

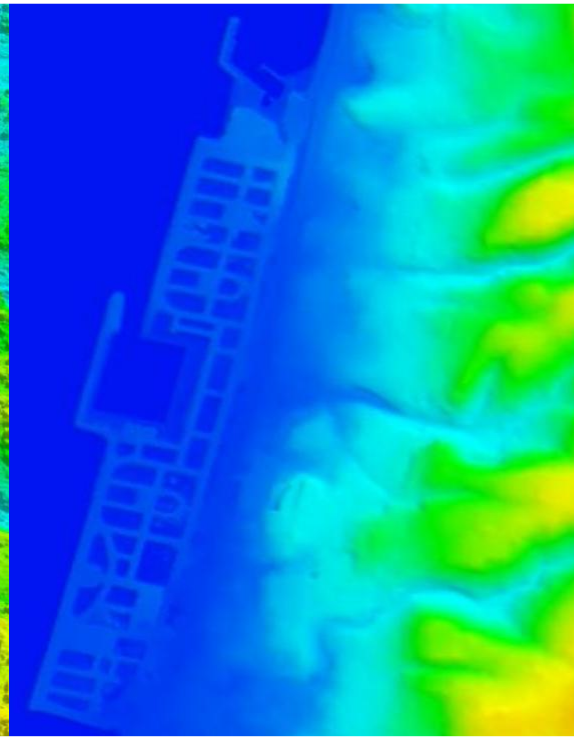
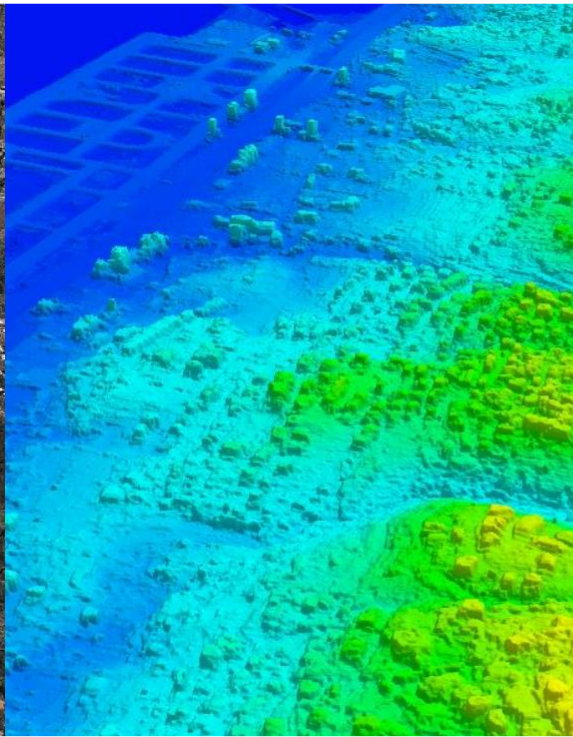
GLOBAL RESOURCES MANAGEMENT CONSULTANCY INC.

Geo Intelligence Asia June 2015



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LiDAR Capability Overview

US Elevation for the nation study

- **Carried out by Dewberry (800 page report)**
- **34 Federal Agencies including NGA**
- **50 States**
- **17 large cities**
- **22 Regional governments**
- **11 Native American tribes**
- **27 different business use cases**

- **LiDAR is now the defacto standard for deriving engineering grade elevation models**
- **Every single project in the past 5 years has used LiDAR**

- **Using the most conservative results the return on investment was 5:1**

Elevation for the Nation savings

BU#	BU Name	Enhanced Elevation Data Annual Benefits	
		Conservative Benefits	Potential Benefits
1	Natural Resources Conservation	\$159.225M	\$335.152M
2	Water Supply and Quality	\$85.288M	\$156.351M
3	River and Stream Resource Management	\$38.422M	\$86.582M
4	Coastal Zone Management	\$23.785M	\$41.740M
5	Forest Resources Management	\$43.949M	\$61.655M
6	Rangeland Management	\$0	\$0
7	Wildlife and Habitat Management	\$1.510M	\$4.020M
8	Agriculture and Precision Farming	\$122.330M	\$2,011.330M
9	Geologic Resource Assessment and Hazard Mitigation	\$51.750M	\$1,066.750M
10	Resource Mining	\$1.686M	\$4.864M
11	Renewable Energy Resources	\$10.050M	\$100.050M
12	Oil and Gas Resources	\$10.000M	\$100.000M
13	Cultural Resources Preservation and Management	\$0M	\$7.000M
14	Flood Risk Management	\$294.706M	\$501.576M
15	Sea Level Rise and Subsidence	\$5.780M	\$21.660M
16	Wildfire Management, Planning and Response	\$75.700M	\$158.950M
17	Homeland Security, Law Enforcement, Disaster Response	\$9.975M	\$126.469M
18	Land Navigation and Safety	\$0.191M	\$7,124.875M
19	Marine Navigation and Safety	\$0	\$0
20	Aviation Navigation and Safety	\$35.000M	\$56.000M
21	Infrastructure and Construction Management	\$206.212M	\$941.951M
22	Urban and Regional Planning	\$4.197M	\$68.569M
23	Health and Human Services	\$0	\$1.000M
24	Real Estate, Banking, Mortgage, Insurance	\$0	\$0.000M
25	Education K-12 and Beyond	\$0.264M	\$2.264M
26	Recreation	\$0.050M	\$0.050M
27	Telecommunications	\$0.185M	\$1.850M
	Total Estimated Annual Dollar Benefits	\$1,180.224M	\$12,980.707M

What will a LIDAR survey mean to the Geo-Intelligence community in Asia?

- An engineering grade three dimensional terrain model forms a critical basemap for your river basin, state or country
- The terrain model serves literally dozens of critical applications such as flood mapping, evacuation planning, emergency services, health and human services, natural resources, water resources, forestry, smart city and much, much more
- The latest technology can map the earth and under the water to provide a seamless dataset to greatly increase the safety of your citizens
- This technology can be used for persistent surveillance and linked to live feeds
- The latest technology can acquire the necessary data quickly and cost effectively
- The latest technology can process and mine the data so it can be shared virtually across the enterprise and served up to every government agency and citizen on desktops, tablets and smart phones

What are the Problems with LiDAR Today?

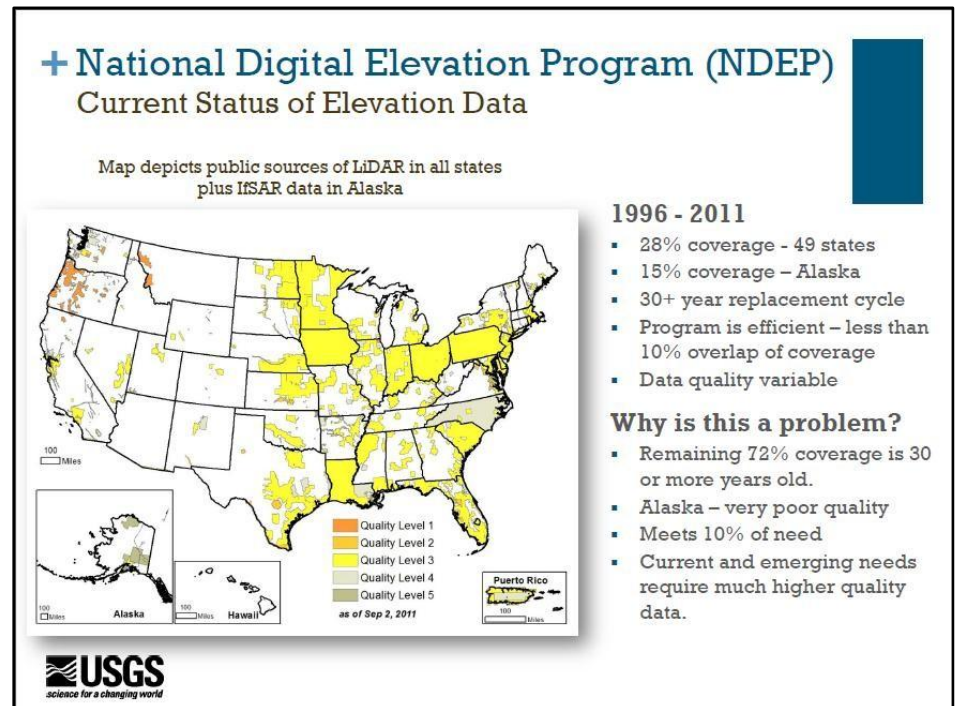
LiDAR collection takes a long time

- Multiple years, aircraft & sensors required for large areas

High cost of LiDAR

- Long, complex collections drive costs

USGS has only managed to collect 28% coverage over the last 20 years



The Linear System

Technology Comparison

Linear LiDAR



- Single pulse
- Single measurement
- Low sample rate

HARRIS

Approximately 500KHz for single scanner designs

Technology Comparison

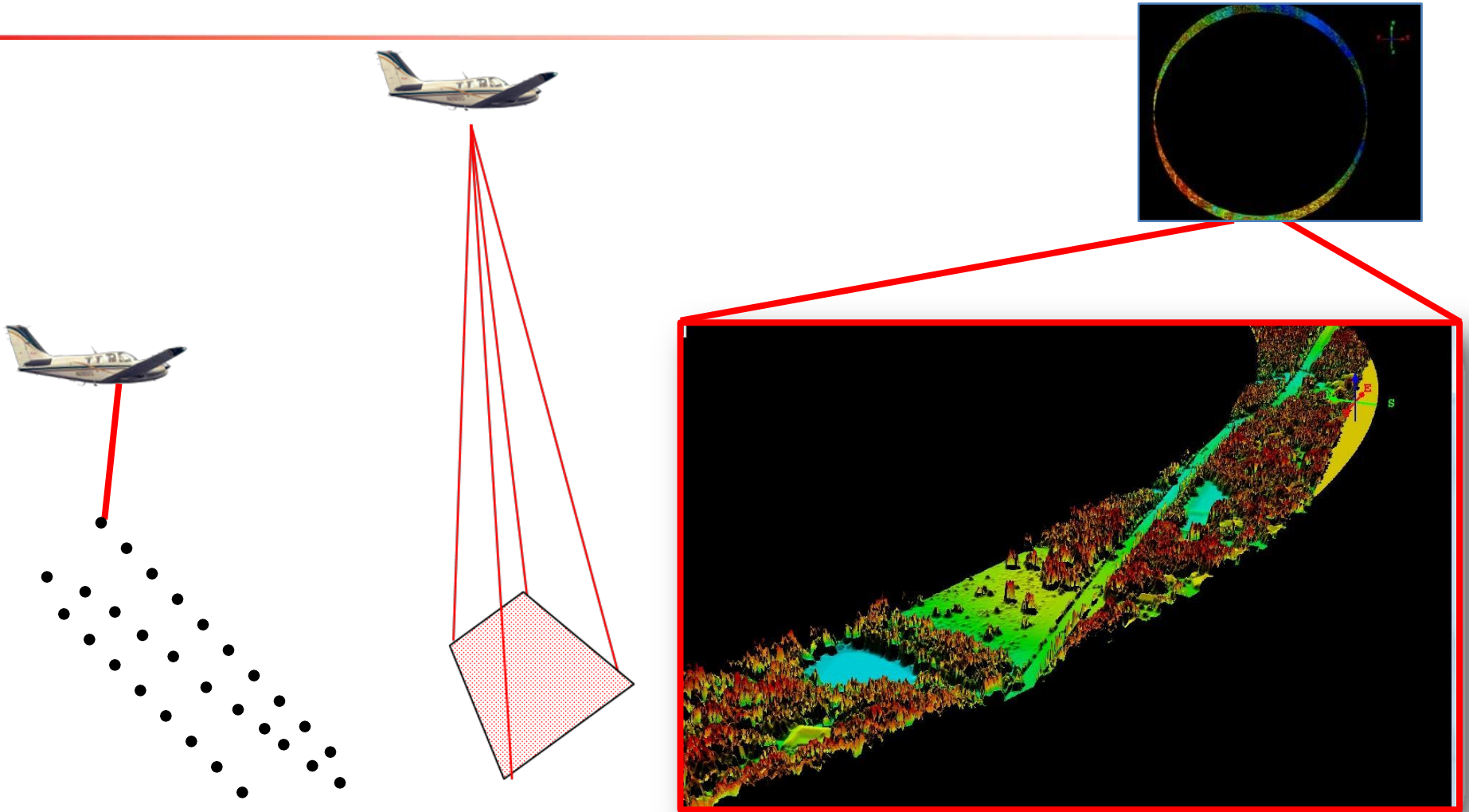
Geiger LiDAR

- Large array collection
- Collection from multiple angles
- High sample rate
(204 million samples per second)



200MHz vs. 500KHz

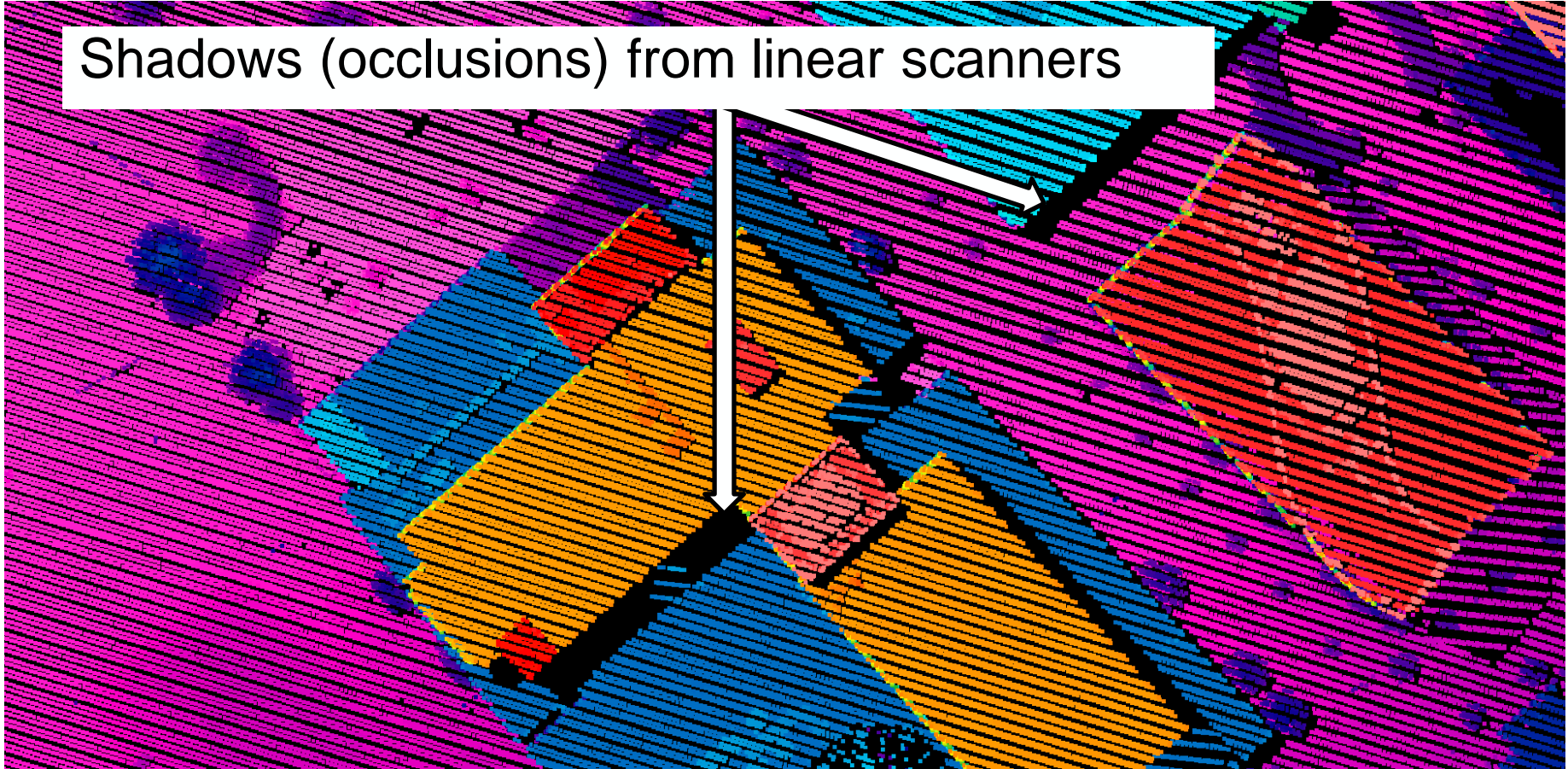
Geiger-mode vs. today's technology



Geiger-mode sensors sample the same spot on the ground multiple times

Single Look Linear Artifact Example1

Shadows (occlusions) from linear scanners



Solution multi-Look and Oversampling

Multi-angle Illumination

- Improves foliage penetration
- Removes shadows
- Eliminates voids

Collection Comparison @ 8PPM

Superior Performance

HARRIS[®]

Linear LiDAR

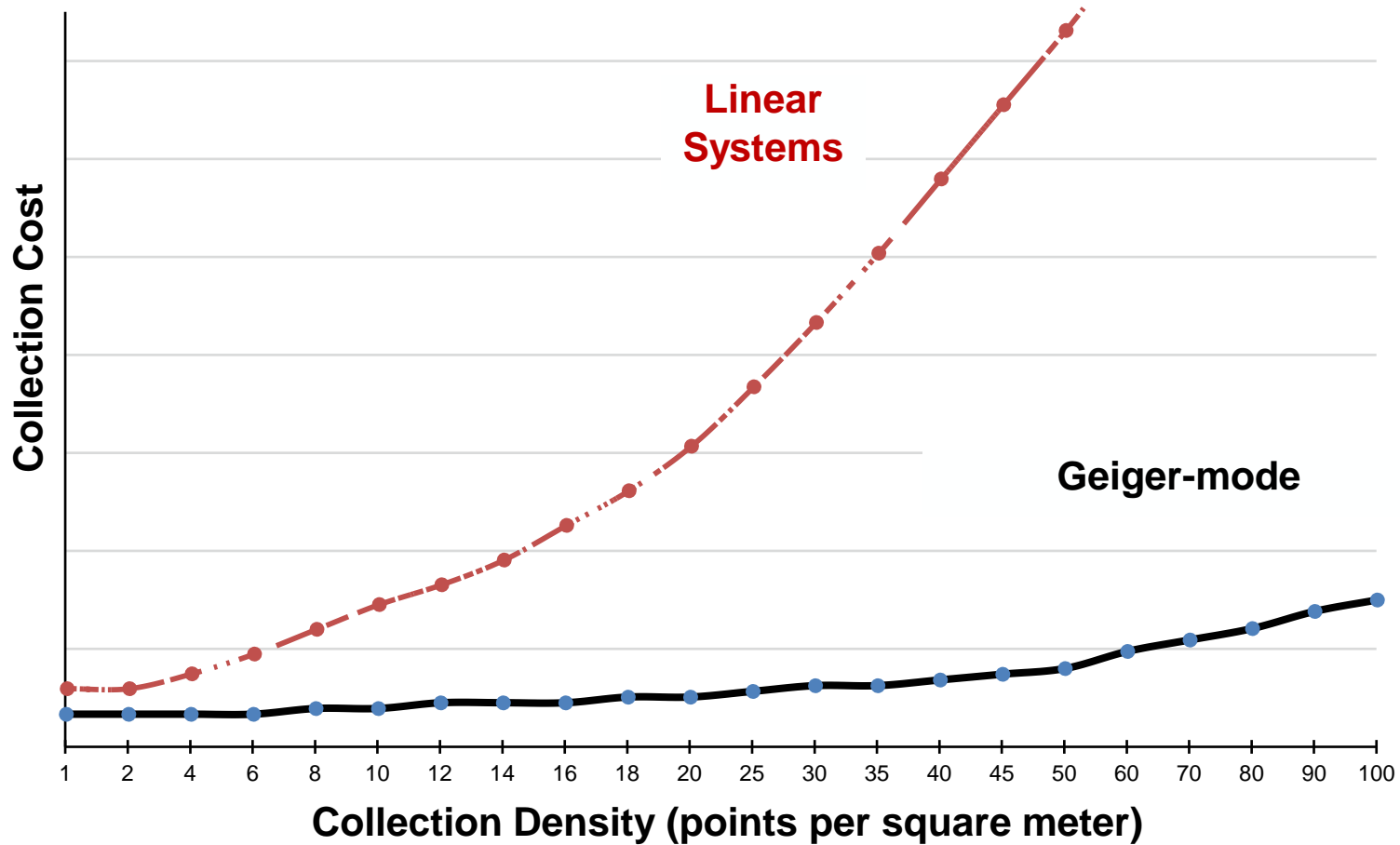
Geiger LiDAR

Density (points per meter)	8	8
Instantaneous Coverage Rate (mi ² /hr)	50	850
RMSEz (cm)	9.25	9.25
Altitude (AGL ft)	3,200	27,000
Swath Width (ft)	3,300	16,000
Ground Speed (kts)	90	290

17X

Higher the density greater the payback

Reduced Cost at Higher Resolutions



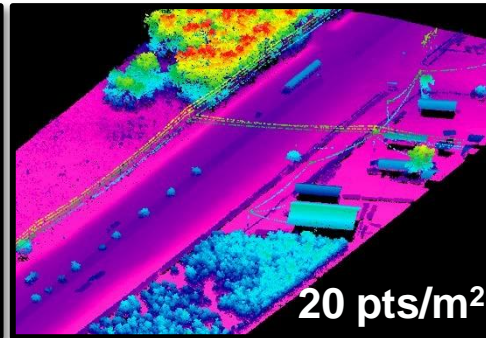
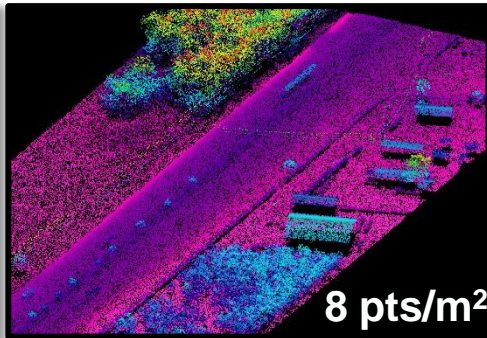
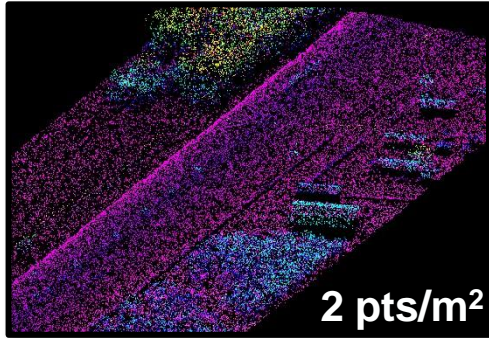
Efficiency gains keep costs down at higher collection densities

Geiger-Mode LiDAR Summary

- **Improves speed of collection**
- **Increased data density (resolution) at lower cost**
- **Improves foliage penetration**
- **Multi-look reduces shadows/voids (artifacts)**
- **Higher accuracy with robust bundle adjustment**
- **Improved vertical target separation**

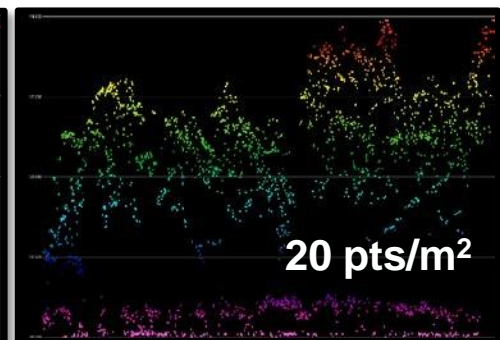
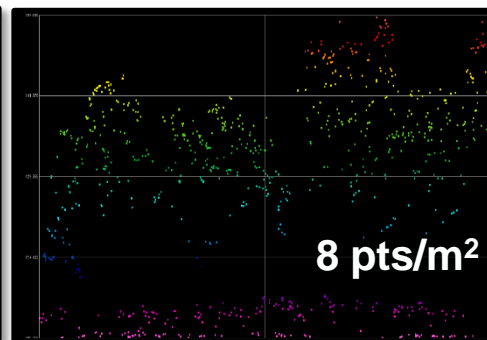
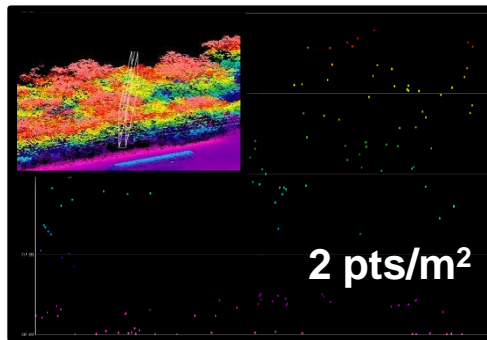
Large area, high density collection leads to new adopters and opportunities

Why do higher densities matter?



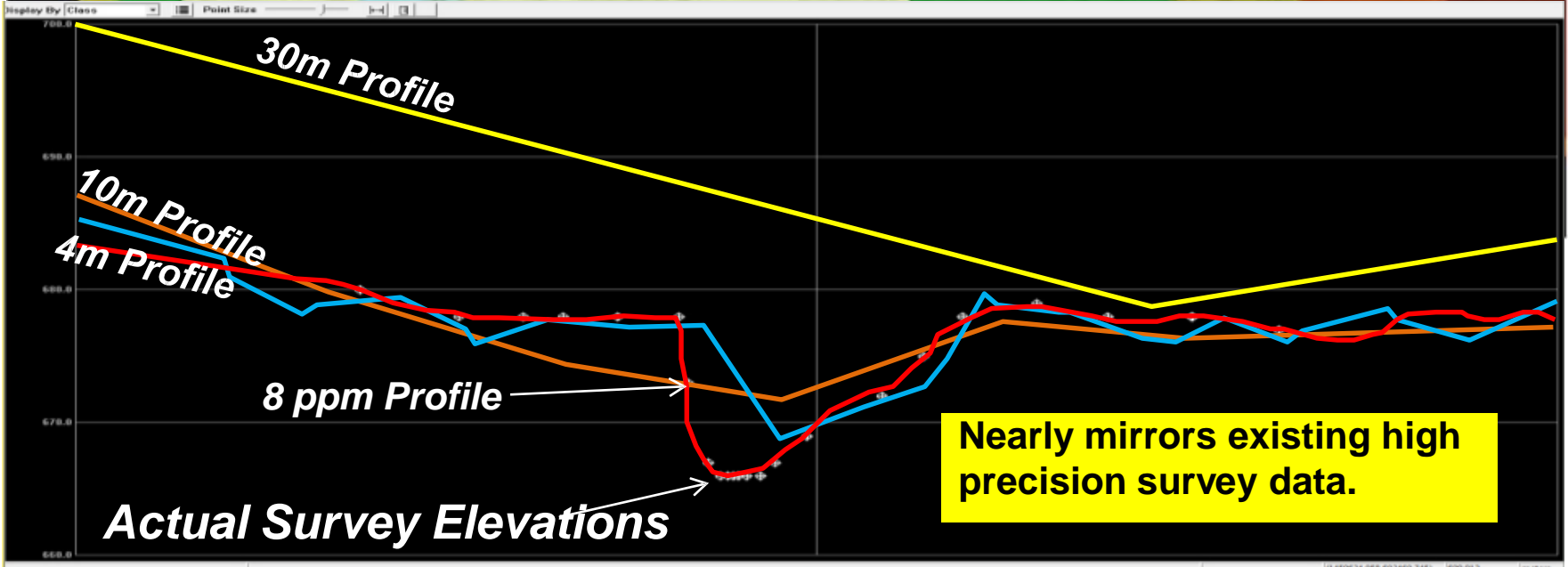
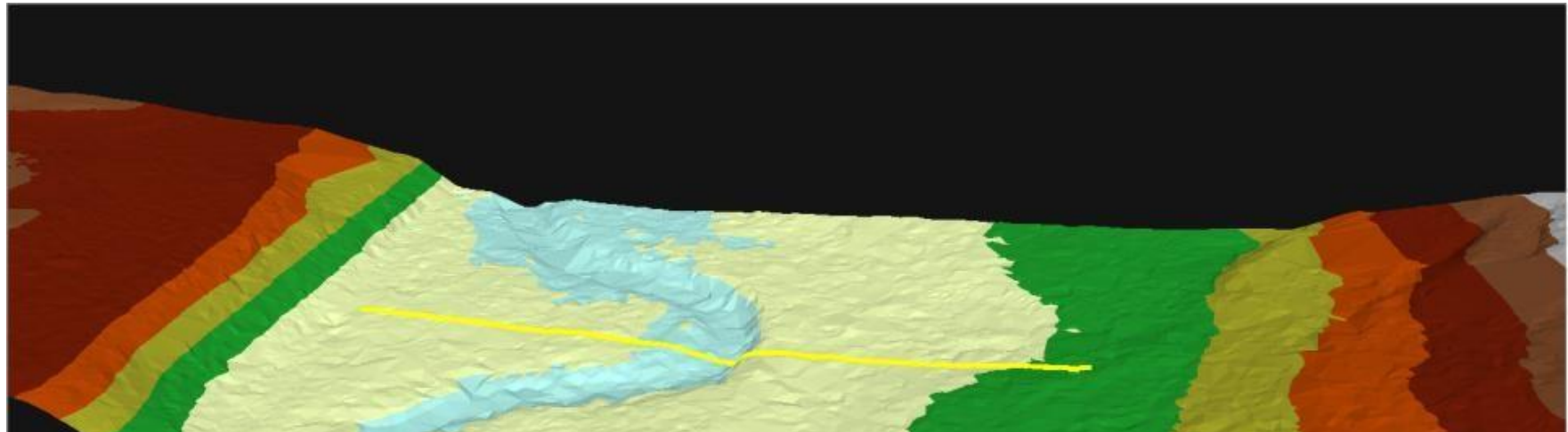
Infrastructure details better defined

Improves foliage penetration to better sample bare earth



Improves accuracy and enables a high level of automation

8 Points per Meter: Higher Point Density Enables Accurate Flood Mapping Decisions



What to do with all this data?

- Not for the workstation in raw form
- Terabytes to petabytes in data management and processing
- Requires high-speed, distributed, multi-core processing
- System has been highly evolved over 15 years
- Sorties are processed in <24 hours
- Total solution requires innovations in both hardware and software

Horizon/Pelydryn



- **Offers comprehensive Survey, Geotechnical & Environmental Services to the marine industry**
- **LiDAR/Sonar**
- Established 2004
- workforce over 430
- UAE based, offices in India and the UK

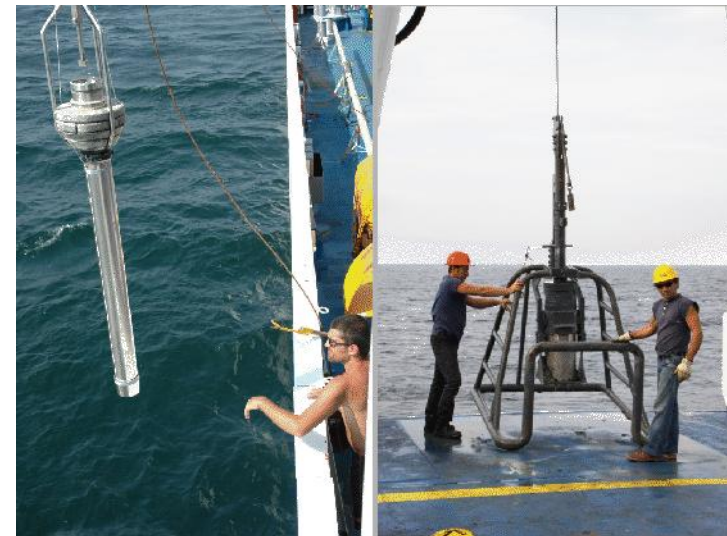
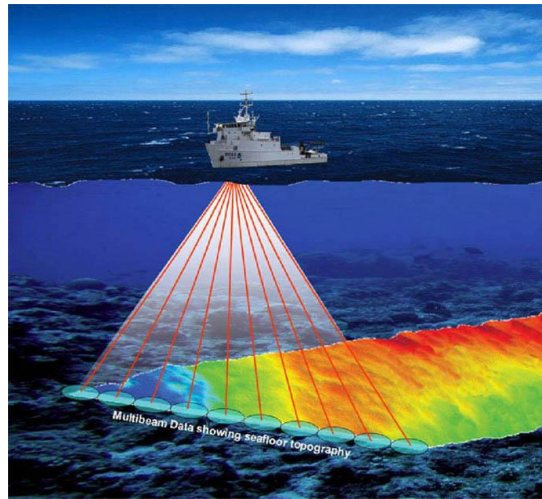


• Hydrographic Survey

- 4 x ships
- Numerous smaller survey boats, all conducting Hydrographic survey
- **2 x Hawkeye IIb LiDAR systems**
- **1 x Chiroptera IIb and**

• Environmental Dept:

- Water Quality Sampling:
- Analysis of Biological and sediment makeup
- Mapping of Species & Habitat
- Data Processing & Analysis
- Seabed/Riverbed core sampling
- Environmental Impact Assessments and Baseline Surveys



Bathy/Topo Applications

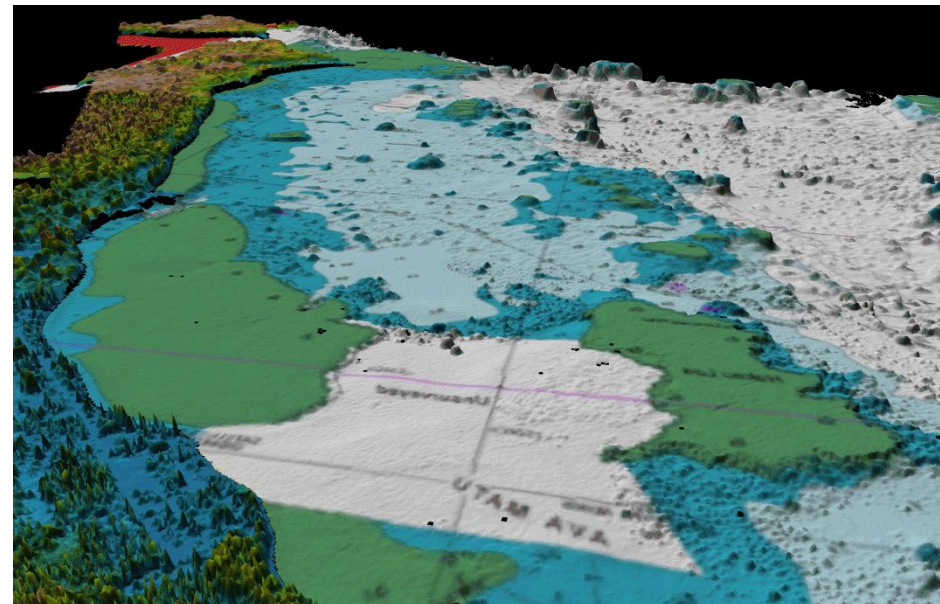
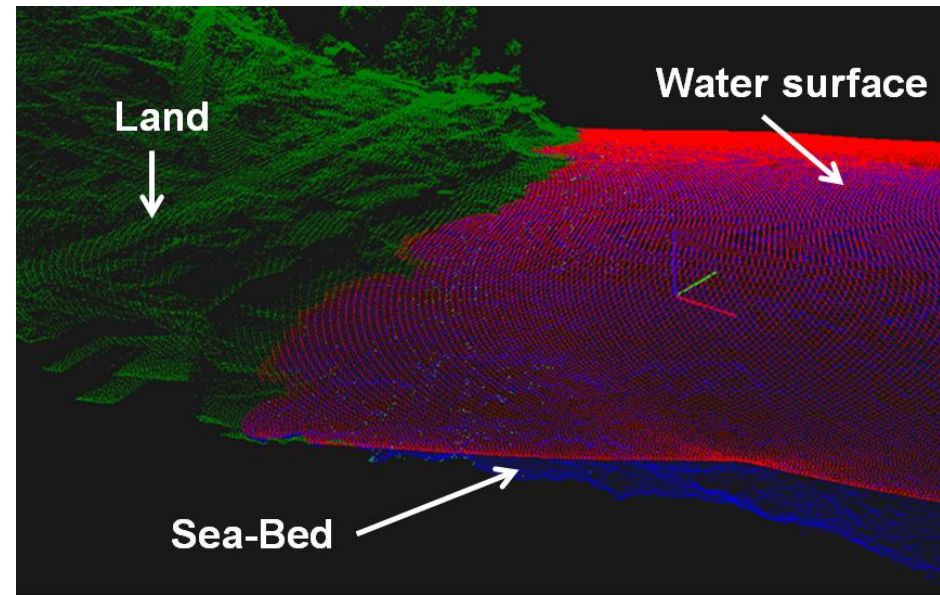
- Coastal Erosion Monitoring
- River profiling
- Flood mapping
- Evacuation route planning
- Sea level Rise Mitigation Planning
- Storm Surge/Tsunami Modeling
- Habitat Mapping
- Nautical Charting
- Renewable Energy and Shallow Geophysical Site Surveys

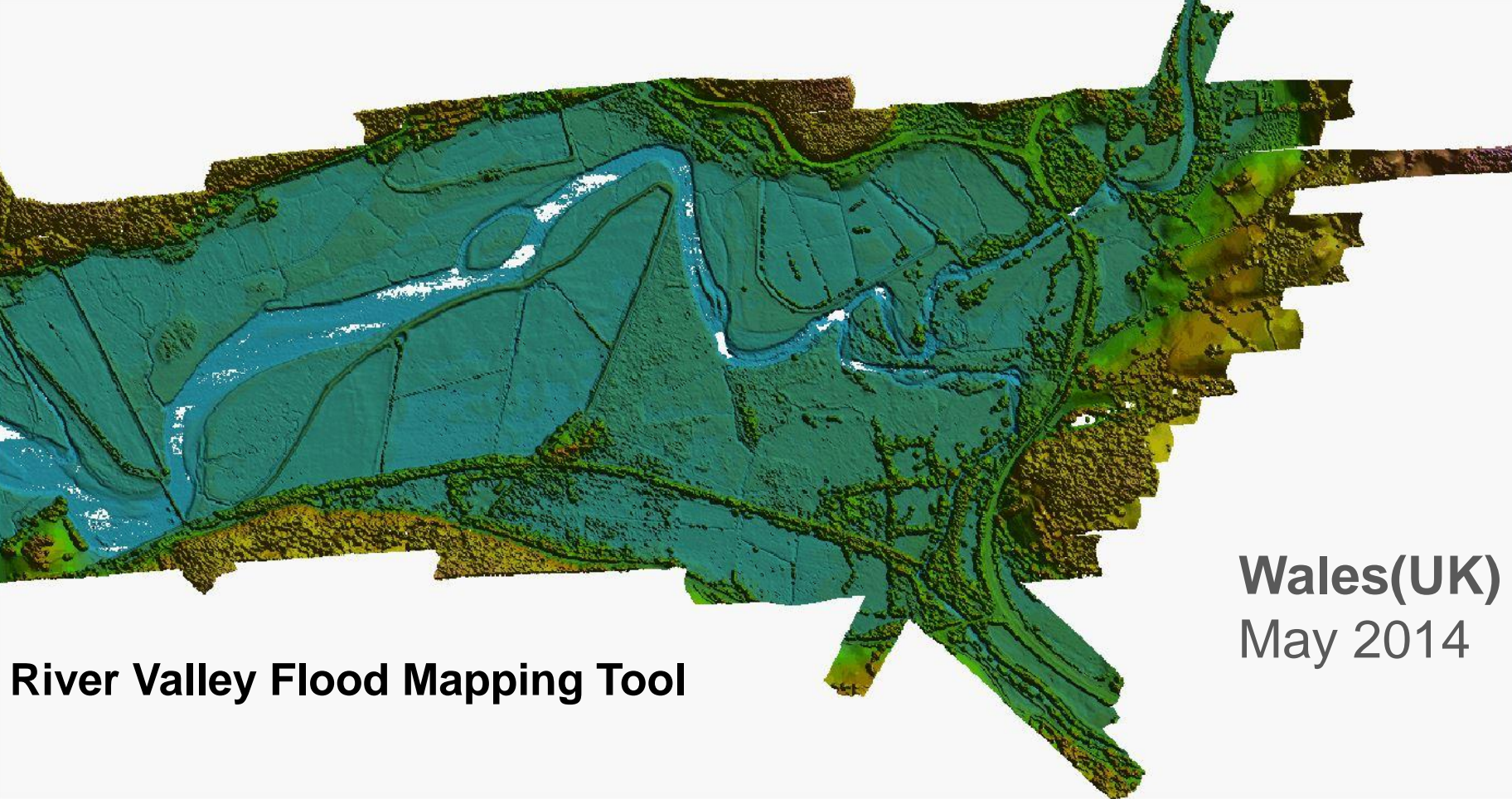
Capability of Bathymetric LiDAR



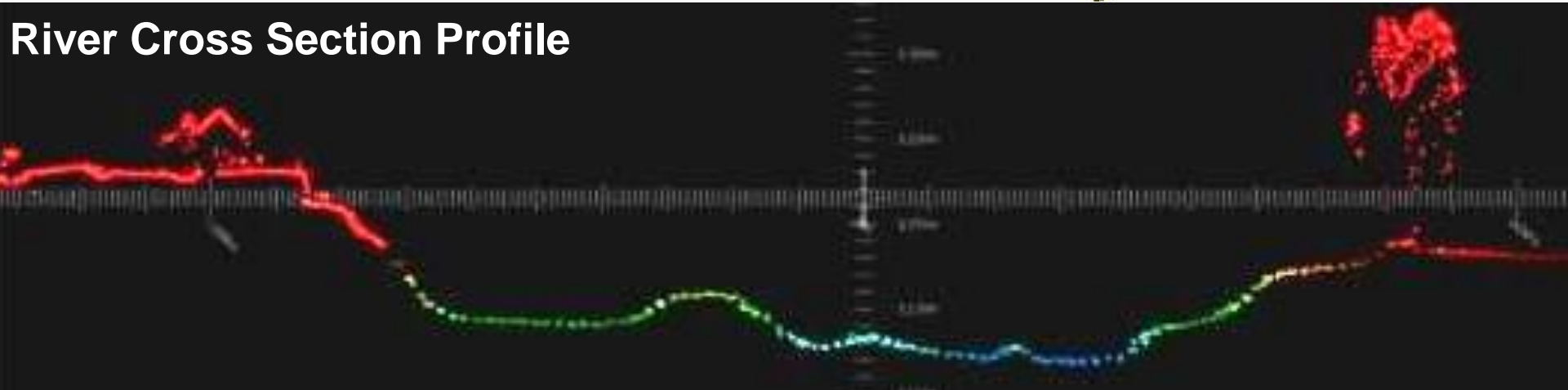
Bathymetric LiDAR (Green) allows the collection of depths from the seabed over a wide area from a low flying aircraft.

When used simultaneously with **Topographic LiDAR (Red)** - depths can be taken of the seabed seamlessly up on to the land

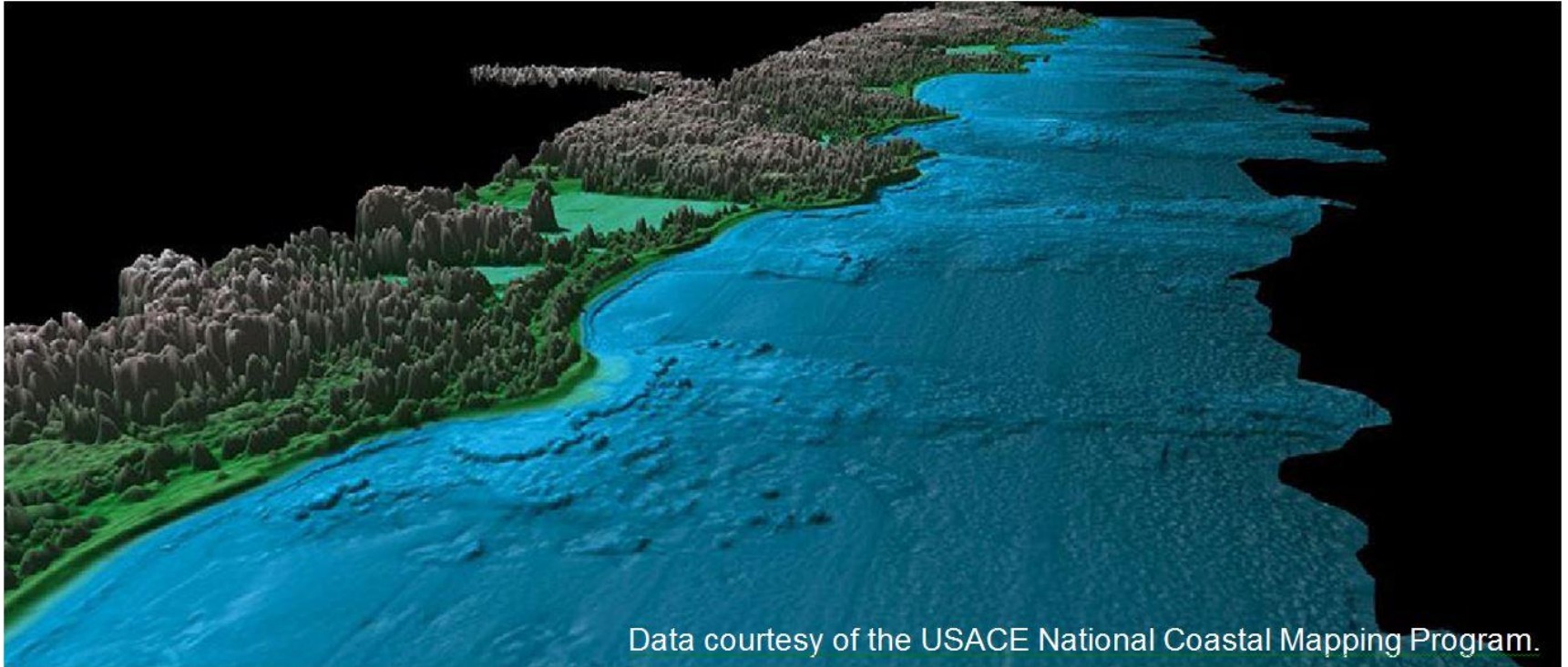




River Valley Flood Mapping Tool



Bathy/terrestrial lidar merge



Data courtesy of the USACE National Coastal Mapping Program.

Data Supports Flood Model/Flood Risk Applications

Data will be delivered as fully hydro enforced data

- Breaklined Rivers with monotonic behavior
- Lakes Hydro - Flattened
- Can be integrated with Bathymetric data from:
 - Bathy LiDAR
 - Soundings
 - Survey Cross Sections
- Will support HECRAS or other model efforts for:
 - Flood Risk
 - Flood Mitigation
 - Disaster Response



GRMC Team can Provide a Total Solution

Homeland security

Flood Risk

Emergency Management

Forestry

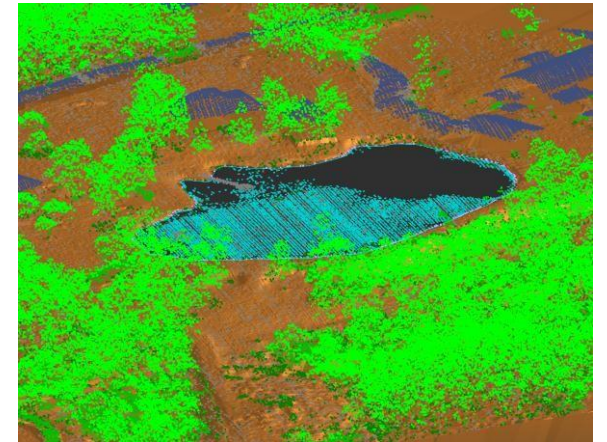
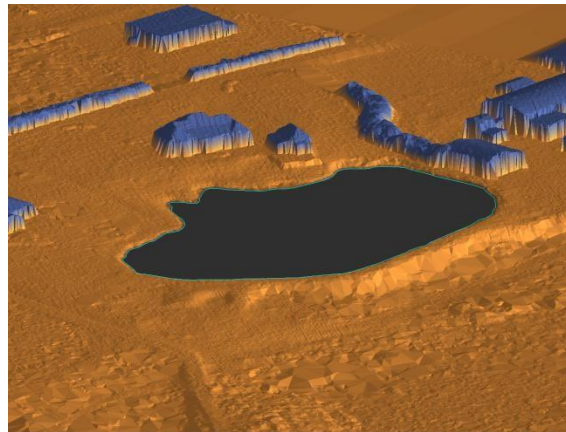
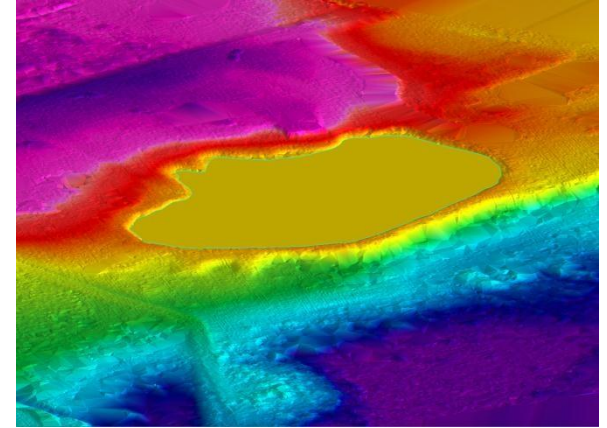
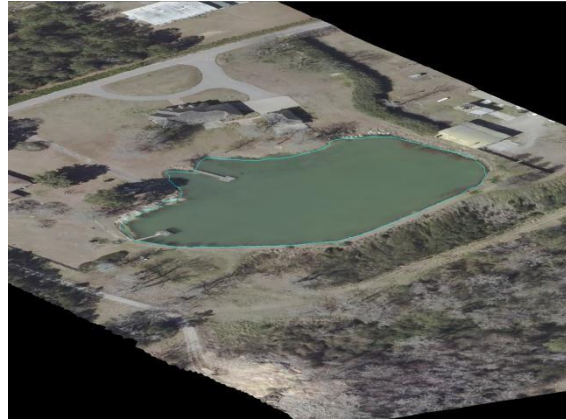
Feature Extraction

3D Modeling

Data Fusion/Visualization

Utility Mapping

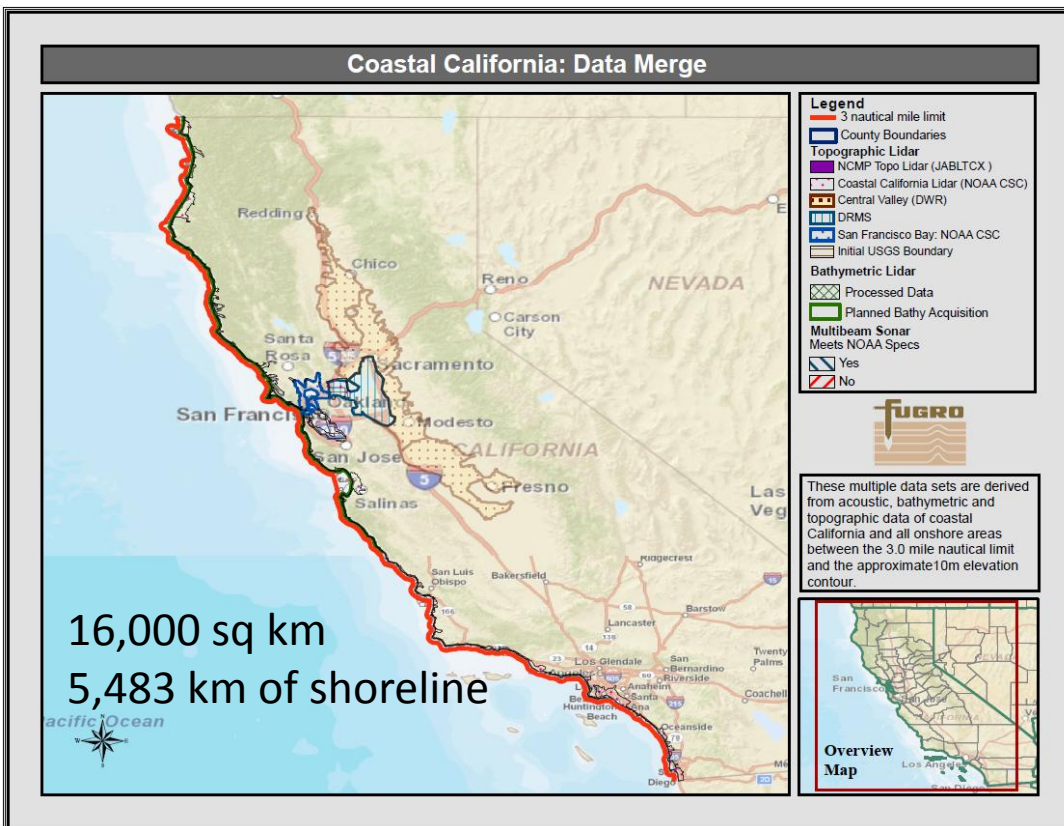
Others



High Quality >8PPM Data Supports Multiple Applications

Merging remote sensing data

- Dewberry recently conducted two very large projects in US to merge various imagery and elevation data.



GRMC Solutions

- No other company offers such a diverse range of integrated technology solutions
- Focused on solving problems not delivering data
- Massive data center focused on processing all acquired data in-country
- Big data mining capability
- Total solution from planning and project design, to acquisition, processing and delivery of solutions

THANK YOU!

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