MBSHC-21 - Cádiz, Spain (11-13 June 2019)

Fugro Report: Hydrographic Services

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We will keep asking for more because we want the industry to meet our needs.

Client quote

Hydrographic Services

Hydrographic charting
to IHO standards
using conventional **acoustic**,
airborne **Lidar** technology and
remote sensing techniques

to provide maps and charts that characterize the ground surface from land, across the land-water boundary, and to full ocean depth

Marine Site Characterisation

Global Hydrographic Survey Capability

- N. Staff: 150+
- 3 “Centre of Excellence” Locations
  - Bremen, Houston, Adelaide
- Vessel + boats
  - Shallow, medium and full ocean capability. Multiple survey launches and coastal boats
  - New Unmanned Surface Vessels (FAS-900)
  - + Vessels of Opportunity globally
  - Survey spread – Various SBE, MBE, MPE, SSS, SBP, UCTD, SVP, IMU, grabs, etc.
- Aircraft
  - 1 (Dash 8, Full time with RAN)
  - + Aircraft of Opportunity globally
  - Survey spread – 3 x RAMMS (2 x UAV form factor) 2 x LADS HD (incl. Phase One Cameras inbuilt) 2 x Riegl VQ-820-G, 2 x Phase One cameras w/ multispectral
- Nautical cartography production and coordination center
- Satellite derive bathymetry

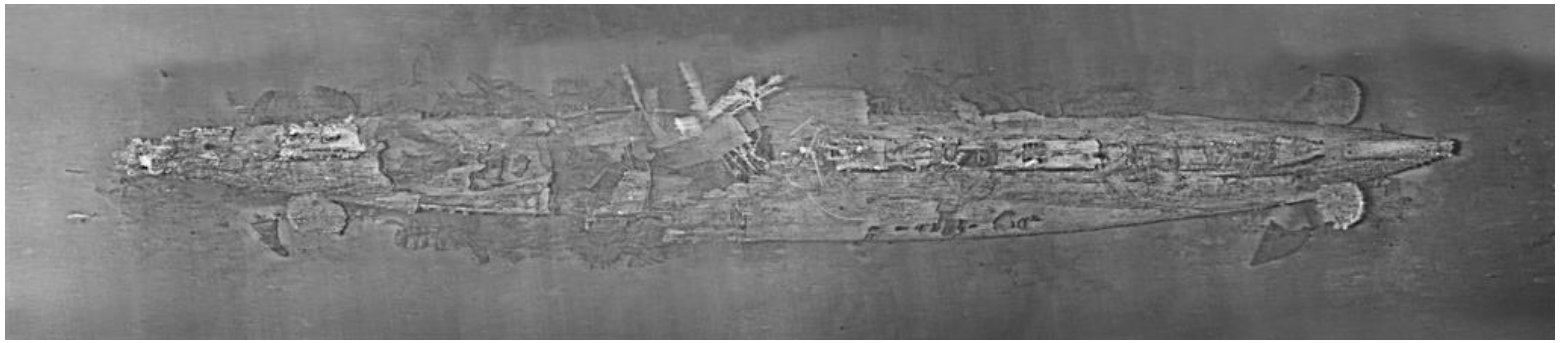
FUGRO

Good News Stories

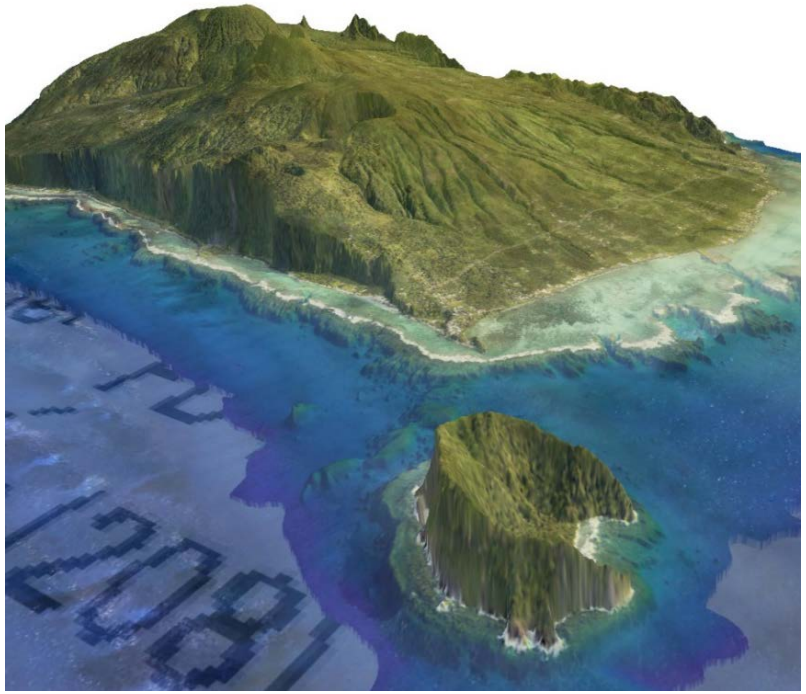
Discovery of paddle steamer D/S Norge wreck. This ship was lost after colliding with the paddle steamer D/S Bergen. This was the first steamship catastrophe in Norwegian waters and, therefore, an important find.

Good News Stories

Fugro's role in the expedition to find HMAS AE1 has helped to solve Australia's oldest naval mystery, 103 years after the First World War Australian submarine vanished off Rabaul, Papua New Guinea.



Main achievements during the year



- Accredited Category B hydrographic surveying training course (S-5B).
- Involvement in IHO HSPT S-44 6th Edition (HSSC Working Group), NCWG, Geohub and others.
- Active involvement in GEBCO “Seabed 2030” and “AusSeabed” Initiatives
- Technology Developments into SDB, USV, ALB and Data Processing…:
  - Moved 100% of Multibeam workflow to AWS
  - Introduced Fugro RAMMS to the market, and participating in RAMMS UAV missions for Navy
  - Over 7 months, collected >15,000 sq.km of RAMMS data in support of HO support, with 10,000 sq.km funded by various funds directed towards Coastal Resilience.
  - Original RAMMS currently has over 1,100 flight hours without downtime

Progress on Surveys – completed 2018 - 2019

- Turks and Caicos (ALB) – Order 1a and 1b
- Turks and Caicos (MBES) – Special Order
- Belize – (ALB) Order 1a, and 1b
- Belize (MBES) – Special Order
- Cayman Islands – Special Order
- 2018 NOAA Florida program – Special Order
- 2018 Quebec Canada program – Order 1b
- 2018 Atlantic Canada program – Order 1b
- Diego Garcia – Special Order, Order 1a, Order 1b
- Kwajalein – Special Order, Order 1a, Order 1b
- PNG – Special Order, Order 1a, Order 1b
- Tuvalu - Order 1b
- 2018 Mareano program - NHS specification
- and many others IHO compliant survey

Progress on Surveys – to come

- Fiji (ALB) – Order 1a
- Marshall Islands (ALB) - Order 1b
- Gold Coast (ALB) - Order 1b
- Middle East (ALB) 3-4 month data acquisition – Order 1b
- Jamaica (ALB) Order 1a, and 1b
- Haiti (ALB) Order 1a, and 1b
- Guyana (ALB) Order 1a, and 1b
- 2019 Hydro program America region - Special Order
- 2019 Quebec Canada program – Order 1b
- 2019 Atlantic Canada program program – Order 1b
- Mareano 2018 continue + options – NHS specifications

Contributions to GEBCO

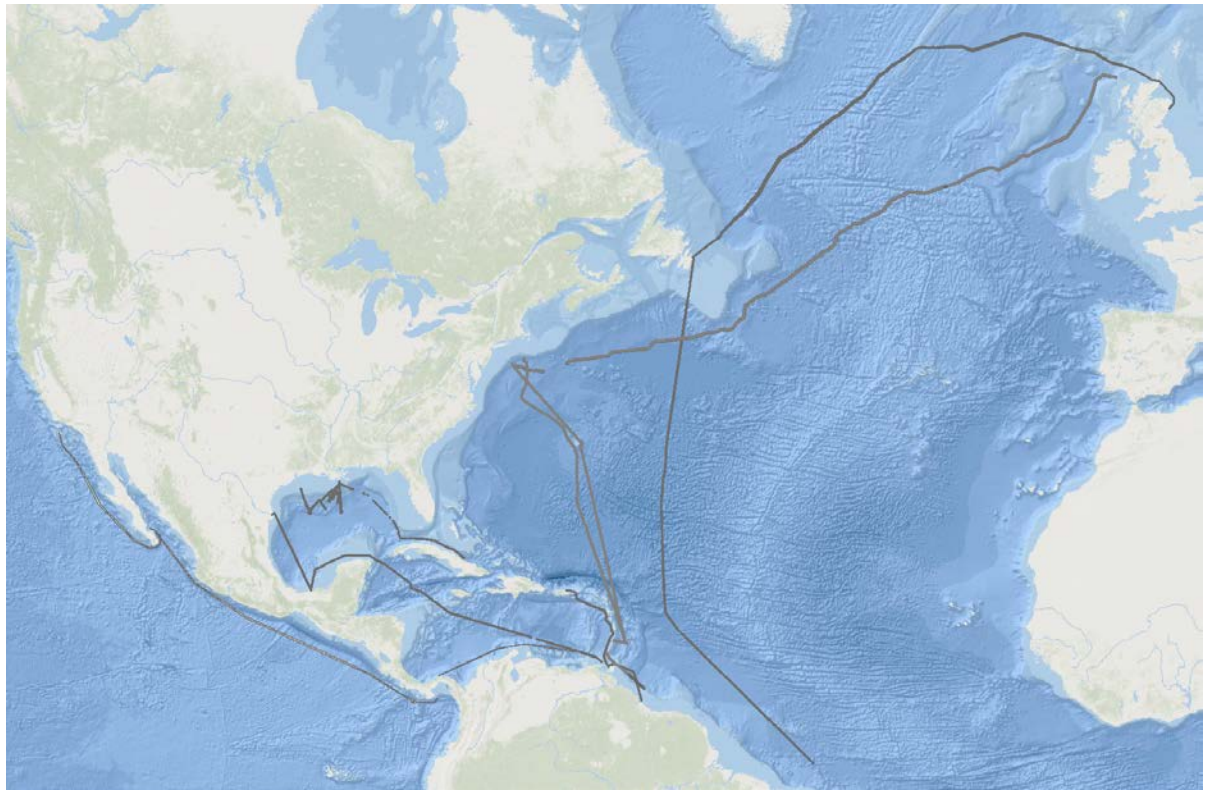
In-transit data collection. Data are collected from Fugro survey vessels as they transit between projects

Remote technology solution. Fugro OARS® enables safe and efficient data acquisition without survey staff on board

7 vessels currently involved. Fugro intends to incorporate the approach across its entire global survey fleet

~450,000 km2 of high resolution bathymetry contributed to date.

Some datasets also include backscatter and water column data



Capacity Building / Success Stories to Share

Fugro Academy - Applied Hydrographic Survey Programme

- IBSC accredited Category B hydrographic surveying training course (S-5B)
- Located in Plymouth, UK at permanently based facility
- dedicated computer suites, lecture rooms, workshops, equipment, and vessels
- 24-Week duration
- Open to all who meet course prerequisites
- Plans to role out at other locations internationally

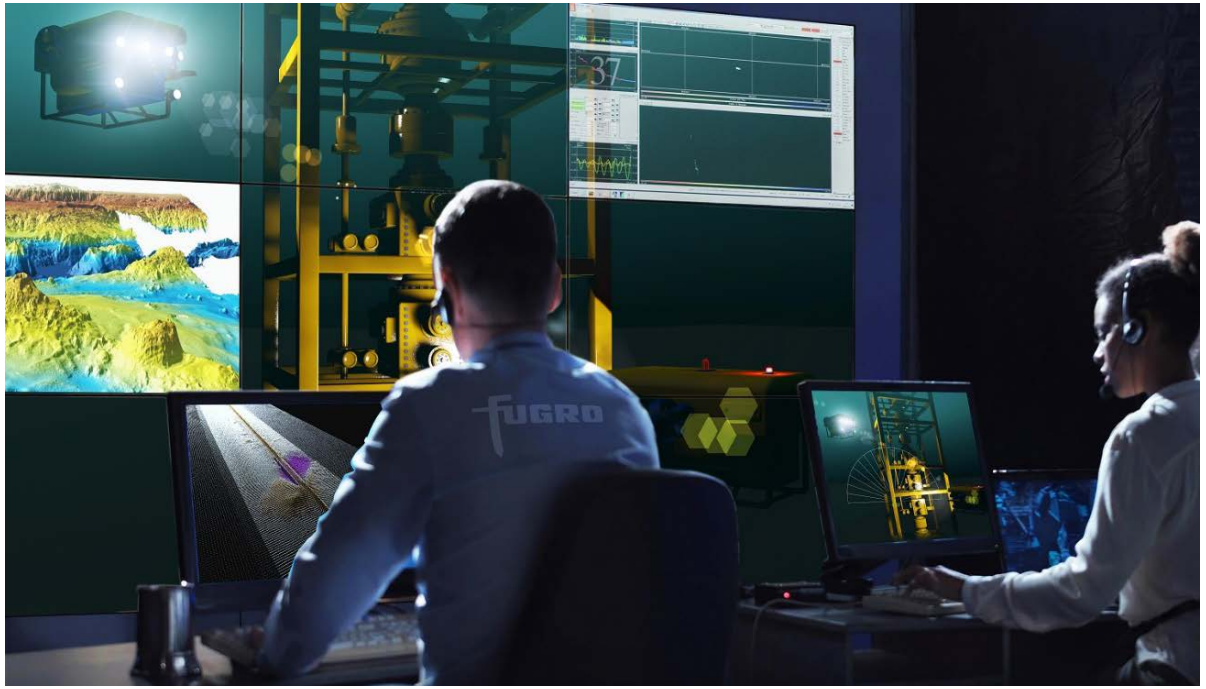
Lessons Learned to Share - Challenges

- Planning and Logistic
  - Working remote and uncharted areas
- Weather / Seasonal Conditions:
  - Impacting water clarity
  - Timing of surveys
- Permitting (up to 3 months in some regions)
- Stringent HSE requirements
- Challenging data acquisition and processing timelines
- Staff Training using new technologies and software's
  - Fugro Academy
  - Nautical cartography workflow

Recent Developments / Innovations

Fugro OARS
(Office Assisted Remote Services)

- centralised command centres throughout the world
- direct access to offshore survey projects
- allows for optimisation of survey crew size
- client engagement
- access to Fugro's subject matter experts around the world



Back2Base

- survey data compression enabling transmission of mega-data sets for onshore processing and evaluation

Recent Developments / Innovations

Internal **Satellite Derived Bathymetry** capability for:

- Desktop study support
- Reconnaissance and background data for line planning and identifying where high resolution surveys should be focused
- Change detection tool
- Gap filler

Autonomous Surface Vessel
(with L3 Technologies - UK)

- designed for medium to large-scale hydrographic survey applications, is scheduled for Q2 2019.
- First used as force Multiplier with Mother vessel (one or a fleet of vessels)
- Envisioned to be controllable form Fugro OARS centralised command centres.

ALB Sensor Developments

- LADS HD upgrade to 7 KHz
- New RAMMS Sensor (with Arete Associates - US)

Satellite Derived Bathymetry

Method 1: IHO Cookbook approach (empirical)

Input: Sentinel-2 satellite image + Fugro Survey data

(Oversimplified) simple method based on green and blue satellite bands

Method 2: ML empirical approach

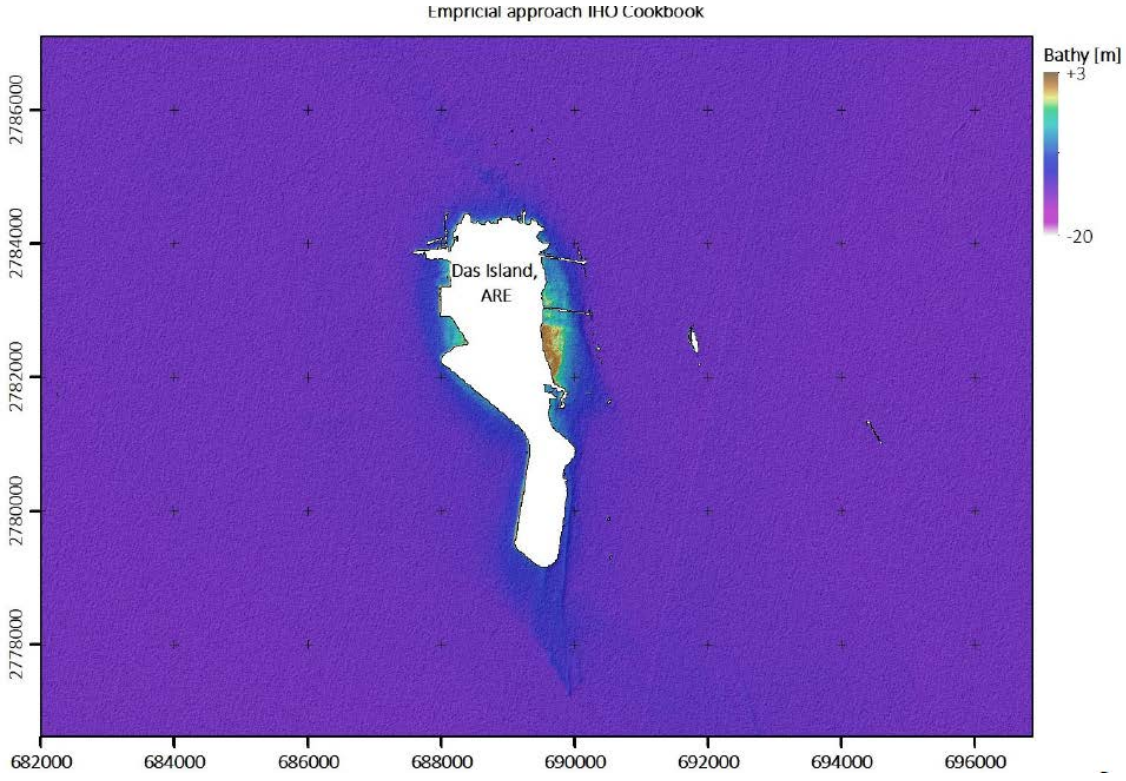
Input: Sentinel-2 satellite image+ Fugro Survey data

Based on a modern machine learning procedures making use of full satellites spectral information.

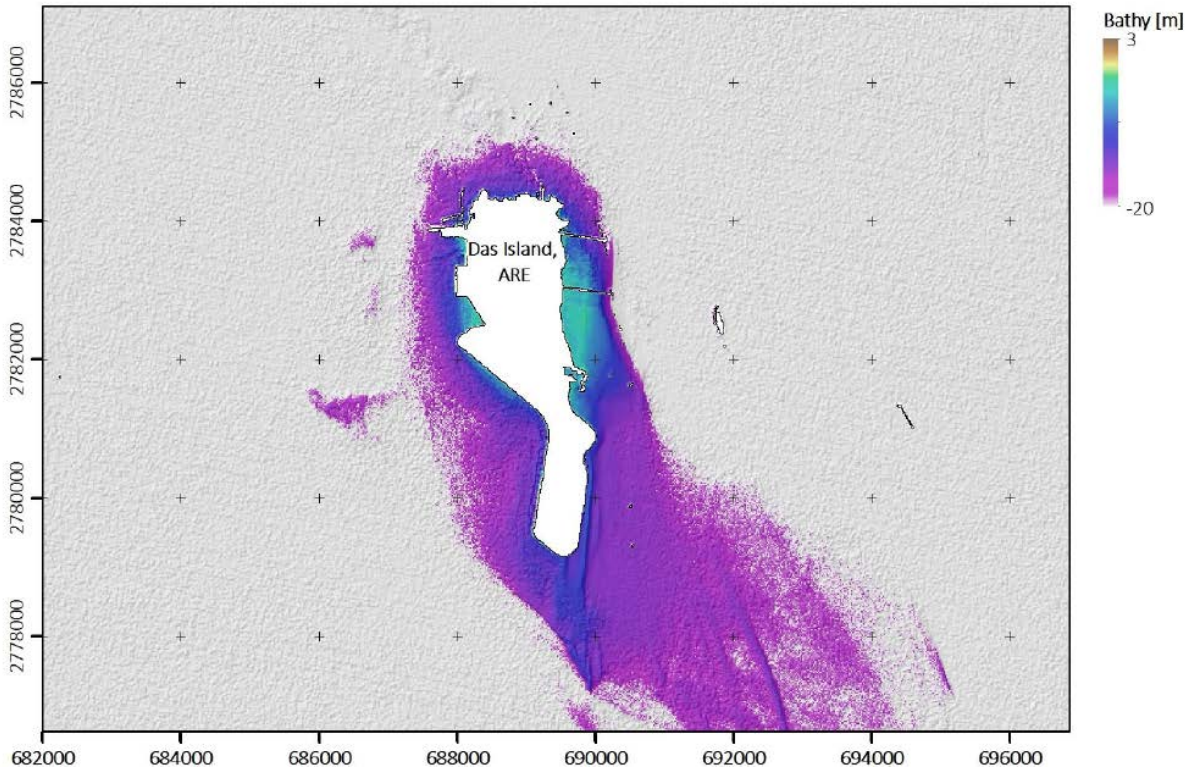
Both methods have in common , that they are empirical and thus , train a model with bathymetric survey data (training data) and predict bathymetric data for the remaining areas areas (prediction dataset). This also means , that methods assume that conditions (atmosphere, seafloor, turbidity, recording geometry,…) are the same for the training and prediction datasets.

Satellite Derived Bathymetry

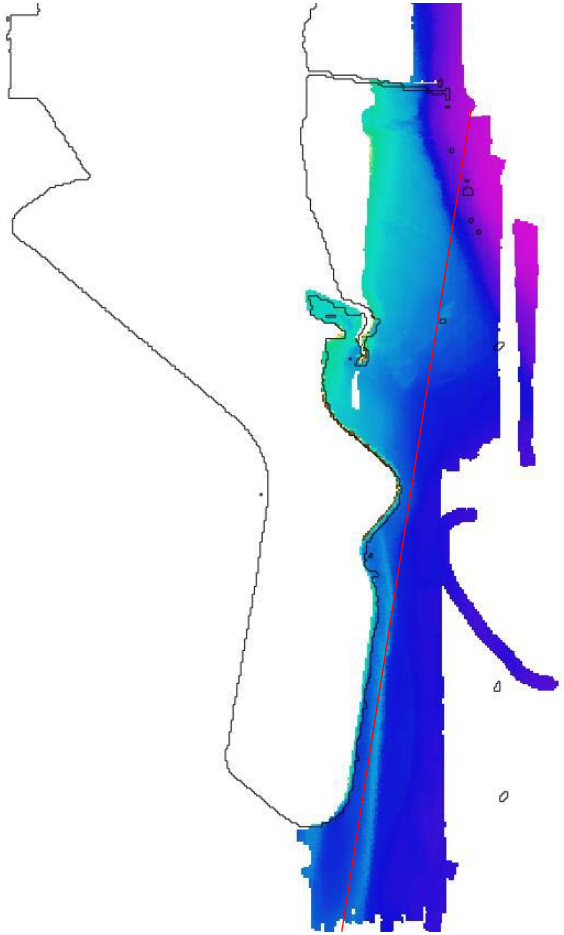
Method 1: IHO Cookbook approach (empirical)



Method 2: ML empirical approach

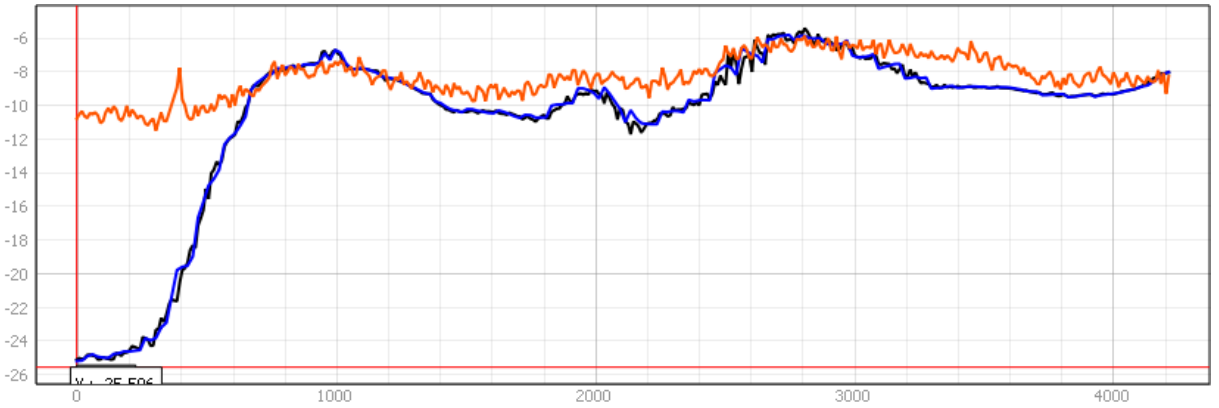


Satellite Derived Bathymetry



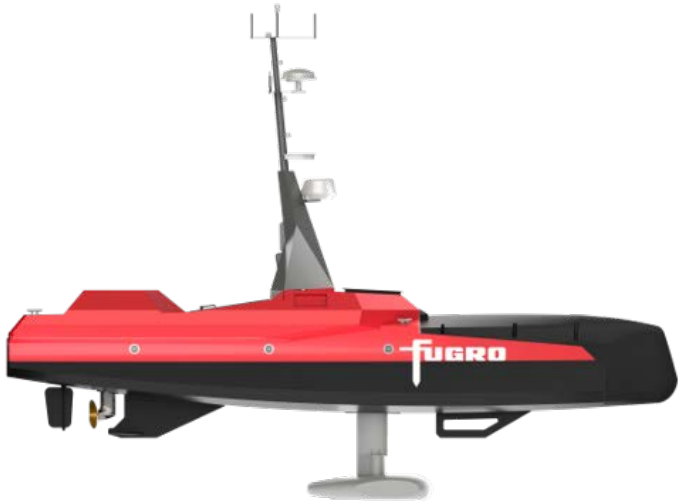
Transect result comparison:

Fugro Survey data
IHO Cookbook
ML empirical approach



Autonomous Surface Vessel

FAS-900
Vessel Overview

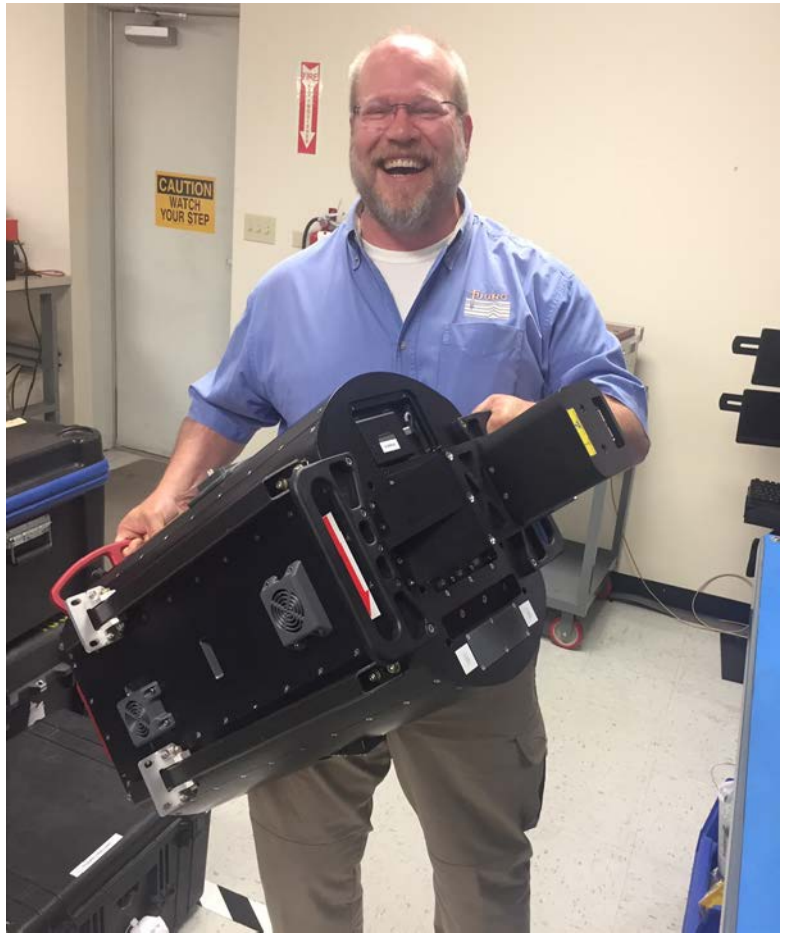


- Designed for utilisation in the hydrographic market
- Reduces HSSE exposure through minimised offshore staffing;
- Faster collection of high data quality;
- Reduced clients' operational costs;
- Provides sustainable operation through significantly reduced fuel consumption and carbon footprint.

Survey Equipment	
Positioning	GNSS with Fugro G4+
Navigation package	FugroStarfixSuite
Motion Reference Unit	MGC-R3 (withinSeapath380-R3)
Echo Sounder (SBES)	TeledyneEchotrackE20
Multi Beam Echo Sounder (MBES)	KongsbergEM2040-04 Mk II
Sound Velocity Profiler	AMLMVP30
Sound Velocity (@ head)	Valeport UV-SVP

Autonomous Surface Vessel

ALB Sensor Developments



- Compact sensor designed for small aircraft and UAVs
- 14 kg
- 3-Secchi depth penetration
- >25,000 range observations per second
- ~1:1 swath:altitude
- No moving parts
- Low-power consumption

FUGRO

Thank you

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