FUGRO

Unlocking **Insights** from **Geo-data**

Map Once
Use Many Technologies

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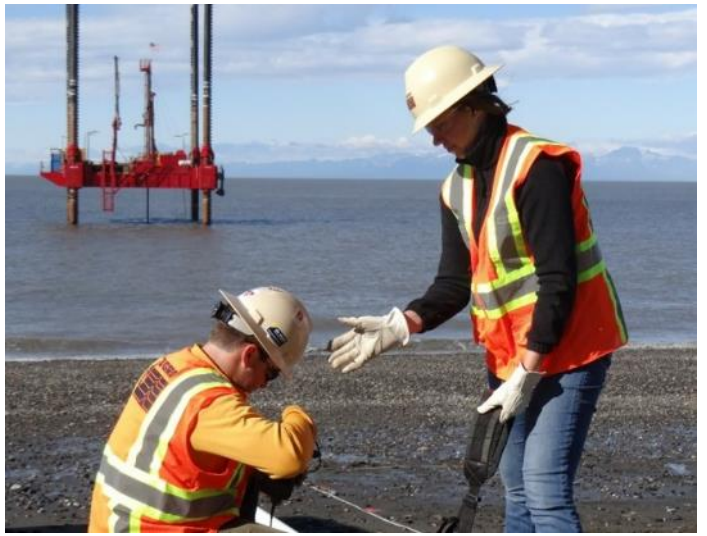
Alaska Coastal Mapping Summit– December 10, 12 noon

Image: SE Unimak Island, USFWS

Unlocking insights from Geo-data



We are the world's leading Geo-data specialist, collecting and analyzing comprehensive information about the Earth and the structures built upon it.

Leading the industry in nearshore and coastal mapping technologies

1992-2003: Develops and operates ALB in concert with Royal Australian Navy

1994-2007: Provides ALB operational support to USACE via JALBTCX program

1998-2020: Provides hydrographic surveys for NOAA charting program

1998-2013: Performs hydrographic surveying in **AK** for NOAA

1998: Uses ALB for field reconnaissance on NOAA project in **AK**

2001: Performs NOAA's first ALB survey; project is based in **AK**

2004: Performs NOAA's first ALB/MBES integrated survey; project based in **AK**

Leading the industry in nearshore and coastal mapping technologies

2005-present: Provides ALB surveys for USACE National Coastal Mapping Program

2006: Helps develop reflectance imagery from full waveform ALB

2006: Performs ALB projects on three different continents concurrently

2007-2012: Serves as private sector lead for CA Seafloor Mapping Program

2012-2014: Performs integrated ALB and MBES survey of the Red Sea (108,000 km2)

2016: Performs NOAA's first integrated SDB, ALB, and MBES survey

2018: Introduces RAMMS, next generation airborne lidar bathymetry system

2018: Integrates Back2Base capability with RAMMS for field-to-shore data transfer

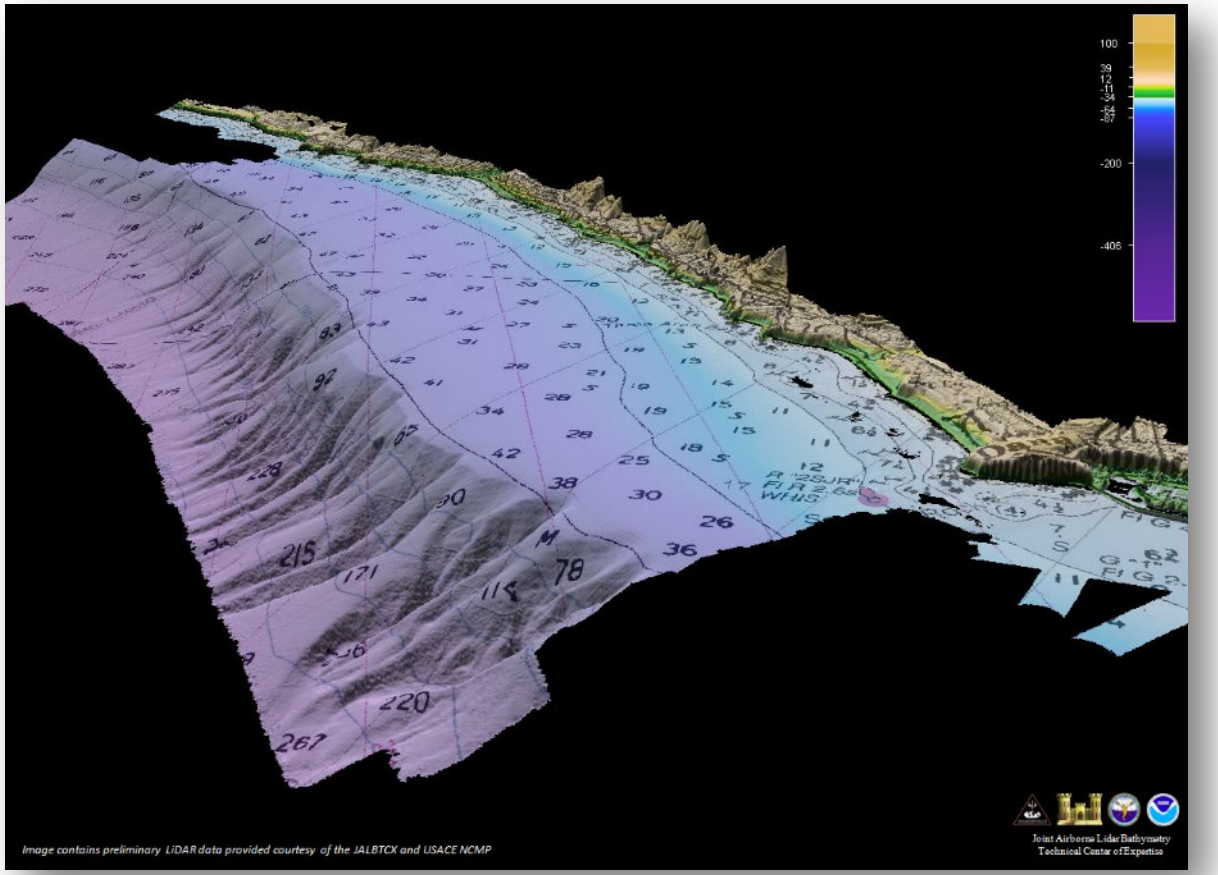
Advocating for Alaska coastal mapping

- Since 2012, developed and annually updated Alaska Coastal Mapping Whitepaper
- Advocating for Alaska Coastal Mapping to congressional committees and members
- Testifying in support of the Digital Coast Act
- Providing technical input to State and Federal studies
- Connecting Alaska government coastal planners with similar programs in other states
- Sharing purpose and need for coastal data through technical panels, working groups, trade association boards and conference presentations

Building on successful partnership models

California Seafloor Mapping Program

- Public Private partnership involving California OPC, NOAA, USGS, USACE, CSUMB, Fugro and others
- Lead private sector participant
- Supported the State of California's planning process
- Combined vessel-based and airborne-based surveys over several years
- Provided topo lidar, bathy lidar, multibeam, interferometric sonar, hyperspectral imagery, RGB imagery surveys and products



A comprehensive shoreline mapping program for Alaska:

Anticipated Products

- Seamless, integrated topography and nearshore bathymetry
- Orthorectified imagery
- Habitat Mapping
- Linear vector collection of the shoreline
- Upgrade of spatial reference system components to support development of accurate coastal products

Focus

- Integrated technology approach
  - Aerial
  - Satellite
  - Vessel
- Performance period:
  - Priority areas in 5 years
  - All remaining areas by 2030

Expand Coastal Data Collection to Deliver Geospatial Products Stakeholders Require

Airborne: ALB, topo, imagery from crewed and autonomous platforms

Vessel: Bathymetry from crewed and uncrewed platforms

Satellite: Imagery, satellite-derived bathymetry for planning and change detection

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Airborne: Leverage Innovation

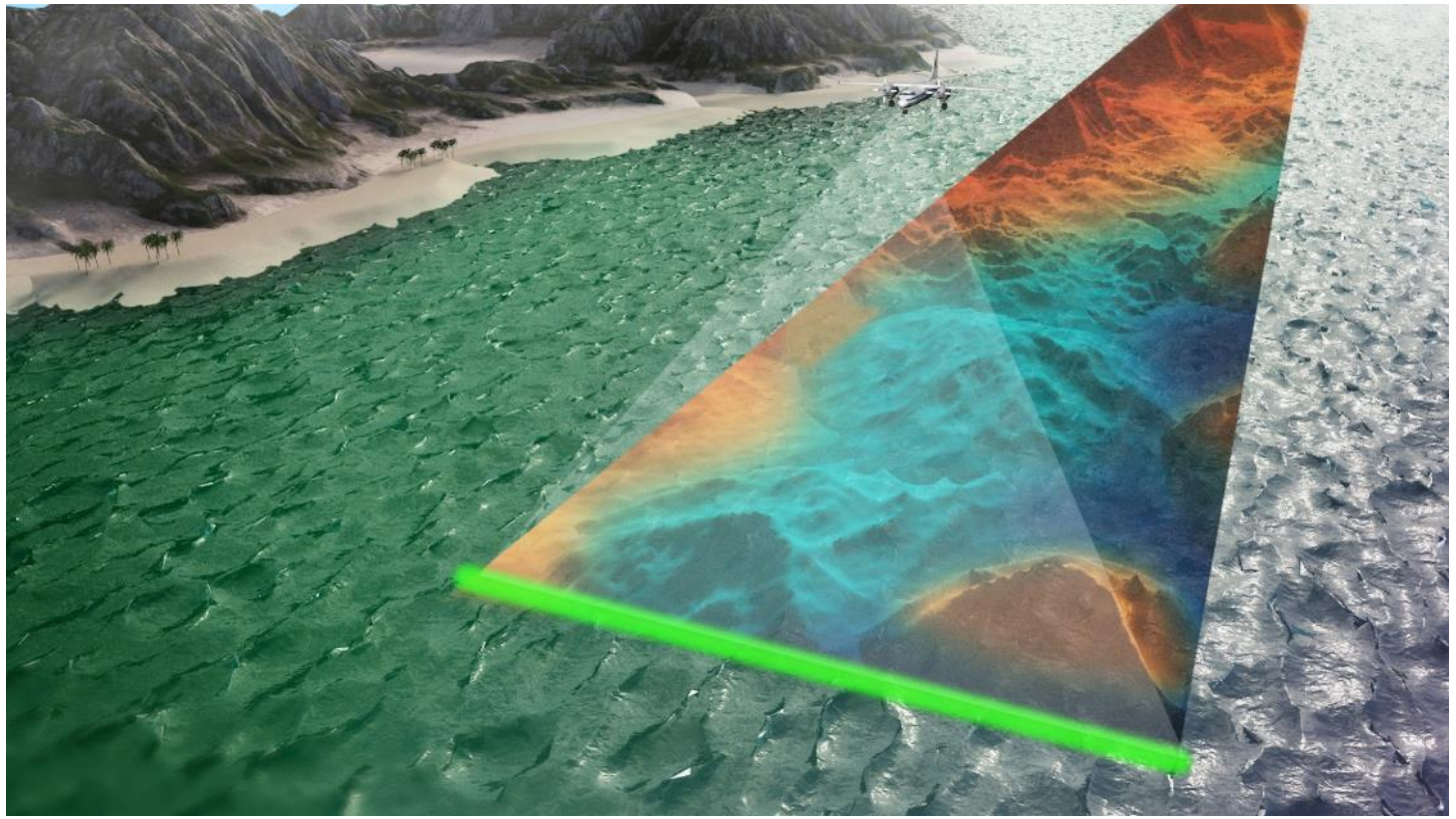
RAMMS Coastal: mapping nearshore and shallow water environments using ALB and orthoimagery from crewed and autonomous platforms

Bermuda "RAMMS Coastal" IHO Order 1a topobathy data merge (Jan 2020)

A paradigm shift in ALB data acquisition

RAMMS: Rapid Airborne Multibeam Mapping System

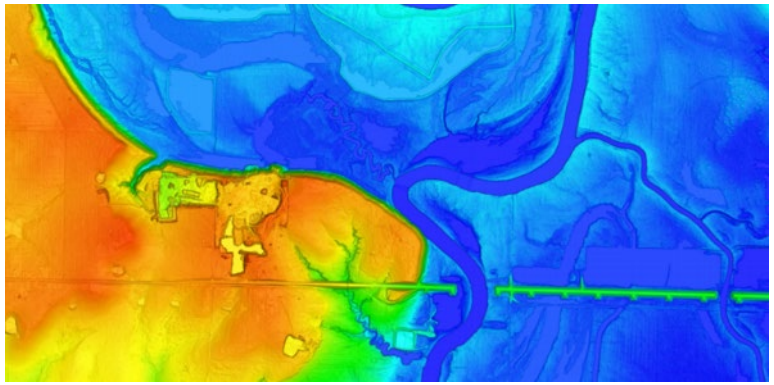
- Delivers high data density ***and*** depth penetration
- Compact sensor for small aircraft and UAVs
- No moving parts for increased reliability
- Streamlined data processing and data delivery



RAMMS Coastal: smaller is better

Sensor bundling for broad coastal applications:

- High-density topographic lidar sensors
- RGB, multispectral, and hyperspectral cameras
- Other sensors



RAMMS Coastal: smaller is better

Greater platform flexibility

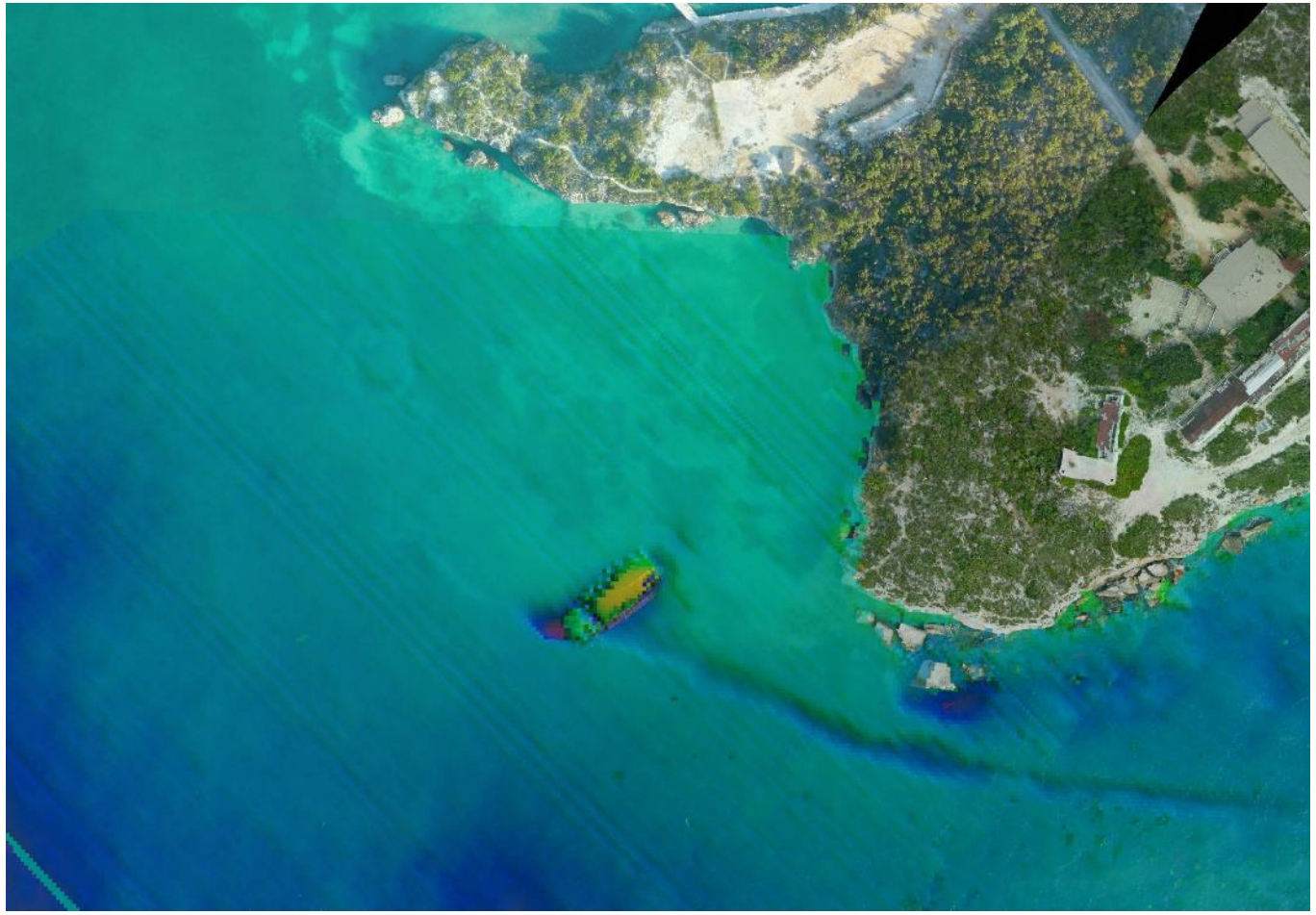
- Smaller fixed-wing aircraft
- UAV capable
- Operable in remote areas with non-asphalt runways
- Lower fuel consumption = increased mission endurance

Easy to ship and mobilize on aircraft

- Less logistical overhead required
- Lower shipping cost & volume
- Aircraft refitting can be performed by field staff
- Safer mobilization due to low weight

Now vs. then

RAMMS Coastal: proven technology



RGB imagery and RAMMS integration

We've mapped 45,000 km² or 13,600 linear mile in the Americas since commercializing the technology in August 2018.

- UKHO: Turks & Caicos
- UKHO: Belize (2x)
- UKHO: Bermuda
- CHS: Quebec
- CHS: Nova Scotia
- CHS: Ontario
- IDB: Jamaica & Haiti
- OWF private client: Denmark
- OWF private client: New England
- World Bank: Sint Maartin (in progress)
- CHS: Ontario (in progress)

RAMMS: improved design = greater benefits

Feature	Benefit
Better depth penetration & data density	Better quality data
No moving parts	Less downtime, improved repeatability
Sensor bundling capability	More robust, integrated datasets
Smaller, more compact sensor	More efficient, versatile & cost effective mobilization
Reduced manpower	Lower costs, lower HSE exposure
Greater platform endurance	Lower costs, reduced carbon footprint
Quicker data turnaround	Rapid decision making

Net benefit: Better performance at *same or lower cost!*

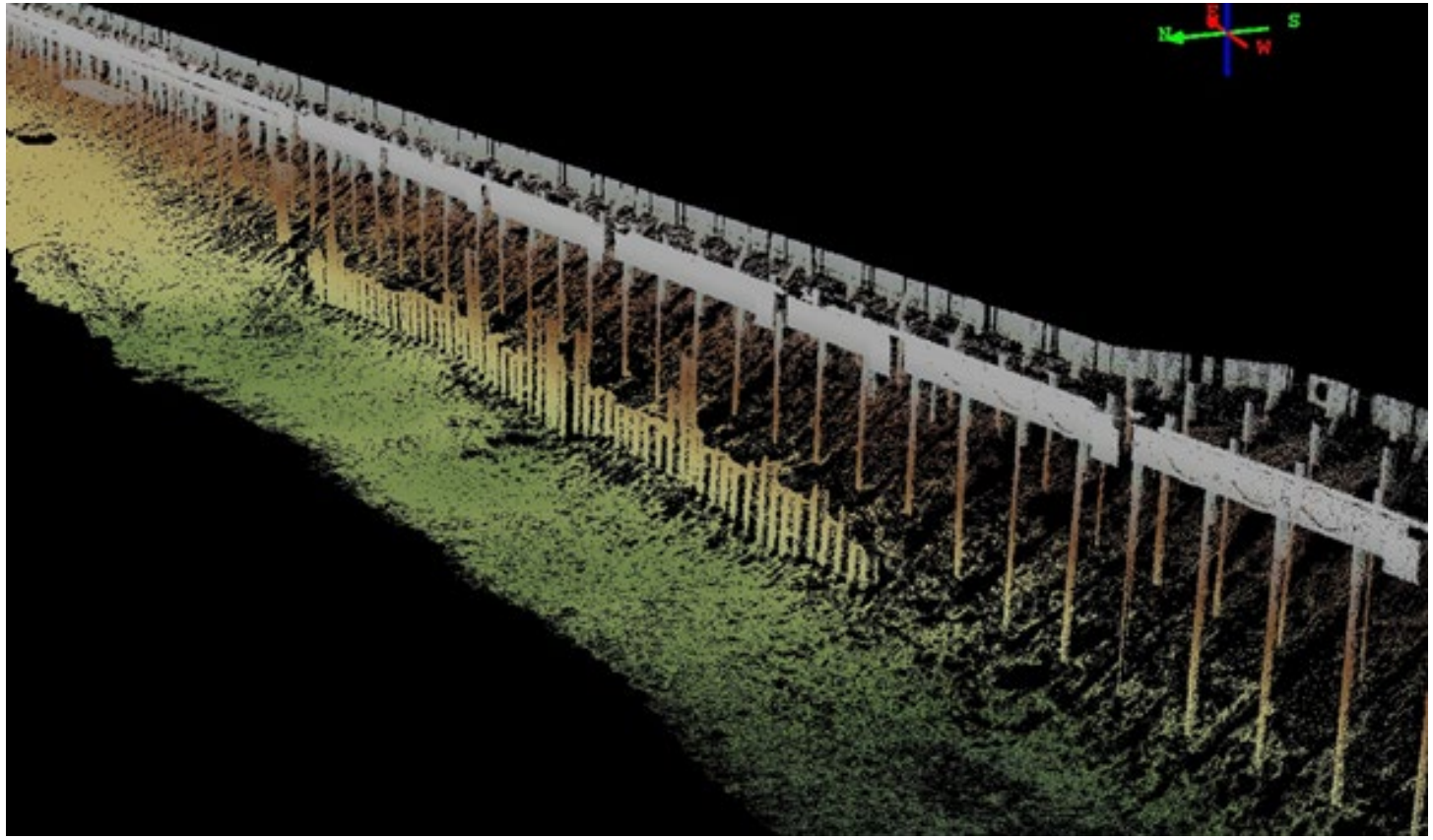
ALB is not the only answer: all laser systems are limited by water clarity and water depth

Vessel

At the limits of ALB, acoustics take over to capture seafloor data in turbid waters and areas beyond 3-Secchi water depth via crewed and uncrewed platforms

20+ years providing quality hydrography to NOAA

Vessel-based multibeam + lidar



Mobile lidar scanning systems can be fitted onto vessels to capture under tree overhang, cliff undersides, under structures, or to ensure bank overlap when water levels change.

30+ years providing coastal and slope stability surveys to industry

Uncrewed operations-in the field

Fugro Blue Shadow

Fugro's uncrewed surface vehicle is developed in partnership with L3.

Used in 2020 for a NOAA job in Apalachicola, Florida

https://www.fugro.com/about-fugro/our-expertise/remote-and-autonomous-solutions/remote-and-autonomous-vessels

Uncrewed operations-hybrid, modular

Blue Essence

Partnership with Sea-Kit USV for a hybrid electric vessel with integrated solar power, batteries and fuel = 30 days of endurance.

- Hydro and geophysical ops
- Collision avoidance system
- Reduced safety risks
- 95% reduction in fuel

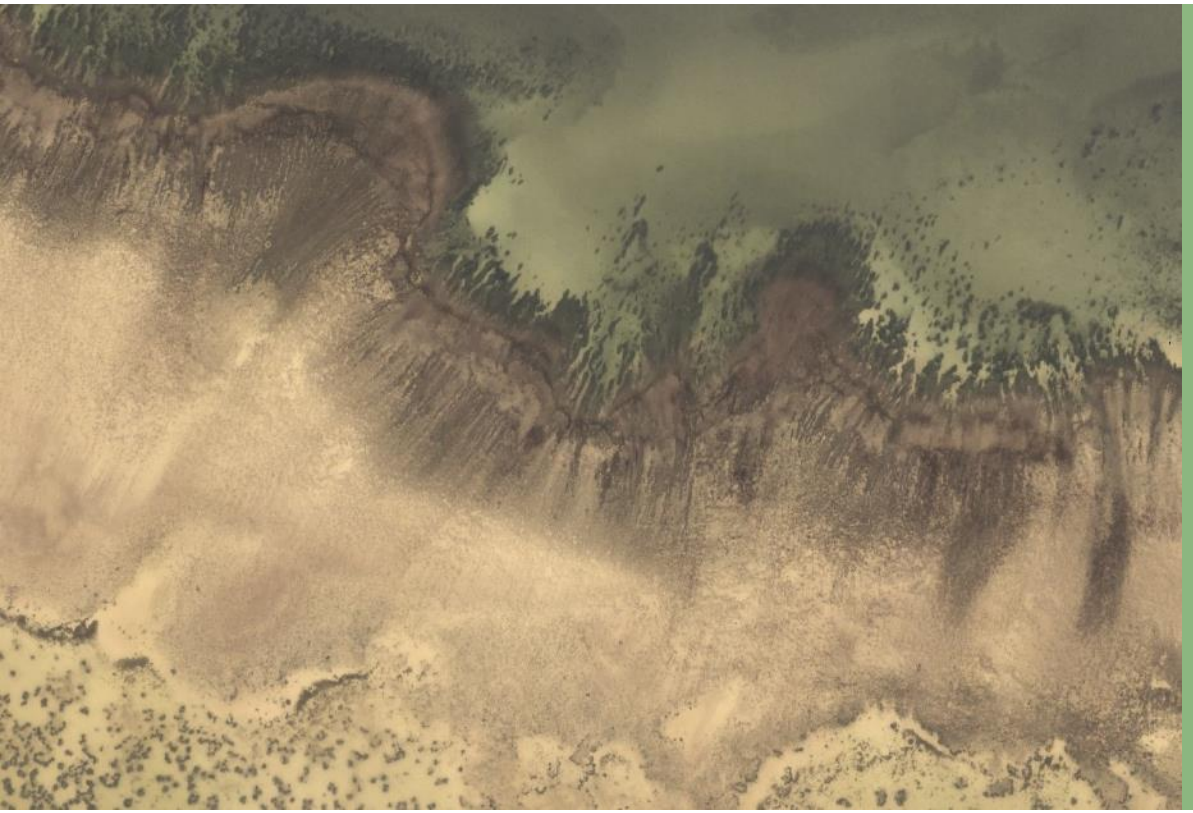
Uncrewed operations: protected waters

Operations

- Two-person-lift portable platform fits in a truck for road or air transport to remote communities
- Easy to deploy from shore
- Field-swappable payload allows to mix and match payloads
- Allows concurrent collection of beach profile and nearshore
- Best for small footprint surveys in protected waters

Benefits

- Faster collection of higher quality data: concurrent land/nearshore collection removes risk of weather induced landscape changes between surveys.
- Cost efficiency: no need to mobilize vessel to remote harbors or at pier bases, bridge footings, flood-control structures



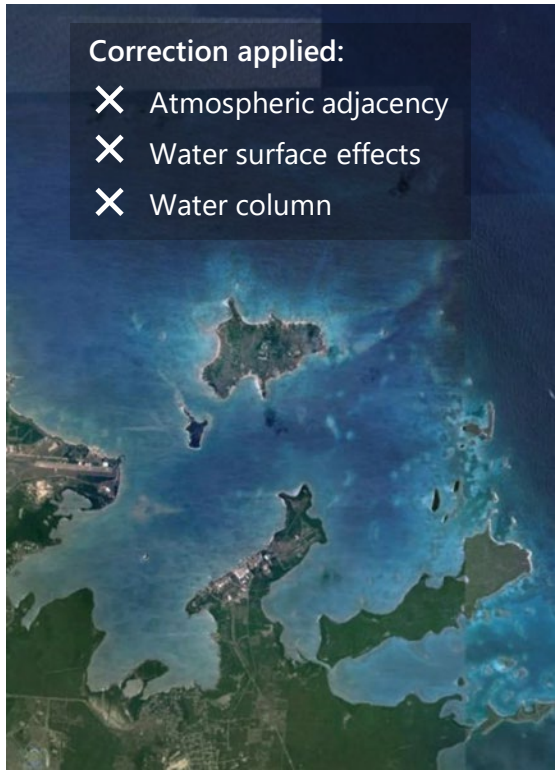
What do we do between no survey and an old survey?

Satellite

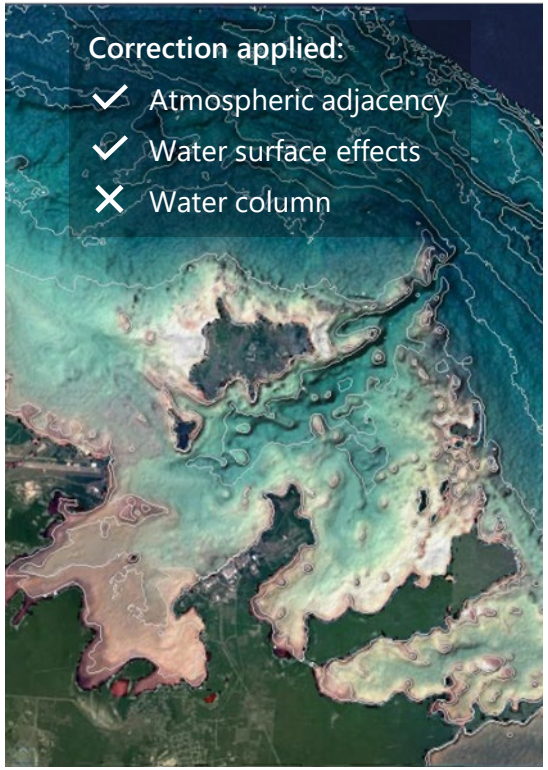
Satellite imagery provides a cost-effective means to detect hazardous or notable changes; prioritize areas after weather or seismic events; and plan active sensor acquisitions

Reindeer Island, Prudhoe Bay, Alaska
Difference between 1955 nautical chart (red) and a recent satellite image

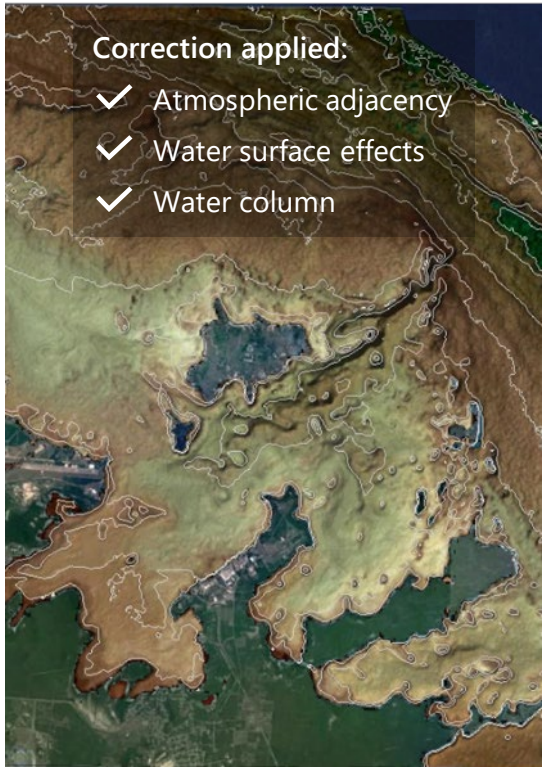
Imagery to morphology, habitat mapping, bathymetry



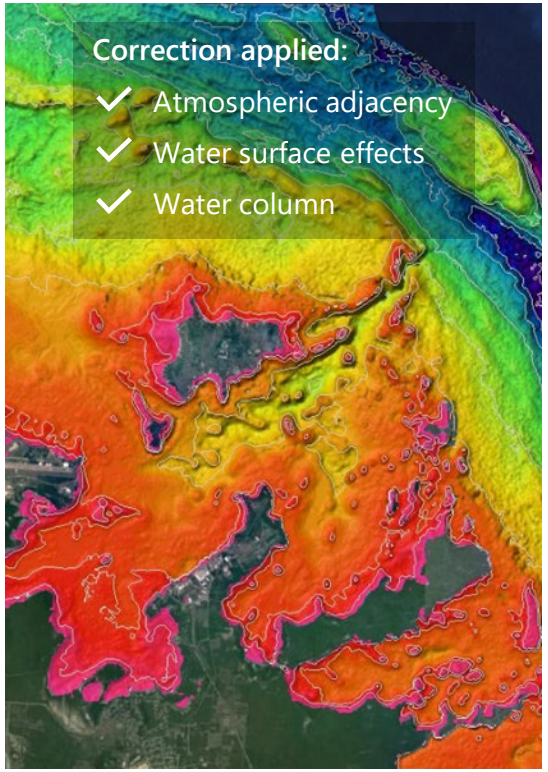
General info, but typically not well suited for aquatic and benthic analysis.



More detailed info on geomorphologic zoning, spatial and spectral patterns of the seafloor and benthic habitats.



Very detailed info on geomorphologic zoning, spatial and spectral patterns of the seafloor and benthic habitats. Represents clear view to the surface being corrected for water column effects and **perfect baseline for benthic habitat mapping.**

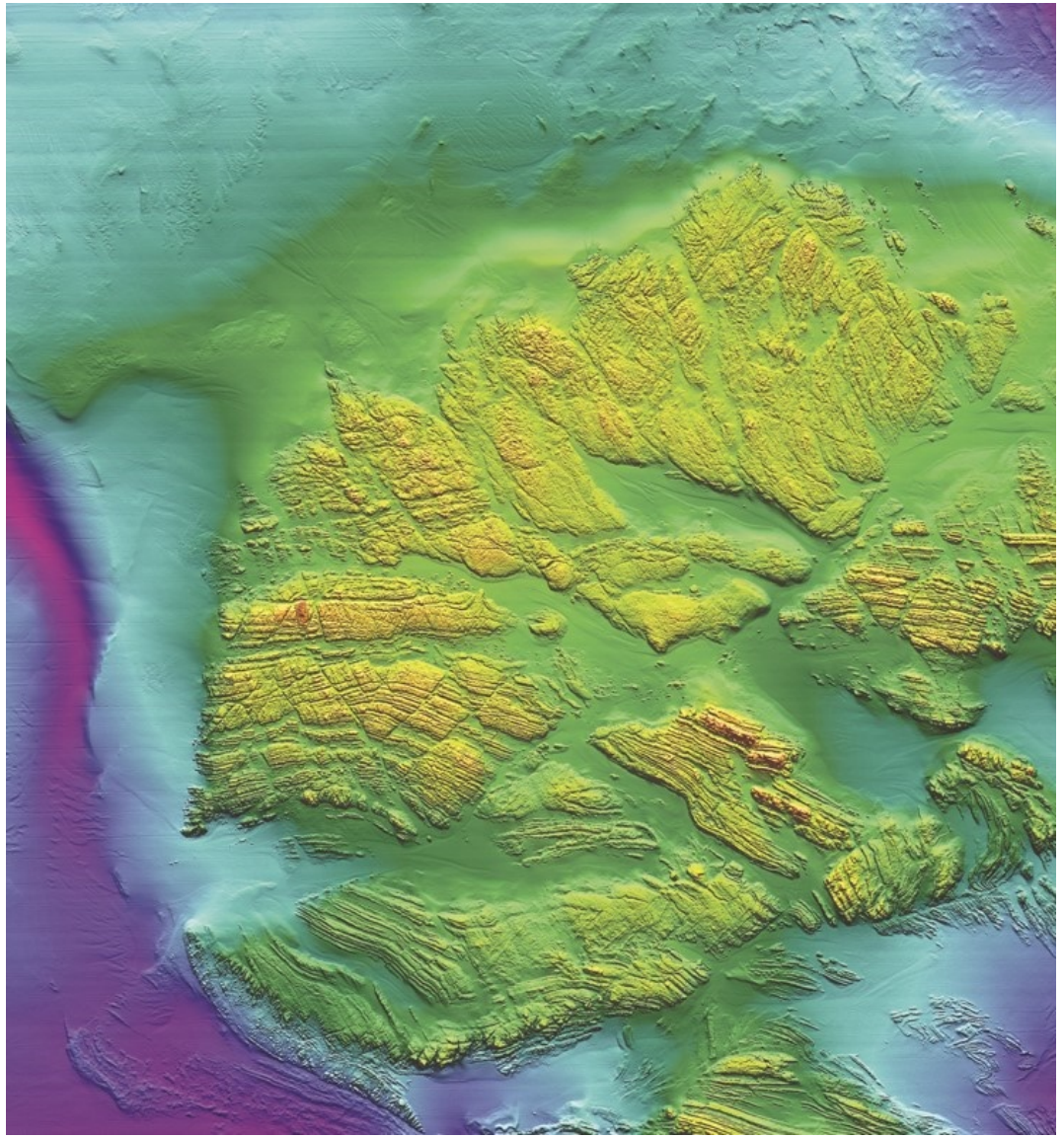


Bathymetric info in dense grid. Data are mapped using EOMAP's physics-based inversion algorithms, which have been applied in more than 40 areas worldwide.

Map Once, Use Many Technologies

Fugro: unlocking insights from *coastal* Geo-data for a safe and liveable world.

- **Acquisition:** coastal technology suite
- **Analyses:** expertise on fit-for-purpose and conditions tools
- **Advice:** input to specifications and how to meet broadest needs most effectively



Thank you

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