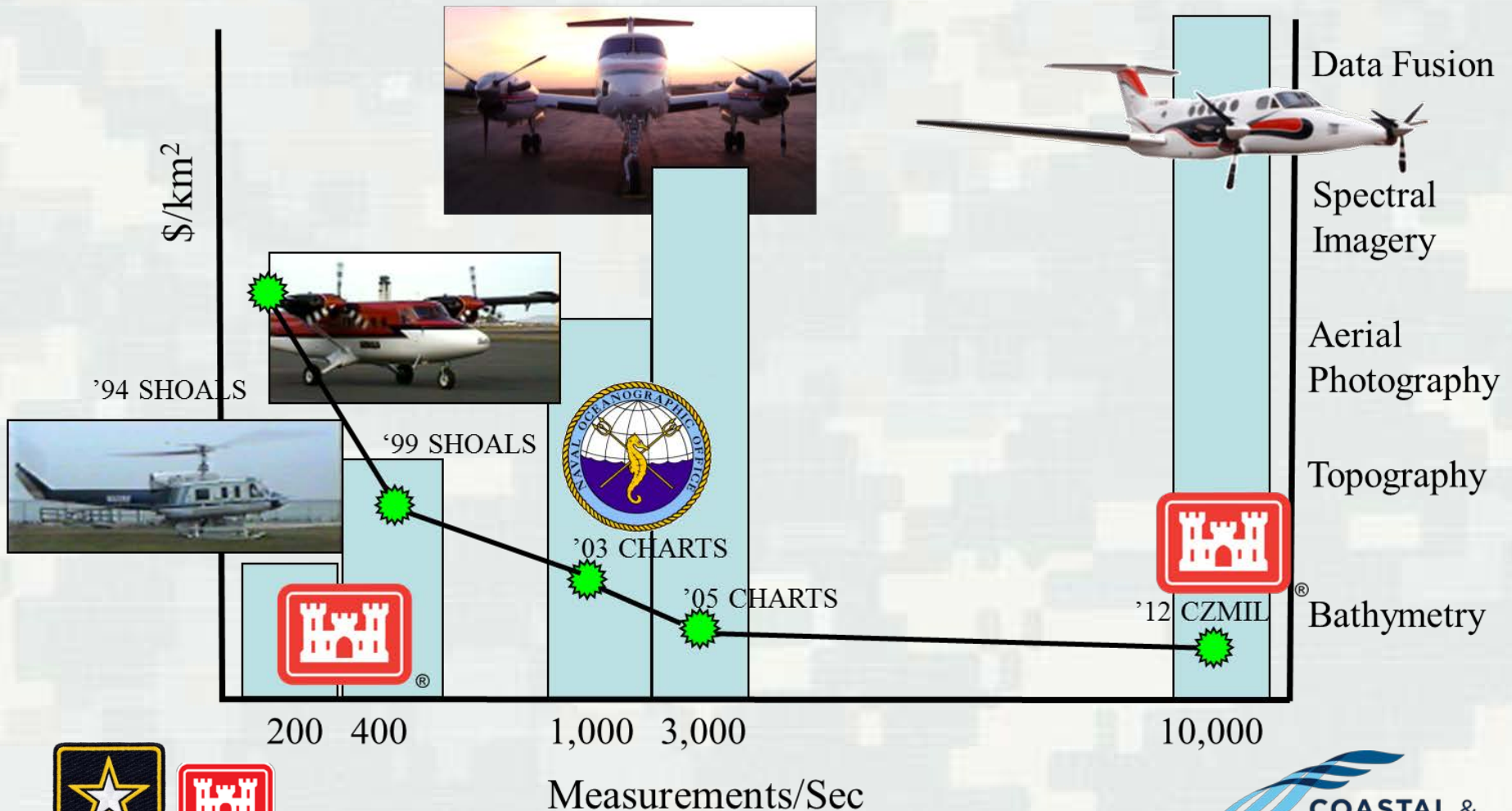
Joint Airborne Lidar Bathymetry Technical Center of Expertise



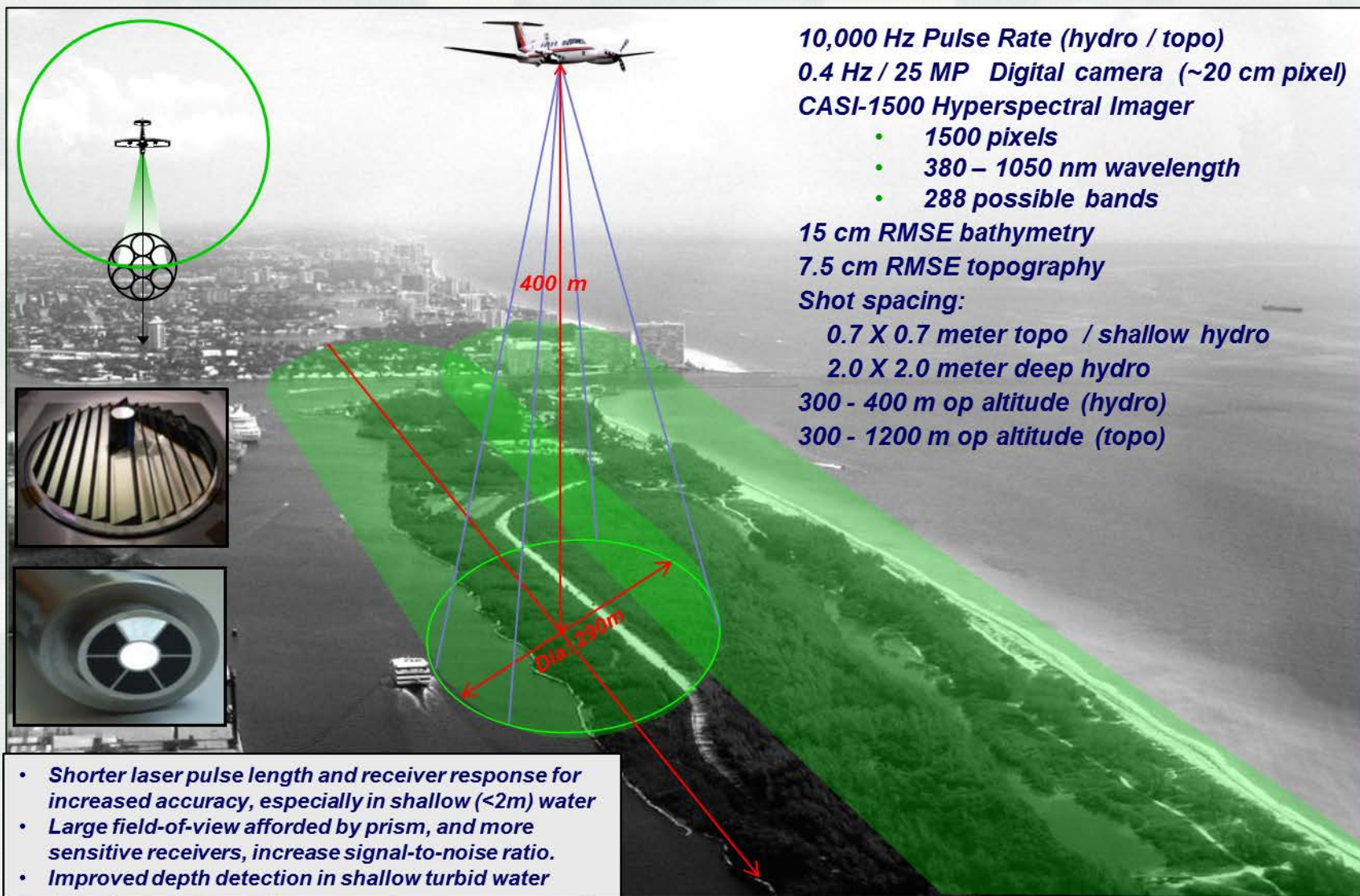
**Annual Technical Workshop
6-8 June 2017, Savannah, GA**



JALBTCX sensor development history

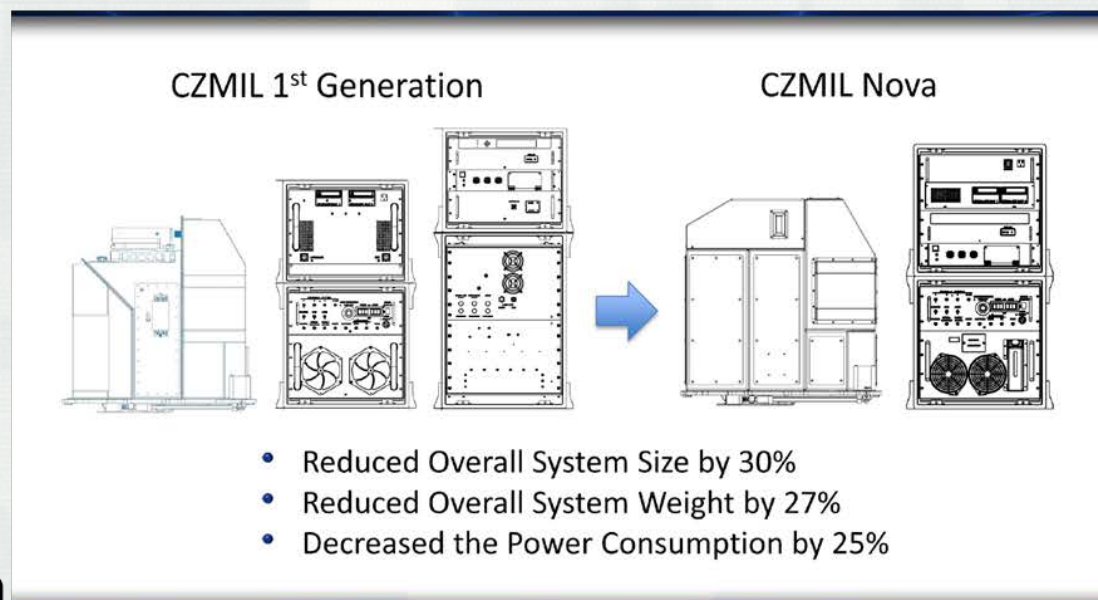


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2016/17 improvements

- New interference filters
- New PMTs
- PDU redesign
- Rewrite SLIC
- Testing of multi-anode PMT
- Land/water classification
- Reprocessing tools
- Total Propagated Uncertainty



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Next generation system?

- Automated processing
 - ▶ Cloud processing
 - ▶ Real-time processing
- UAS/OPA capable
- Better performance
 - ▶ Turbid water
 - ▶ Dense vegetation
- 16 ppsm
- Deep/machine learning
- ?

HRQLS (High Resolution Quantum LIDAR System)

Parameter	Specification
Beams	100
Wavelength	532 nm
Laser Repetition Rate	25 kHz
Laser Pulsewidth	700 psec
Laser Output Power	1.0W
Pixels/sec	2.5 Million
Eye safety	Eye safe by FAA standards
Multiple Return Capability	Yes
Risk Recovery Time	1.8 msec
RMS Range Precision	± 5 cm
Scan Pattern	linear, conical
Scan Width	0 to 40 degrees (selectable)
Operational Altitude Range	6.5 - 10 km
Swath vs AGL™ (at maximum scan angle)	1.3 to 2 Km
Areal Coverage vs AGL™ (at maximum scan angle and 200 Knots)	400 to 640 km ² /hour single pass
Mean Point Density	12 per sq meter, single pass, with 15% reflectivity
Size	19 W x 25 D x 33 H inches
Weight	80 lbs
Prime Power	555 W

PILLS Overview

- Pushbroom Imaging Lidar for Littoral Surveillance (PILLS)
- SBIR project funded by ONR and NAVAIR
- Goal: Capability of current manned platforms in a configuration compatible for tactical UAV (e.g. RQ-21A Blackjack)
- Several manned data collections in the past 3 years
 - Version 1.0 – 2012 to 2015
 - Version 2.0 – 2015 to present
- Current status: Successful completion of flight tests on SeaHunter UAV in May 2016



Total Payload 39" x 9" x 4"

Contact: Jeff Mercer, 520-784-1872, jmercer@arete.com

UNCLASSIFIED

Chiroptera_{II} and HawkEye_{III}

Chiroptera_{II}

- Increased altitude range
 - 600 m → 1 000 m
- Increased PRF in topo
 - 400 kHz → 500 kHz
- Increased depth penetration
 - 100m → 2 → 300m → 2.2
- 80 MPiX RCD 30 camera integrated
 - Full band RGB + IR
- PAV 100 gyro stabilized mount
 - 30% overlap → 15% overlap
- Leica components and Leica software integrated

HawkEye_{III}

- Bathymetric data capture
 - Deep: 10 kHz (10 kHz, single receiver)
 - Shallow: 35 kHz (35 kHz, single receiver)
 - Full waveform, both channels
 - Real time waveform analysis
 - $R_{\text{max}} \times D_{\text{max}} = 4$ (about 3 sec)
- Topographic data capture
 - Up to 500 kHz (single receiver)
 - Full waveform capture
 - Real time waveform analysis
 - Max altitude: 1.6 Km
- Mid format camera
 - 80 MPiX, RGB + IR



TELEDYNE OPTTECH Optech Titan - One Sensor, Many Applications

Multi-spectral sensor configuration
New application opportunities (eg. vegetation/target discrimination, simultaneous topo/bathy, etc.)



Increased classification accuracy
Day/night operation

Discrete and waveform record options

- Seamless land/water transitions are now possible using much more efficient discrete measurement methods, instead of full waveform capture (full waveform record optionally available)

Same 300 kHz PRF for each of 3 laser channels (900kHz total)

- High resolution bathy channel
- High sampling rates for IR channels enable high resolution topo data sets

Embedded Passive Imaging Options

- Capable of supporting any one of the CS-Series camera solutions (80 MP RGB/CIR; 29 MP RGB/CIR/NIR; thermal; 3-5 band multispectral)

www.teledynedtech.com

VQ-880G specifications

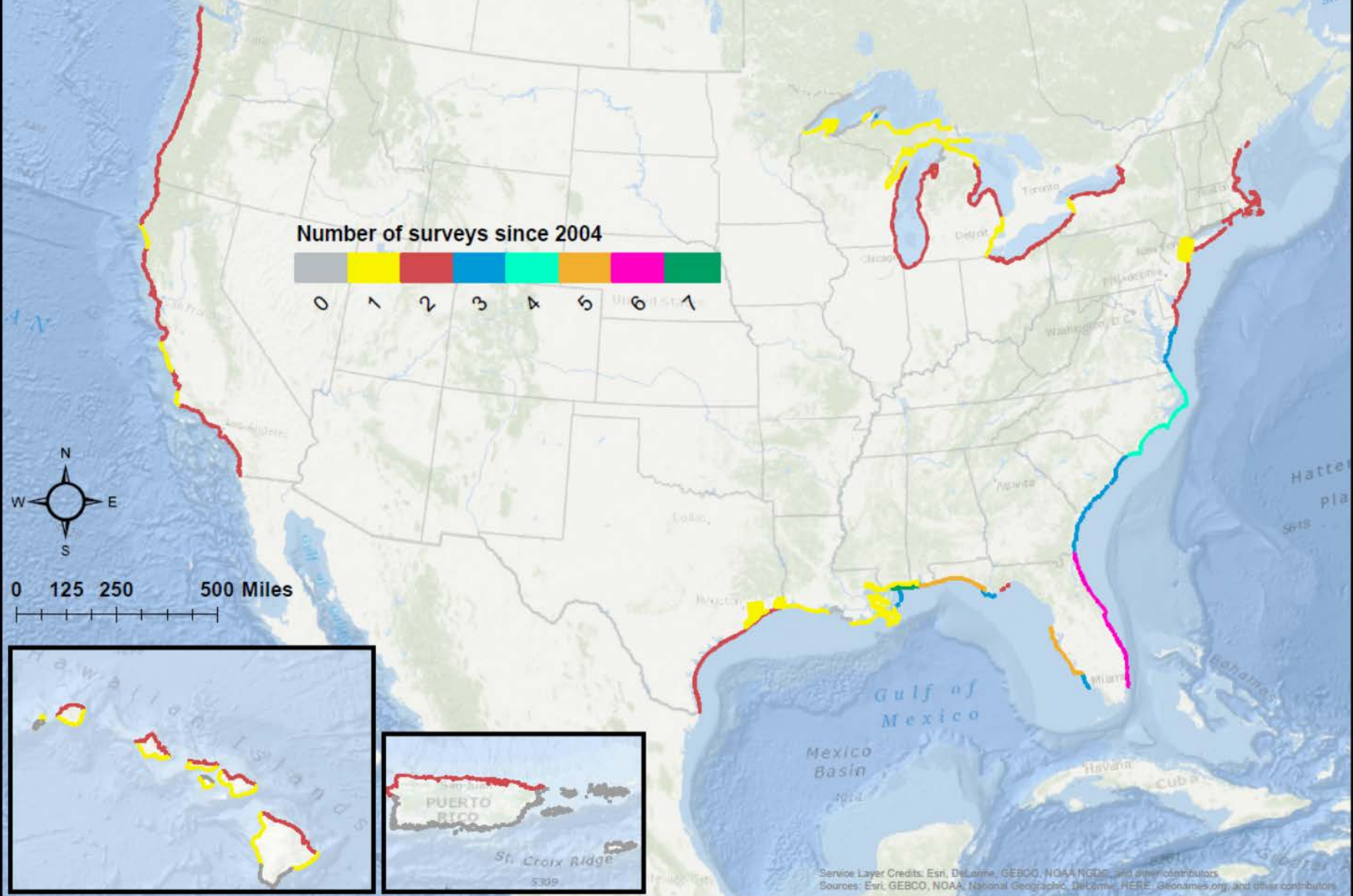
wavelength	532 nm (visible green light)
measurement range	2500 m at $p \geq 20\%$
topography	3600 m at $p \geq 60\%$
measurement range hydrography	>1 Secchi depth
ranging accuracy	25 mm
FOV	+/- 20°
beam divergence	selectable, 0.7-2 mrad
measurement rate	520 kHz
scan speed	10 – 80 revolutions/second
laser safety	Laser Class 3B
multiple time around	yes



www.riegl.com

Innovation in 3D

National Coastal Mapping Program Progress





U.S. ARMY

2016 NCMP Operations



Mobile District Operations Team

Chris Macon
Charlene Sylvester
Nick Johnson
Heath Harwood

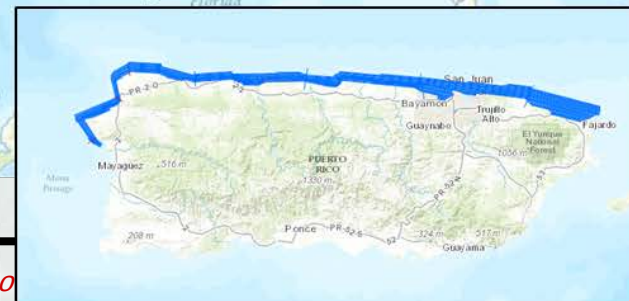


Panhandle
329 flight lines
21 July – 6 Sept
47 days
39 flights

Florida
588 flight lines
17 May – 20 July
64 days
52 flights

Texas
941 flight lines
7 Sept – 17 October
40 days
67 flights
Dual Aircraft Operations

Puerto Rico
521 flight lines
22 Jan – 10 Feb
11 May – 16 May
24 days
27 flights

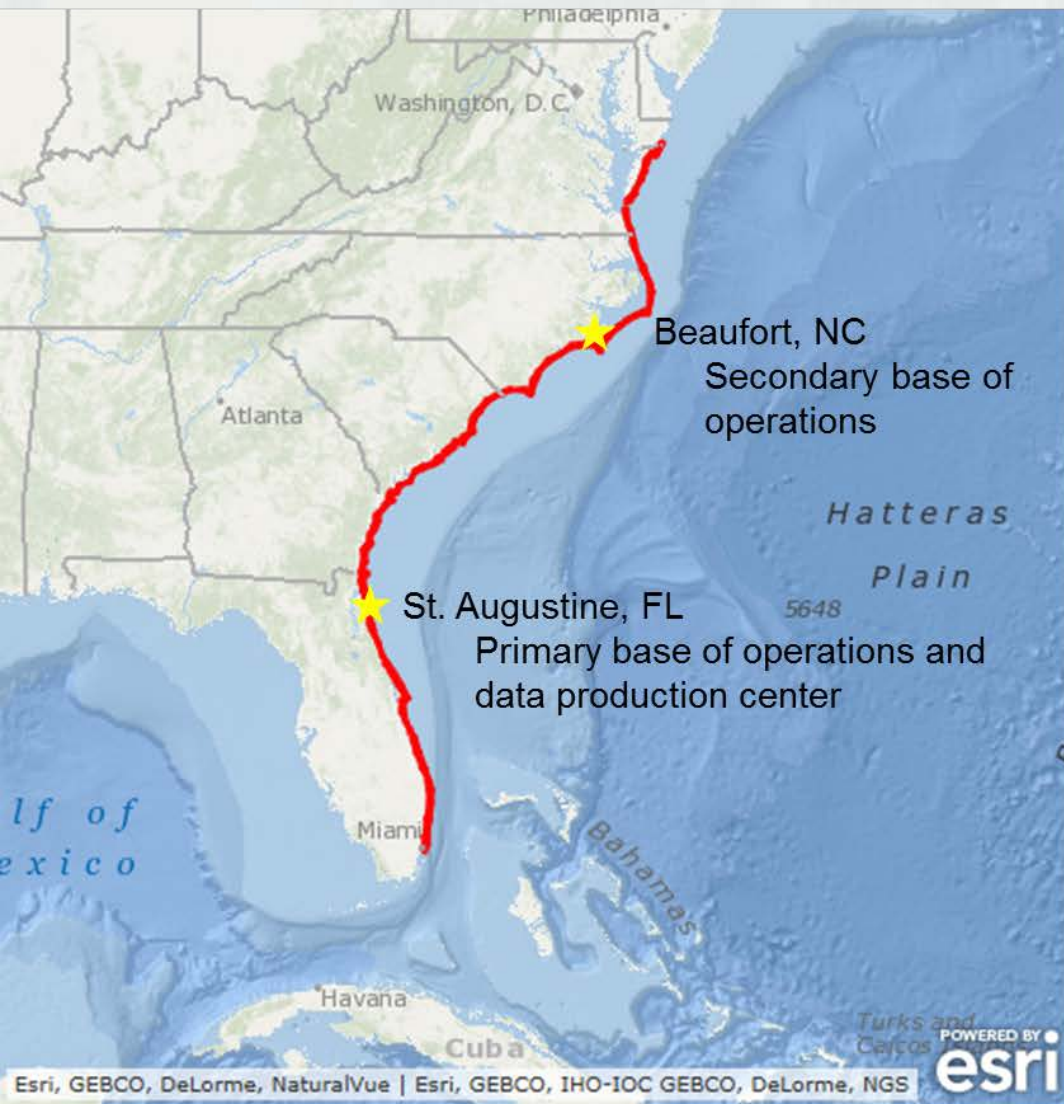




2016 Post-Matthew Operations Overview



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Key Biscayne, FL to VA/MD Border

- Dual aircraft operations
- 991 flight lines
- 27 Oct – 2 Dec
- 36 days
- 76 flights
- 4 ground-truth teams (USGS)
- 24-hr field office
- Rapid-response data product deliveries
- Advanced lidar products for emergency response

SeaSketch - Better decisions

www.seasketch.org/#projecthomepage/5272840f6ec5f42d210016e4/layers

AppsUSACE GRIDInternal USACE WebmExternal PortalJalbtcx Web ServicesMetadata ManagerGeoPlatform - SeaSketchOther bookmarks

U.S. Federal Mapping Coordination
A Demonstration Site for Federal Mapping Data Acquisition Coordinationadmin

take a tourhelpCharlene Sylvester

+

-

Umbus

May - Oct

GA through Long Island

Seeking opportunities for coordination

USACE Planned Lidar

2017

2018

2019

2020

2021

Data Layers

English

My Plans

Participate

Data Layers

Basemap

Legend & Ordering

Search layers by name or keyword

Planned (Funded) and Ongoing Mapping Projects

☐

Topographic Lidar

☒

Topobathymetric Lidar

☐

NOAA

☒

USACE

☐

Great Lakes

☒

JALBTCX Planned and Ongoing Topobathymetric Lidar

The USACE National Coastal Mapping Program (NCMP) acquires high-resolution topographic/bathymetric lidar elevation and imagery on a recurring basis along the sandy shorelines of the US. The typical survey footprint includes an approximately 1-mile wide swath of topography, bathymetry, and imagery 500 m onshore and 1000 m offshore. Planned survey areas and timelines provided in this service are based on the 5-year NCMP update cycle, which follows counter-clockwise along the US West Coast, Gulf Coast, East Coast and Great Lakes. Surveys to support USACE project-specific missions and external partners beyond the standard NCMP footprint are included constituent to requests from project managers. This survey work is coordinated with Federal mapping partners through the Interagency Working Group on Ocean and Coastal Mapping and the 3D Elevation Program.

☒

JALBTCX/JALBTCX_NCMP_Acquisition_Status

☐

USACE In Progress Lidar

☒

USACE Planned Lidar

Esri, HERE, Garmin | Earthstar Geographics | Powered by Esri and SeaSketch

Trusted Partners Delivering Value, Today and Tomorrow

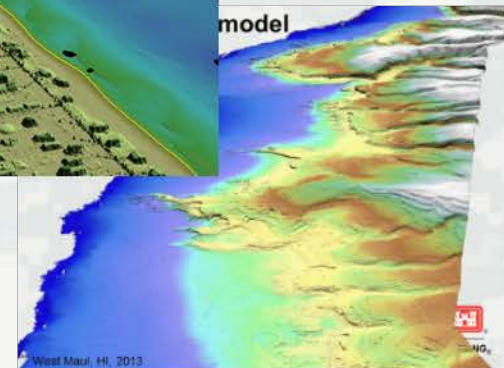
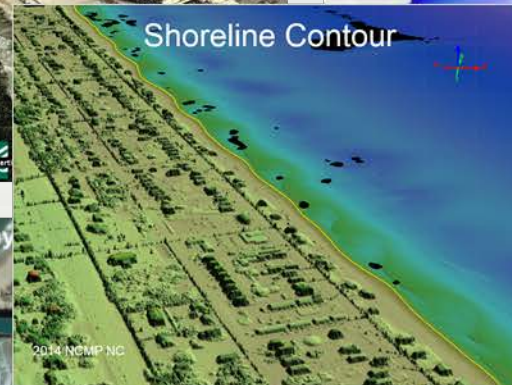
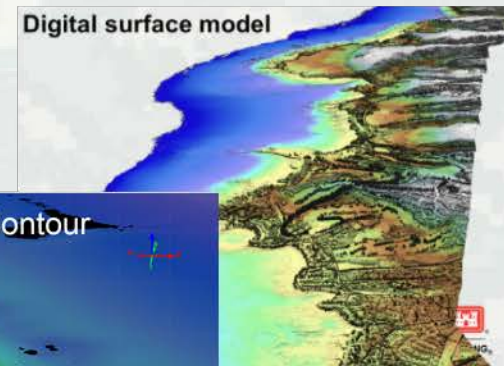


Basic NCMP Data Products



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- Standard product suite
- Born in 2004 and have evolved since
- Workflows promote ease of use and re-use
- Widely disseminated and publically-available





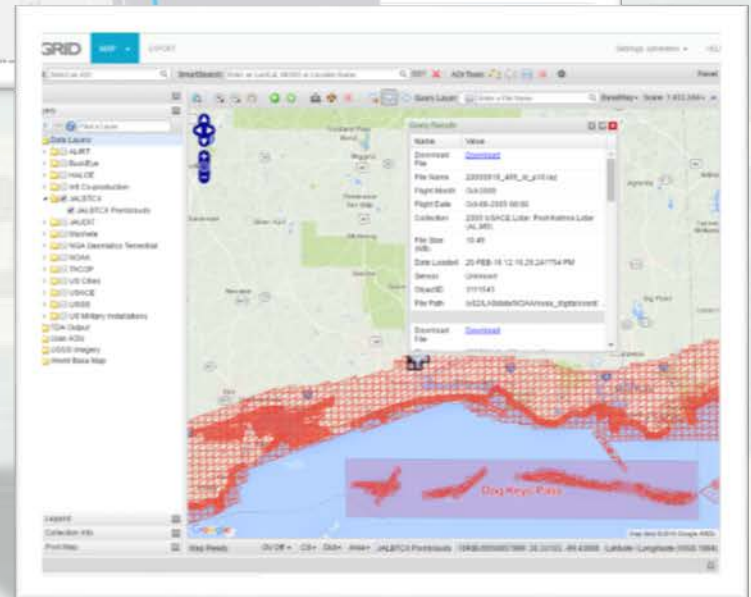
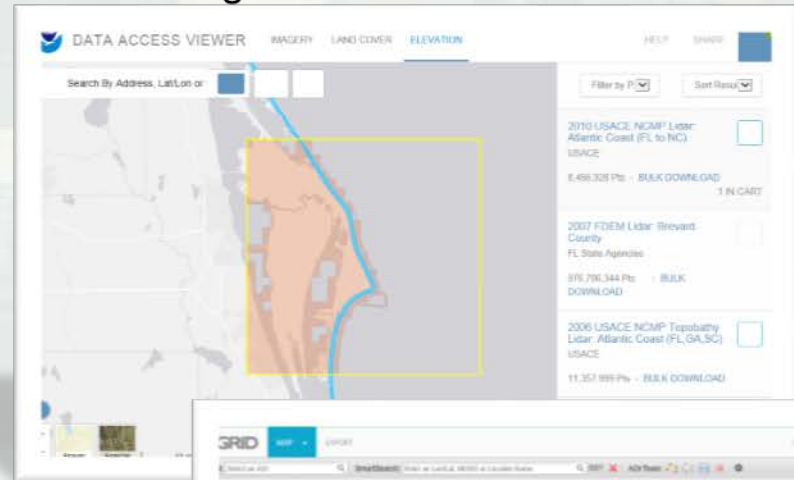
NCMP Data Access



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<https://coast.noaa.gov/dataviewer/>

- USACE District Office
- USACE Geospatial Repository and Data Management System (GRiD)
- NOAA OCM (Digital Coast) and NCEI (Boulder)
- USGS St. Petersburg, FL and Sioux Falls, SD
- By request to jalbtcx@usace.army.mil



<https://griduc.rsgis.ercd.dren.mil/griduc/corpsmap/>



Fusion Data Products

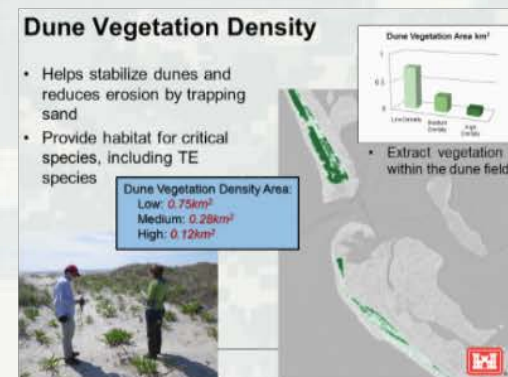
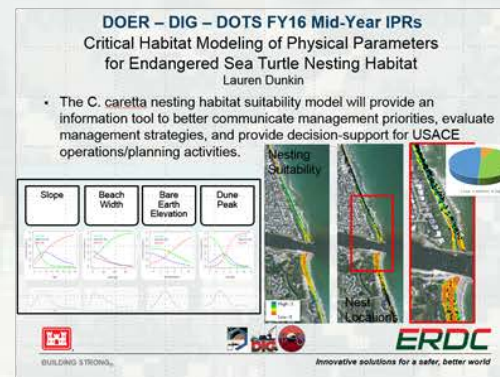
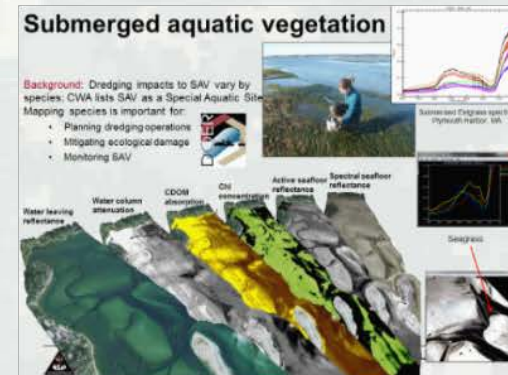


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- Fusion of lidar-derived metrics with spectral information for habitat characterization and monitoring, and critical species detection and modeling



Leveraging ERDC R&D Expertise



- ❖ Dune vegetation
- ❖ SAV
- ❖ Land cover
- ❖ Water quality indicators

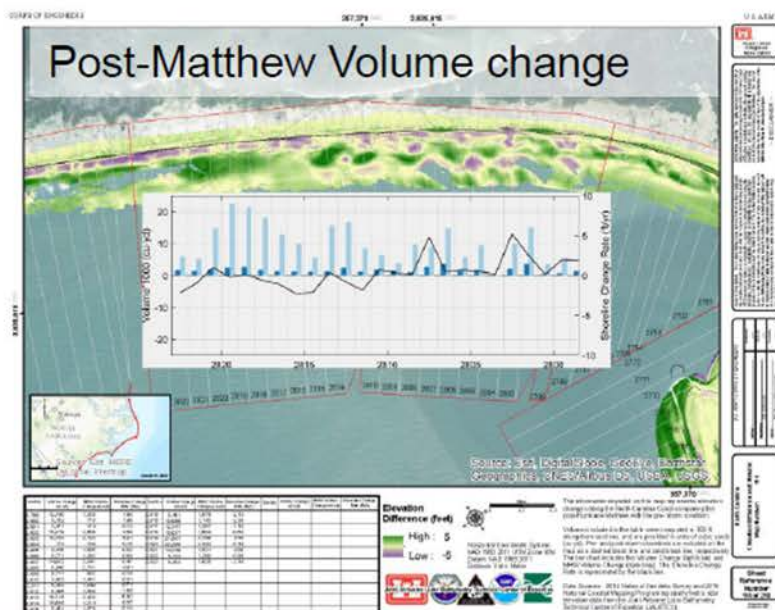
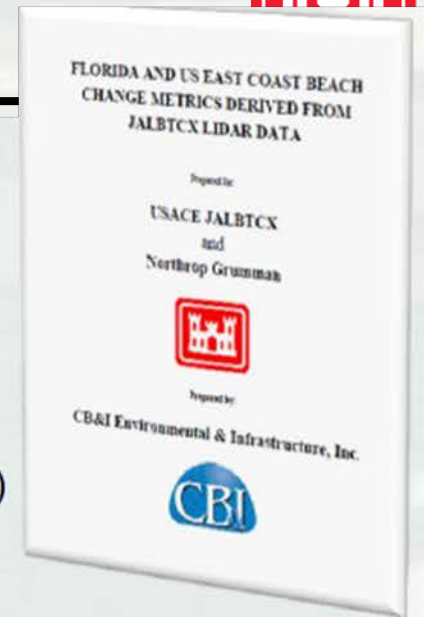


Advanced Lidar Products

Volume Change



- **Operations:** provide streamlined method to generate volume/shoreline change datasets on a regional scale
- **Planning:** generate map products that can be used to communicate between agency partners to identify priority areas that would benefit from beneficially using sediment
- **R&D:** provide input for SBAS (Sediment Budget Analysis System)
- **Post-Storm:** Hurricane Matthew emergency response – volume change analysis for FL, GA, SC, NC, & VA



East Coast Volume Change (2005 – 2010)

State	Start Date	End Date	Baseline Length	Number of Transects	Average Shoreline Change Rate	Volume Density Rate	MHW Volume Density Rate	Above MHW Volume Density Rate
			km	n	ft/yr	cy/ft/yr	cy/ft/yr	cy/ft/yr
ME	10/19/2005	6/19/2010	62	633	(0.4)	13.5	0.7	0.6
NH	11/01/2005	6/20/2010	15	152	(1.0)	2.6	(0.5)	(0.5)
MA	11/11/2005	5/26/2010	381	3,834	(2.8)	(2.8)	(0.9)	(0.8)
NY	10/26/2005	8/13/2010	192	1,921	6.9	4.5	4.1	4.2
NJ	9/2/2005	8/28/2010	203	2,034	0.6	2.1	2.2	2.2
DE	9/3/2005	9/11/2010	44	440	5.1	3.9	4.1	4.2
MD	9/3/2005	8/2/2010	50	505	(4.3)	2.8	2.7	2.7
VA	9/8/2005	7/28/2010	183	1,835	7.2	3.1	3.4	2.9
NC_2009	9/28/2005	8/16/2009	272	2,725	3.9	0.6	(1.3)	0.2
NC_2010	9/28/2005	5/4/2010	236	2,369	0.2	2.7	2.5	2.5
SC	1/13/2006	5/4/2010	277	2,778	2.1	2.3	1.3	0.9
GA	1/13/2006	5/4/2010	145	1,452	(0.2)	4.2	3.0	2.8
FL-E	7/1/2004	5/4/2010	587	5,875	(2.7)	6.2	1.0	0.8
FL-W	6/1/2004	6/20/2010	298	2,998	7.7	19.3	2.3	2.4
FL-NW	6/1/2004	6/20/2010	346	3,461	(9.5)	4.6	(0.2)	(0.2)
Total/Average			3,289	33,012	0.9	4.6	1.6	1.7



Post-Matthew Volume Change Viewer

Post Matthew

Secure <https://cesamusace.maps.arcgis.com/apps/webappviewer/index.html?id=96beaa39fc4493f8478c88cb0c755ef>

Apps USACE GRiD Internal USACE Web External Portal Jalbtcx Web Services Metadata Manager GeoPlatform - SeaSke US Federal Mapping Other bookmarks

Post Matthew with Web AppBuilder for ArcGIS

Click a box to open the pop-up to download that box's .pdf map under the Attachments, or download the full state .pdf by clicking the [More info](#) link.

PostMatthewVolumes:
MapPlot 139
Download State PDF [More info](#)
Attachments:
[20161215_FL_Volumes_PreliminaryDraft 139.pdf](#)
[Zoom to](#)

If you wish download multiple boxes, click the select arrow, then on the Select pulldown choose either Rectangle or Polygon.

Select
Select
Select By Rectangle
Select By Polygon

Draw your area of interest on the map to select multiple boxes. This will open a results window that lists the

Esri World Geocoder

Legend

JALBTCX_NCMP_Post_Matthew_Volumes - PostMatthewVolumes

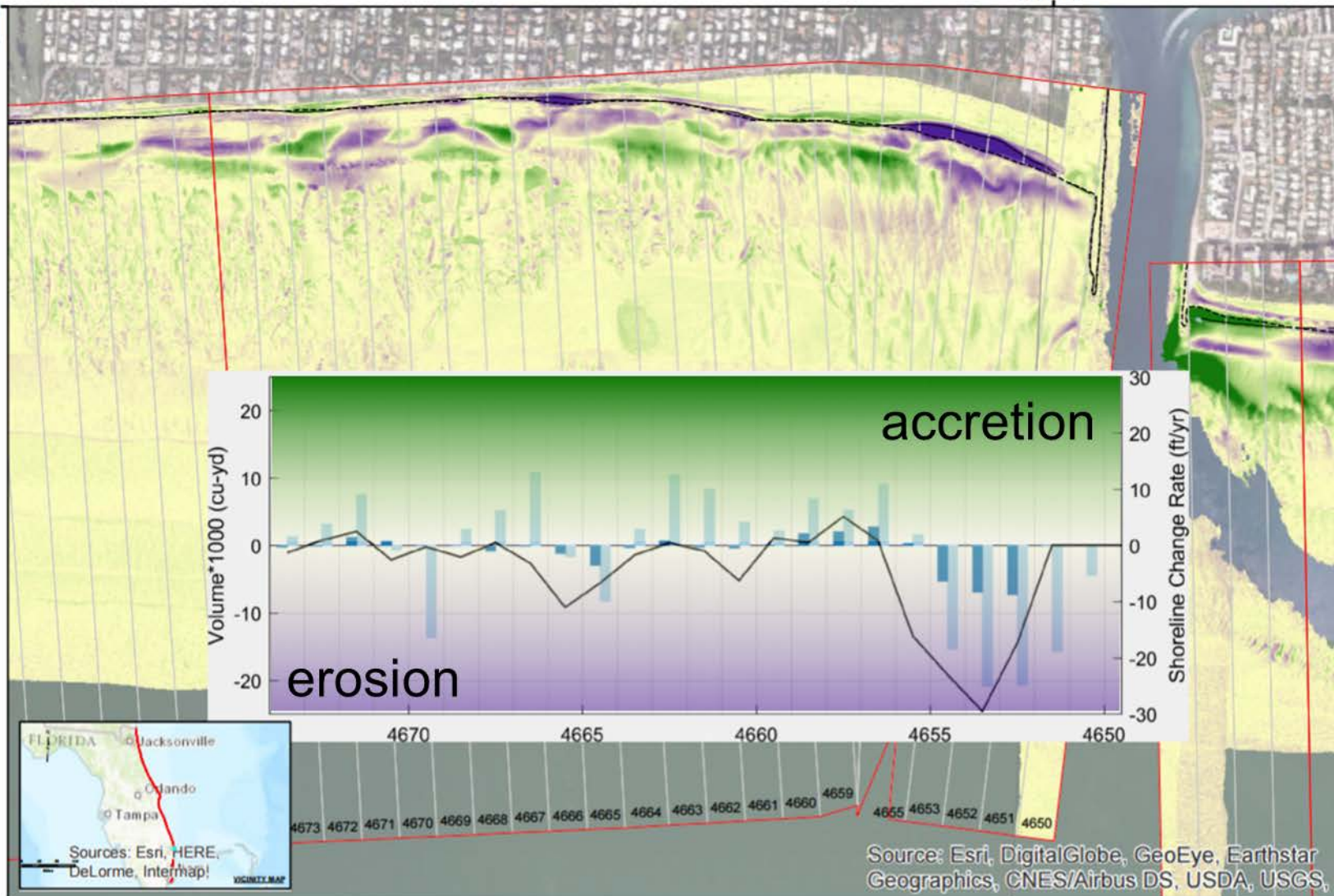
Complete
In Progress

PostMatthewVolumes: NC_177

Download State PDF [More info](#)

Attachments:
[20161223_NC_Volumes_Draft 177.pdf](#)
[Zoom to](#)

NC_177
NC_178
NC_179
NC_180



Section	Volume Change (cu-yd)	MHW Volume Change (cu-yd)	Shoreline Change Rate (ft/yr)	Section	Volume Change (cu-yd)	MHW Volume Change (cu-yd)	Shoreline Change Rate (ft/yr)	Section	Volume Change (cu-yd)	MHW Volume Change (cu-yd)	Shoreline Change Rate (ft/yr)
4,650	-8,219	0	0.00	4,666	-1,624	-1,183	-11.02				
4,651	-4,452	0	0.00	4,667	10,932	-70	-3.18				
4,652	-15,720	0	0.00	4,668	5,205	-805	0.48				
4,653	-20,685	-7,256	-17.43	4,669	2,481	-15	-2.08				
4,654	-20,922	-6,897	-28.53	4,670	-13,694	16	-0.25				
4,655	-15,368	-5,257	-23.03	4,671	-668	610	-2.56				
4,656	1,603	260	-16.13	4,672	7,638	1,244	2.48				
4,657	9,187	2,798	0.84	4,673	3,232	-99	0.90				
4,658	5,278	2,067	5.13	4,674	1,350	-198	-1.34				
4,659	6,955	1,752	0.52								
4,660	2,190	78	1.34								
4,661	3,469	-370	-6.26								
4,662	8,359	-222	-0.97								
4,663	10,522	662	0.43								
4,664	2,470	-257	-1.71								
4,665	-8,272	-2,947	-6.73								
4,666	-1,624	-1,183	-11.02								

Elevation Difference (feet)

High : 5
Low : -5



Horizontal Coordinate System:
NAD 1983 UTM Zone 17N
Datum: North American 1983
Distance Units: Meter



The information depicted on this map represents elevation changes along the Florida Coast comparing the post-Hurricane Matthew with the pre-storm condition.

Volumes included in the table were computed in 300-ft alongshore sections, and are provided in units of cubic yards (cu-yd). Pre- and post-storm shorelines are included on the map as a dashed black line and solid black line, respectively. The bar chart includes the Volume Change (light blue) and MHW Volume Change (dark blue). The Shoreline Change Rate is represented by the black line.

Data Sources: 2016 pre storm and 2016 National Coastal Mapping Program topobathymetric lidar elevation data from the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX).



Disclaimer
The data represented on this map is derived from the results of a data collection project for a specific US Army Corps of Engineers activity and indicates the general location of the data. The data is not intended to be used for any purpose other than the specific activity for which it was collected. The user is responsible for the results of any application of the data for other purposes.

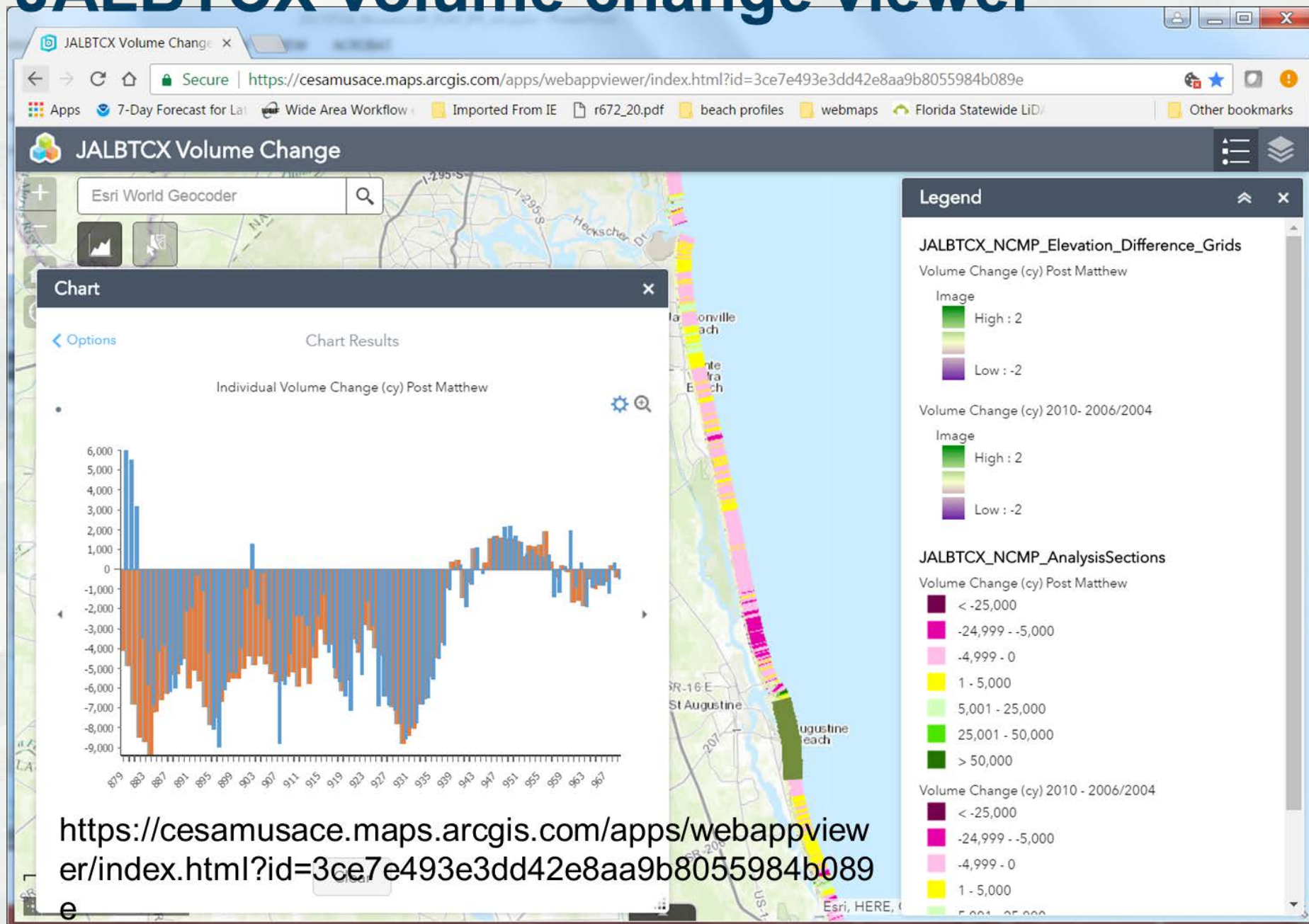
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U.S. ARMY CORPS OF ENGINEERS	Map Number:	Sheet Reference Number
191	191	191

Elevation Difference and Volume
Map Number: 191

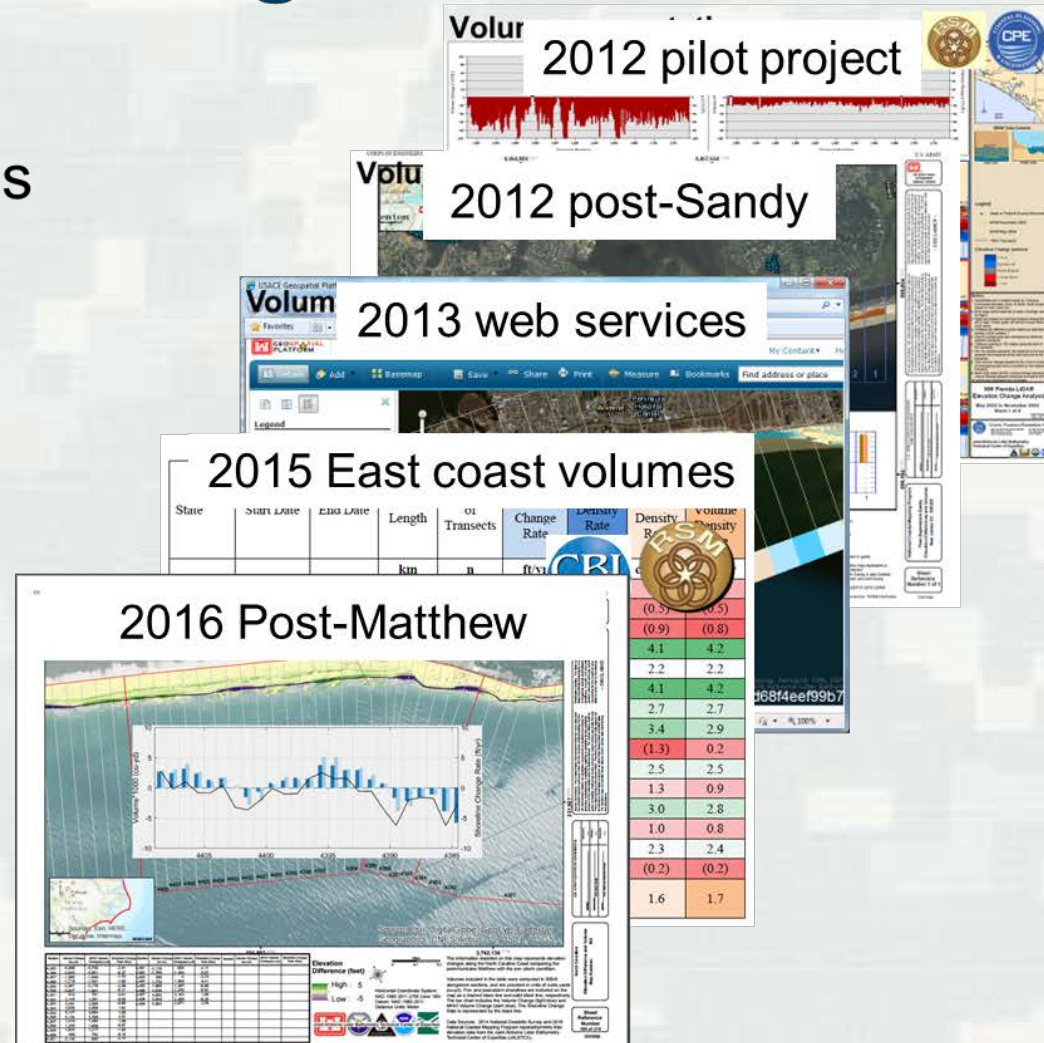
Sheet Reference Number
191 of 242

JALBTCX volume change viewer



Improving volume change tools

- Current inputs
 - ▶ Before and after DEMs
 - ▶ Shorelines
 - ▶ Backline
 - ▶ Transects
- Future inputs
 - ▶ Difference layer
 - enables QC
 - ▶ Shapefile boundary
 - landward/seaward
- Automatic detection
 - ▶ Landward/seaward boundary

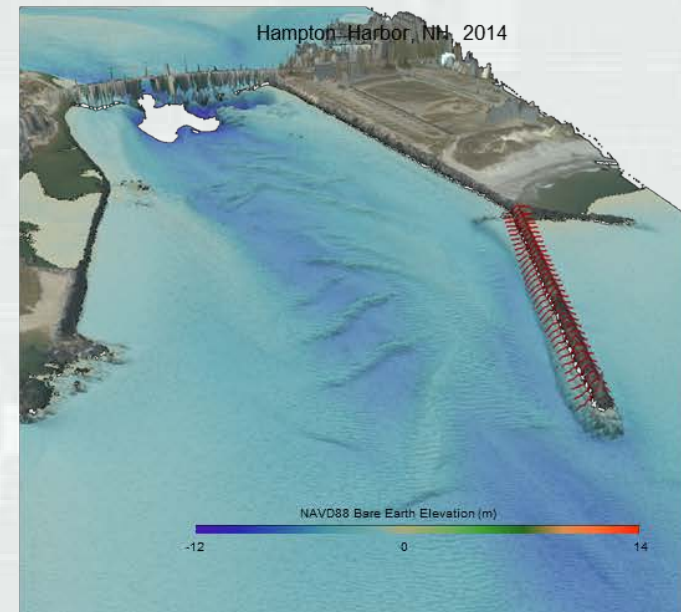
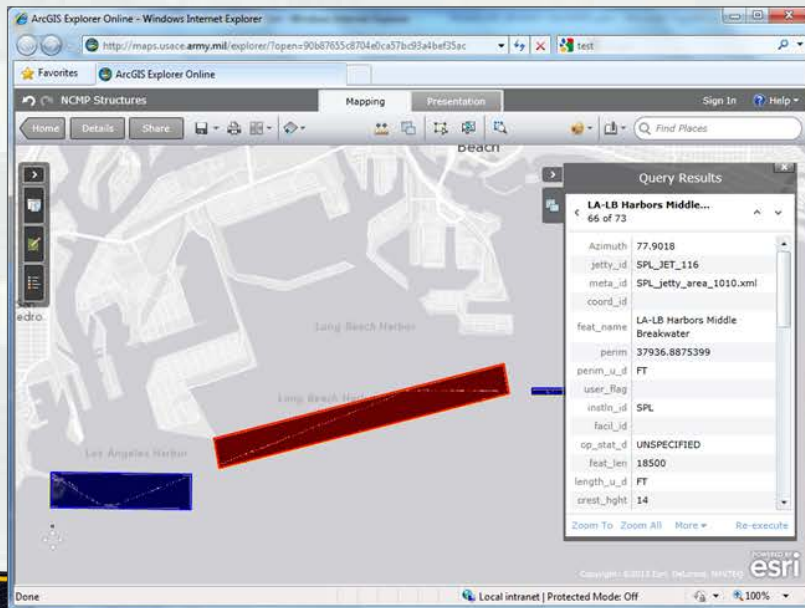


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Navigation Structures

- **Operations:** extracted parameters provide data needed to determine condition and functional performance of structures in addition to bathymetric conditions around structures
- **Planning:** prioritize site visits using high resolution lidar data and imagery
- **R&D:** virtually 'walk' the structure using AR (Augmented Reality)



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Navigation structures feature extraction

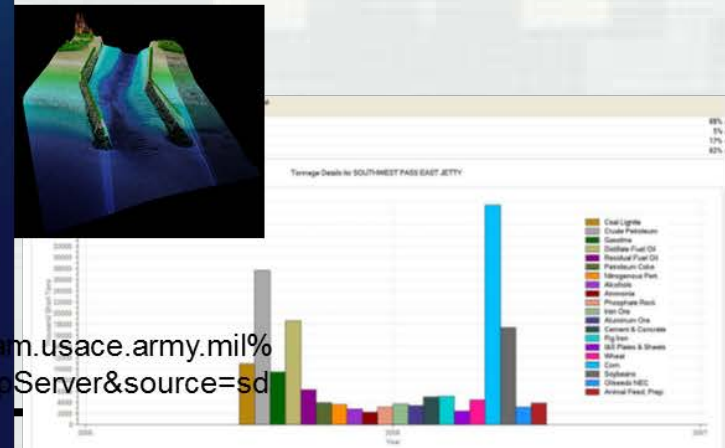
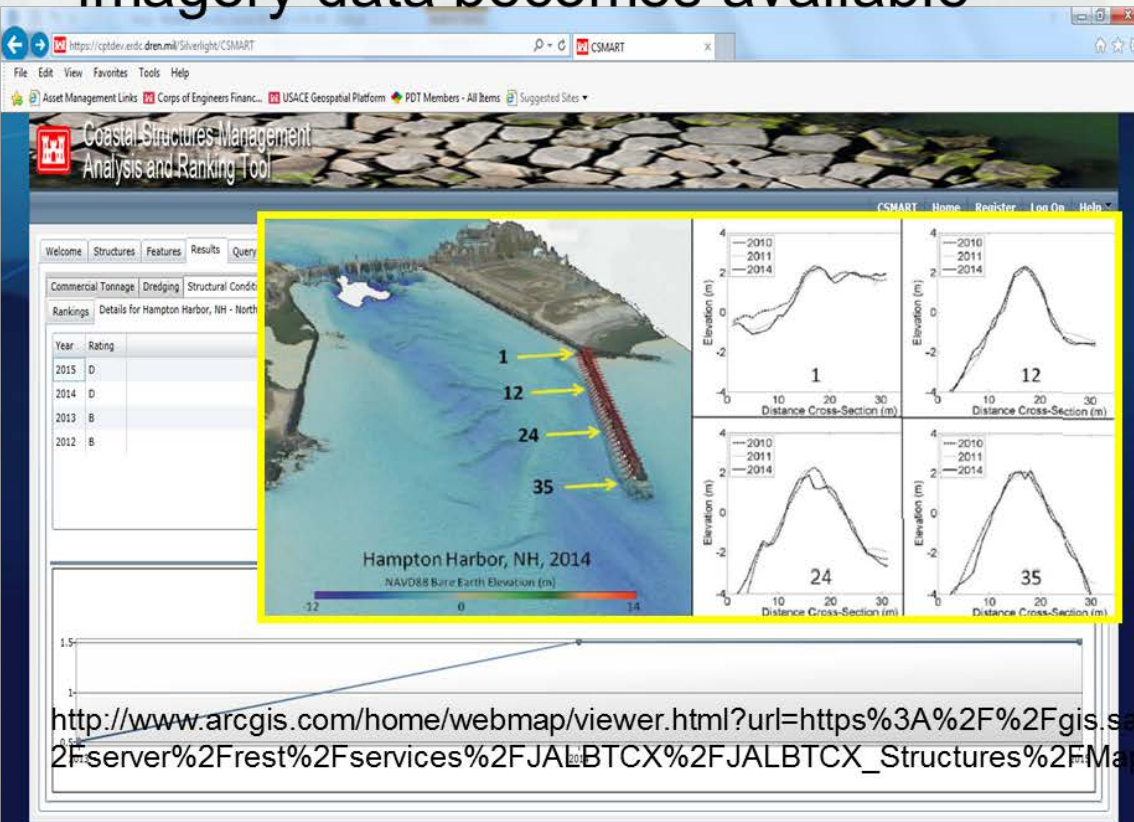


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Lidar & imagery

- Link structure analysis using spatial data with economic analysis
- Update structure analysis on a recurring basis as new lidar and imagery data becomes available

- Tool in CSMART to allow user to cut the lidar grid or upload cross section locations to extract the values





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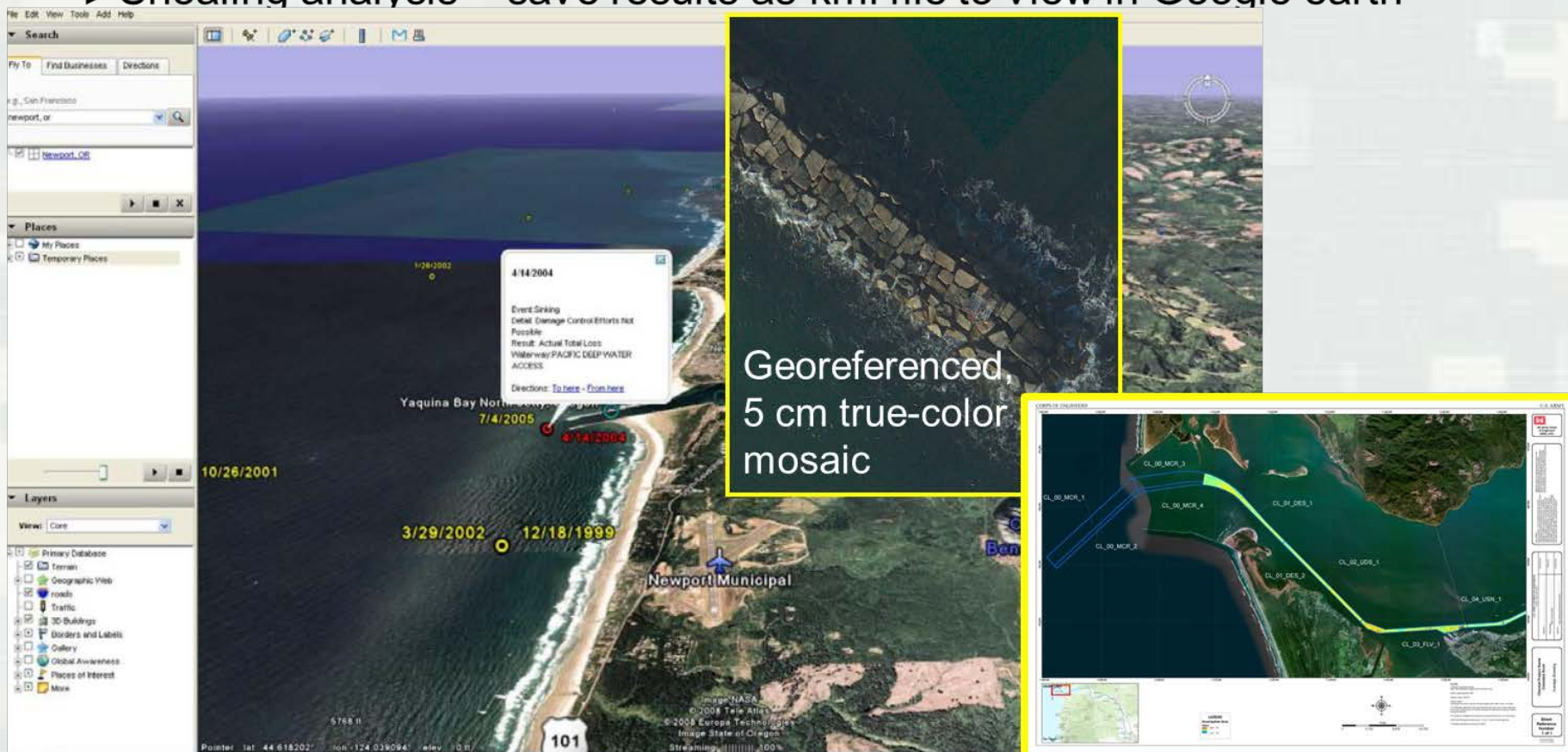
Navigation structures visualization



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Spatial Updates

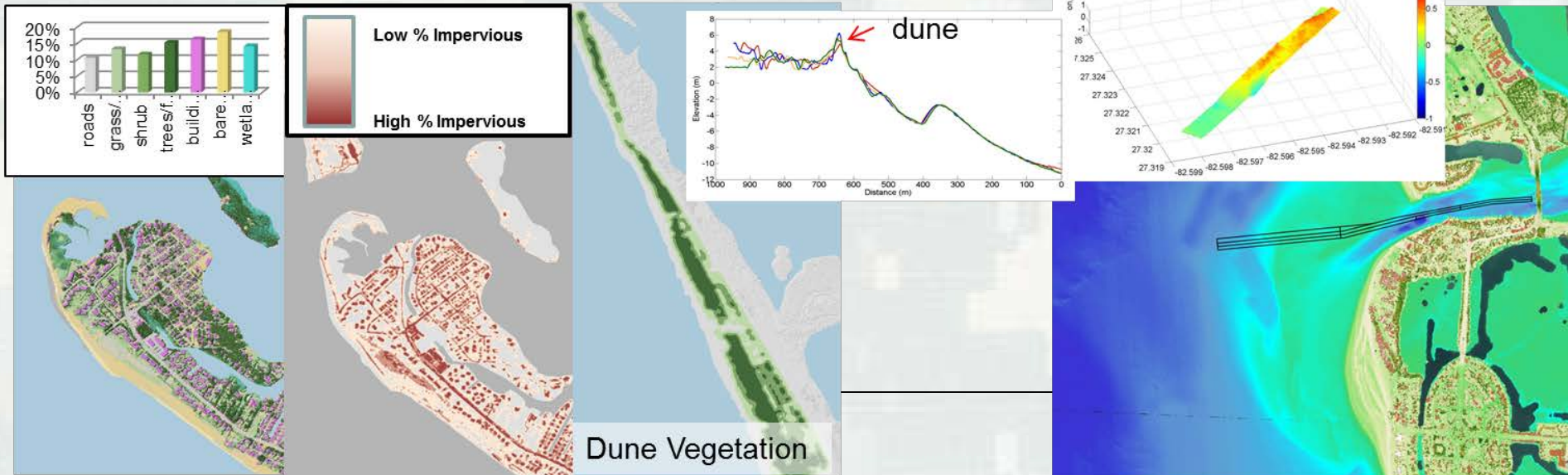
- Improve Google earth view to include:
 - ▶ Link to high-resolution imagery file – updated on a recurring 5-yr cycle
 - ▶ Shoaling analysis – save results as kml file to view in Google earth



Trusted Partners Delivering Value, Today and Tomorrow

Feature Extraction

- **Operations:** a unique set of criteria that is combined for the coastal U.S. to assess condition and can be applied to any coastline and monitored long term to track the changing status of the coast, or the impacts of management decisions
 - data using remote sensing image and elevation products that do not require ground based sampling
- **Planning:** synthesized data provides 'snap shot' of coast
- **R&D:** Parameters are ranked relative to specific regional criteria within each category and combined
 - ranking and combining could be used to address various research questions (breachability, resilience related questions, etc.)



Coastal dashboard

combined coastal engineering geomorphology index



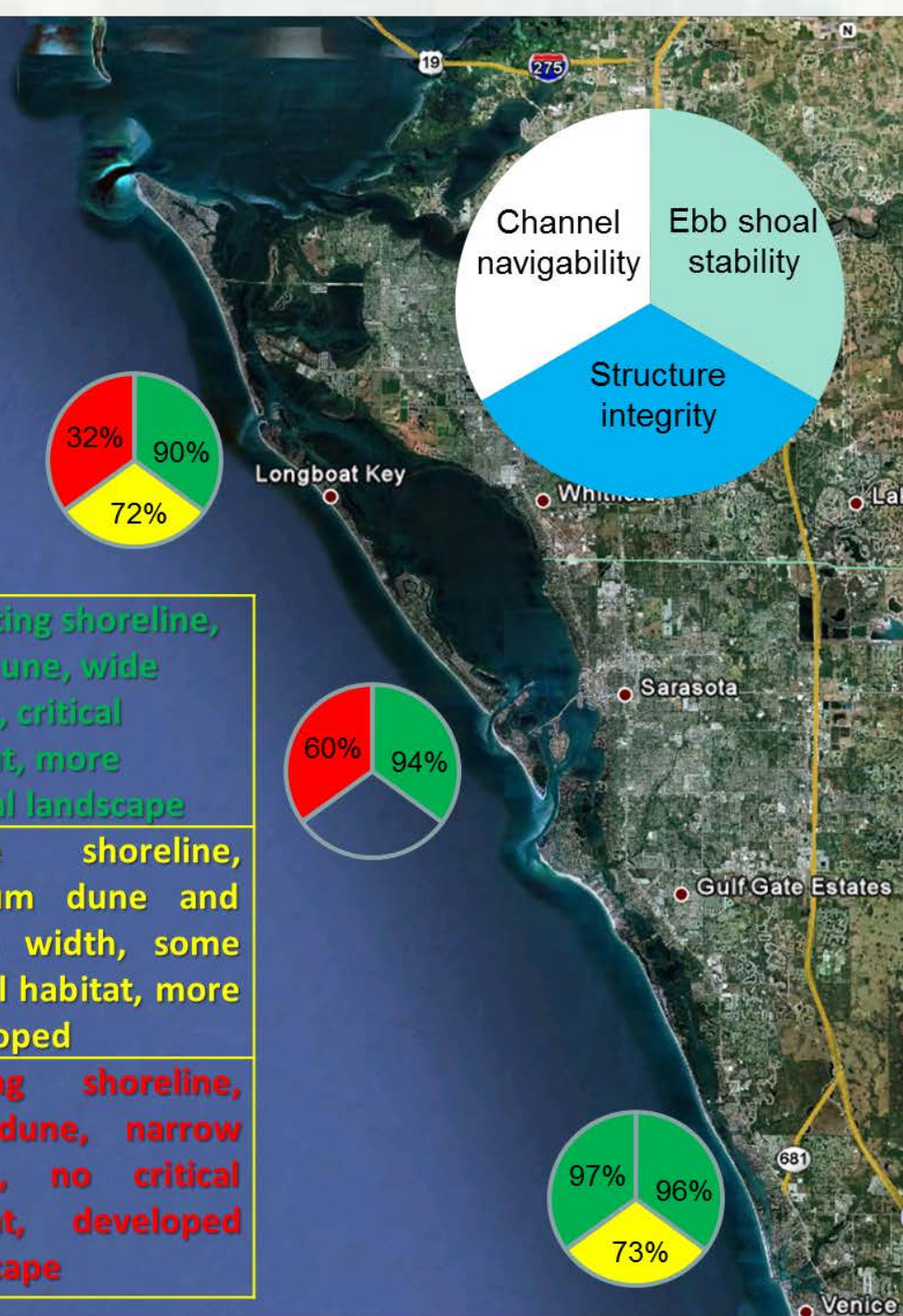
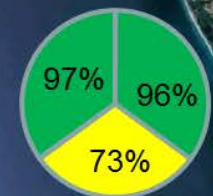
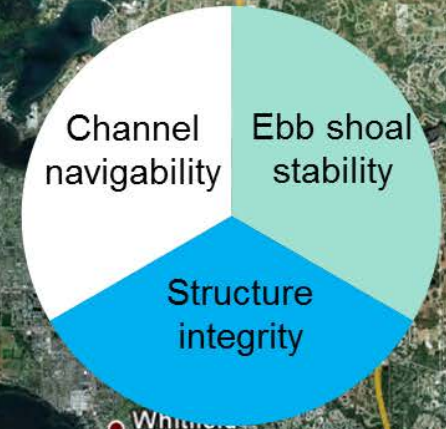
combined environmental index



human use index

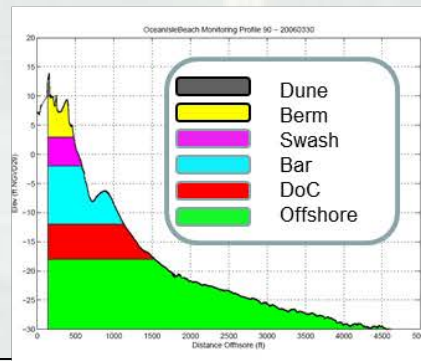
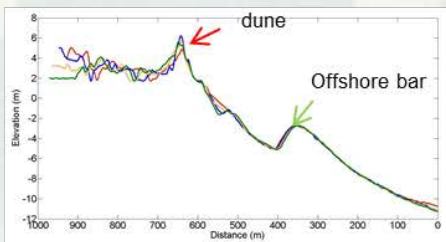


Green	Accreting shoreline, high dune, wide beach, critical habitat, more natural landscape
Yellow	Stable shoreline, medium dune and beach width, some critical habitat, more developed
Red	Eroding shoreline, low dune, narrow beach, no critical habitat, developed landscape

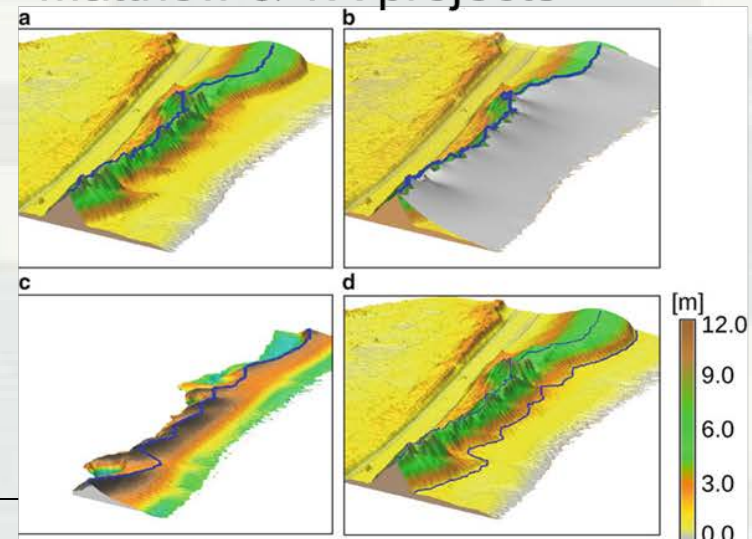


Dune extraction collaboration with USGS

- Extract geomorphic parameters/features
 - ▶ needed as boundaries for some additional analyses (model input) also including hyperspectral imagery
- Use DEMs
 - ▶ standard work flow/QC process
- Current code rotates grid in Matlab and finds peaks – technically a transect based approach
- Goal – parameters/features provided as standard products
 - ▶ Efficient processing
 - ▶ Standard QC – filtering
 - ▶ Topo & bathy
- Run code in house to provide standard products but also allow user flexibility
- GIS based approach (FRF, NC State)
- Post – Matthew & TX projects



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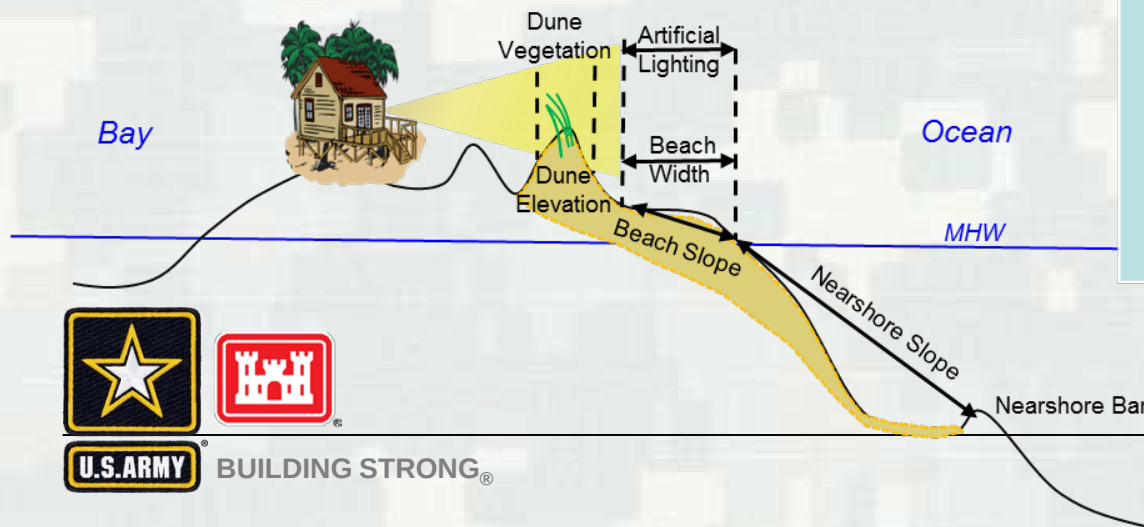


E. Hardin et al., *GIS-based Analysis of Coastal Lidar Time-Series*, SpringerBriefs in Computer Science, DOI 10.1007/978-1-4939-1835-5_4

Coastal Engineering Index Collaboration CESWG

Joint effort to:

- Automate codes to extract parameters for the TX coast
- Extract metrics and compute volumes for 2009 and 2016 data



Geomorphic	barrier island width
	dune toe
	Dune peak
	Shoreline
	beach width
	slope of beach
	barrier island cross-section volume
Environmental	Impervious area
	Dune vegetation coverage
	Height of veg. above ground



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Questions?

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