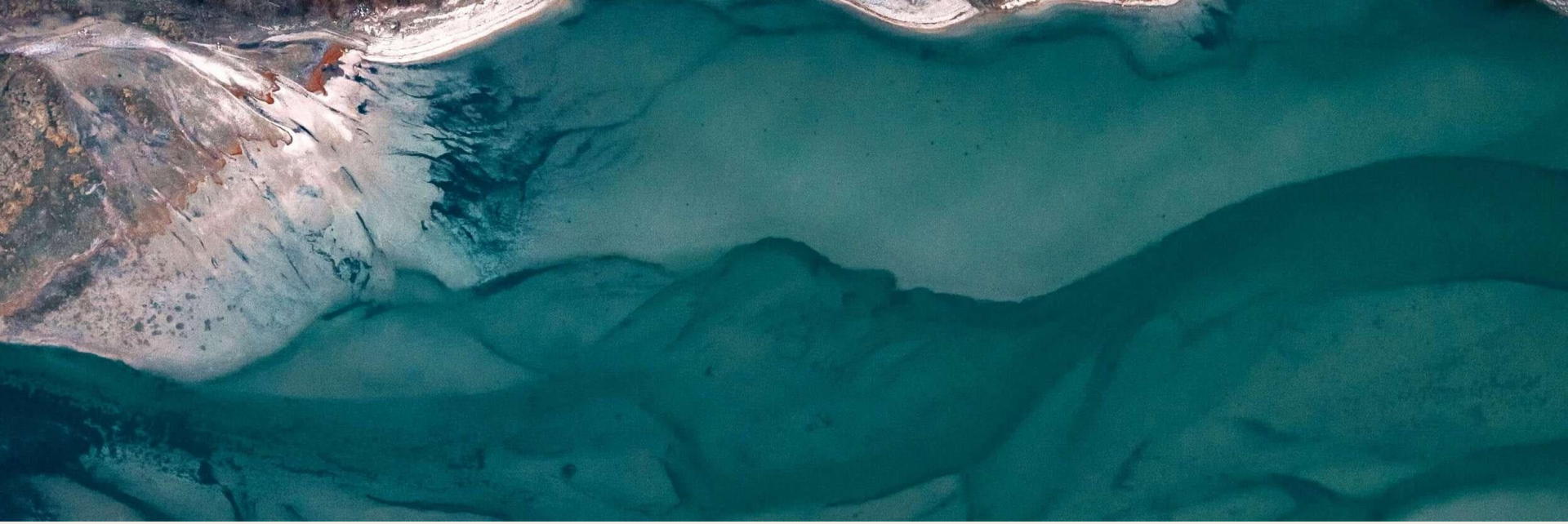


# Airborne Lidar Bathymetry

## Advantages & Challenges

By Charles de Jongh

Field

HYDRO 2024
Hydrographic Conference

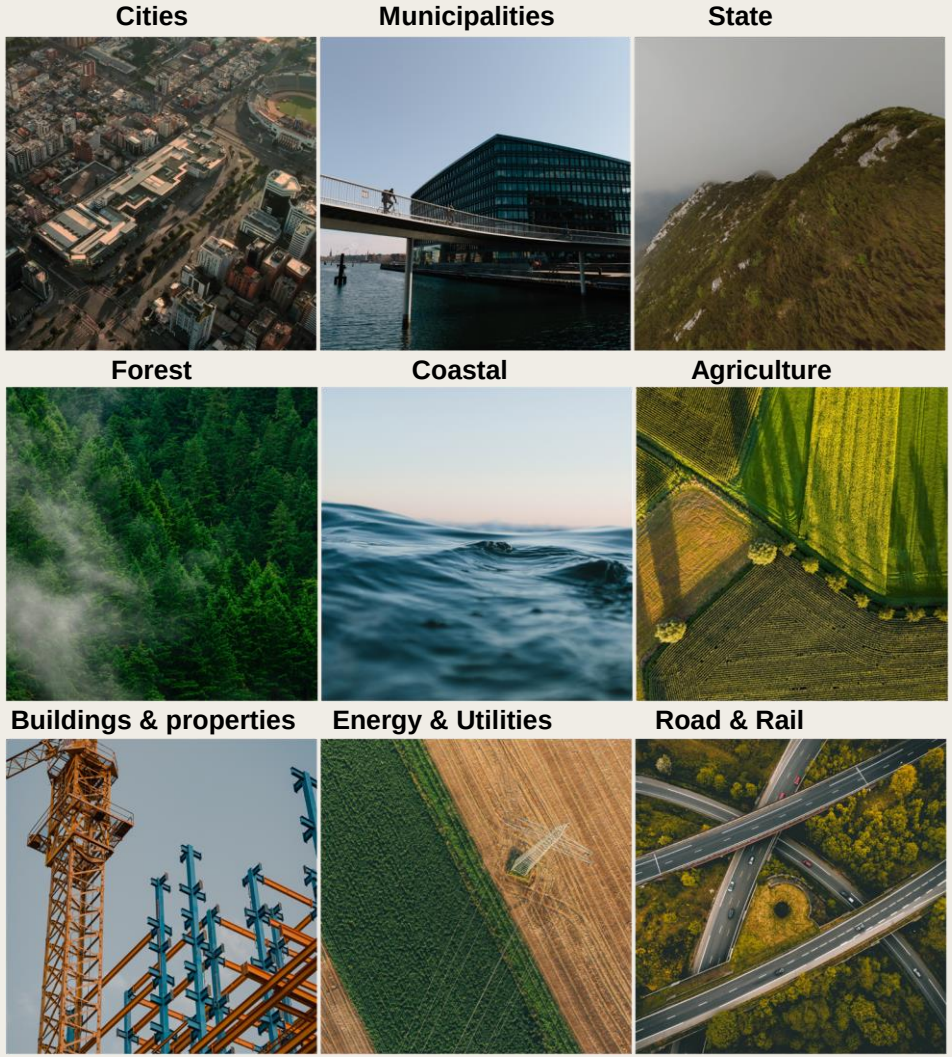
# Field

Field delivers geodata acquisition, analysis and visualization services.

~250 employees, 13 offices in 5 countries. Headquarters in Oslo, Norway.

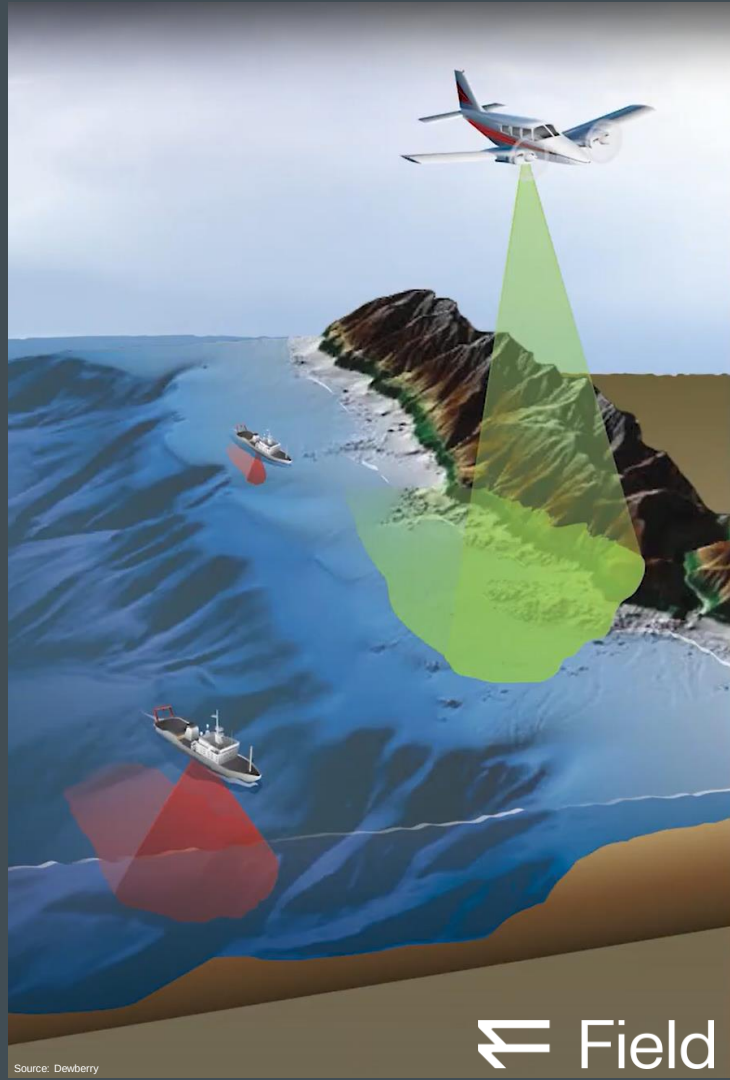
5 survey aircraft, 3 mobile mapping systems & several helicopter setups.

State-of-the-art lidar- and camera sensors, including bathymetric lidar.



# Advantages of Airborne Lidar Bathymetry

- Fast, accurate & cost-effective hydrographic survey method.
- Seamless mapping of land & water in the coastal zone, rivers and lakes.
- Ability to measure about 3 times the visible water depth (depending on the sensor type).
- More effective survey technique in shallow areas than multibeam echosounder technology. ALB & MBES are complementary to each other.



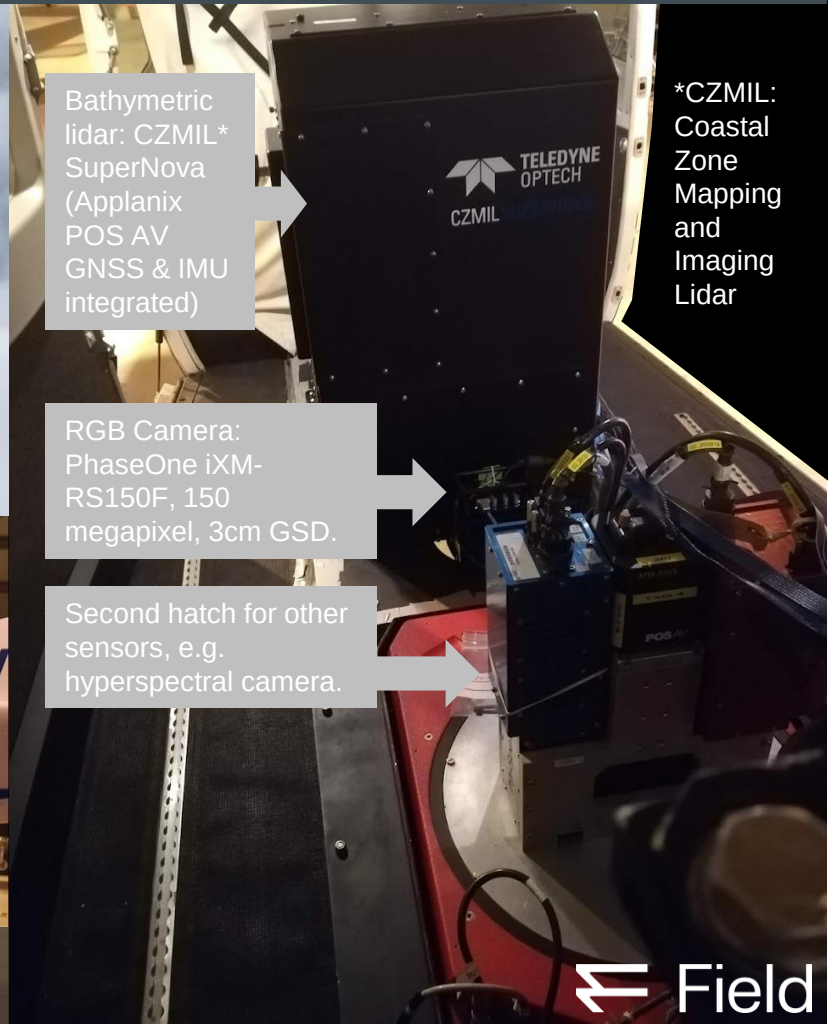
# Airborne Lidar Bathymetry – increasing demand

- Technique has proven its value and has significantly improved (e.g. resulting in higher point density and accuracy).
- Increased global requirements for coastal zone, lake and river mapping.

Field

# Field Airborne Lidar Bathymetry Equipment

2x Cessna 208b Grand Caravan aircraft with 2 hatches.
ALB Speed: 120-140 knots (220-260km/h). ALB Flying Height: 400-600m.




Bathymetric lidar: CZMIL* SuperNova (Applanix POS AV GNSS & IMU integrated)

RGB Camera: PhaseOne iXM-RS150F, 150 megapixel, 3cm GSD.

Second hatch for other sensors, e.g. hyperspectral camera.

*CZMIL: Coastal Zone Mapping and Imaging Lidar

Field

# Airborne Lidar Bathymetry – what happens?

- The light reaches the water surface and some of it is reflected directly.

- Some of the light penetrates the water. The light refracts at the water surface.
- The light is dispersed and absorbed before it reaches the bottom.

- Some of the light reflects on the water bottom.
- The bottom type has a big influence on the reflection.

Refraction

Water

Direct light

Dispersed light

Enlightened bottom area

Bottom

Field

# Airborne Lidar Bathymetry – what happens?

- The bathymetric lidar sensor in the aircraft detects and counts the reflected light photons and converts this to a digital signal.

- Light photons reflect from the bottom, through the water column and back into the air.

Water

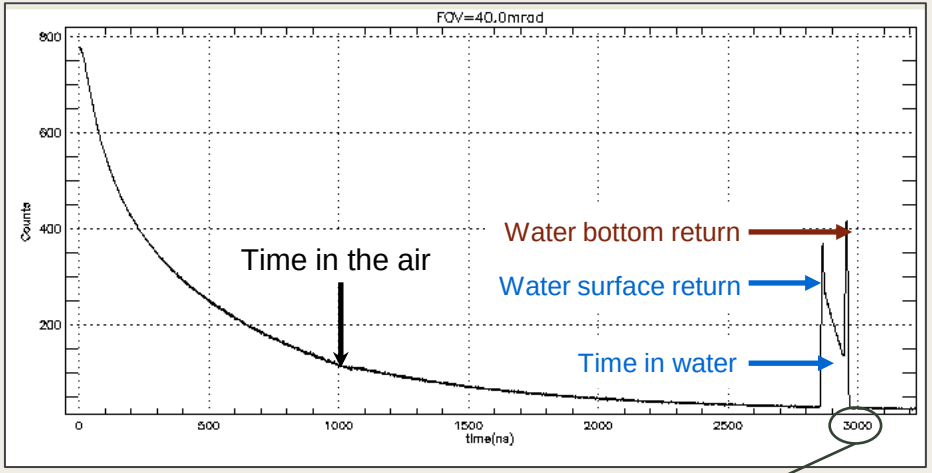
Bottom

Enlightened bottom area

Field

# Airborne Lidar Bathymetry – what happens?

- This results in a detailed waveform for each laser pulse.
- The depth of the water bottom can be defined based on the difference in time between photons hitting the water surface and the water bottom.




3000 nanoseconds =
0,000003 seconds
Aircraft moves 0.02mm

Water

Bottom

Enlightened bottom area

Field

# Field Airborne Lidar Bathymetry Services: From Data to Knowledge

Data Acquisition → Data Processing → Product Creation → Information → Knowledge

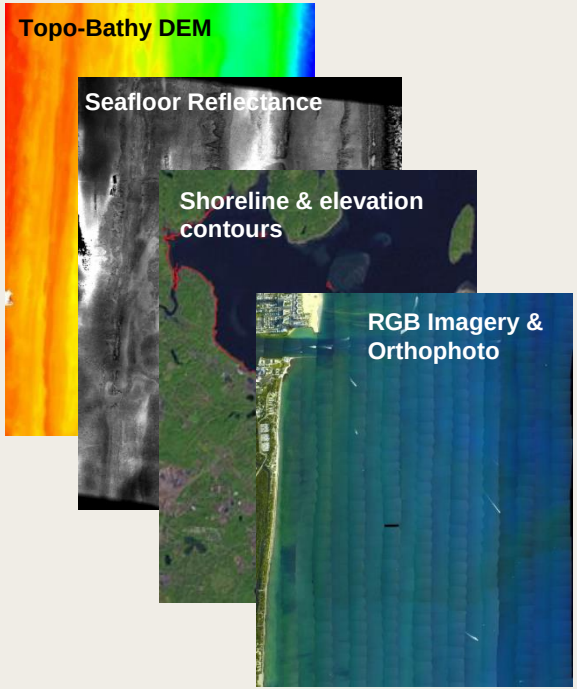
**Aircraft**
Cessna Grand Caravan

**Bathymetric Lidar Sensor**
Teledyne Optech CZMIL SuperNova

**Aerial Camera**
Phase One IXM-RS 150f

**GNSS/INS Positioning**
Applanix POS AV610

**Typical Product Deliveries:**




**Many ALB use cases:**

- Hydrography & Nautical charting.
- Coastal zone management & environmental planning.
- Marine industry & construction.
- Hydrological modelling & Flood mapping.
- Marine biology, e.g. vegetation & habitat mapping.
- Marine geology, e.g. bottom sediment mapping.
- Other…

Field

# Field bathymetric lidar use case: Helligvær archipelago

Kartverket

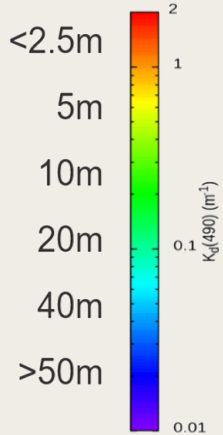
Field

# Data acquisition challenges

- No rain, snow and ice
- Not too windy
- Not too much turbidity.


# The turbidity challenge

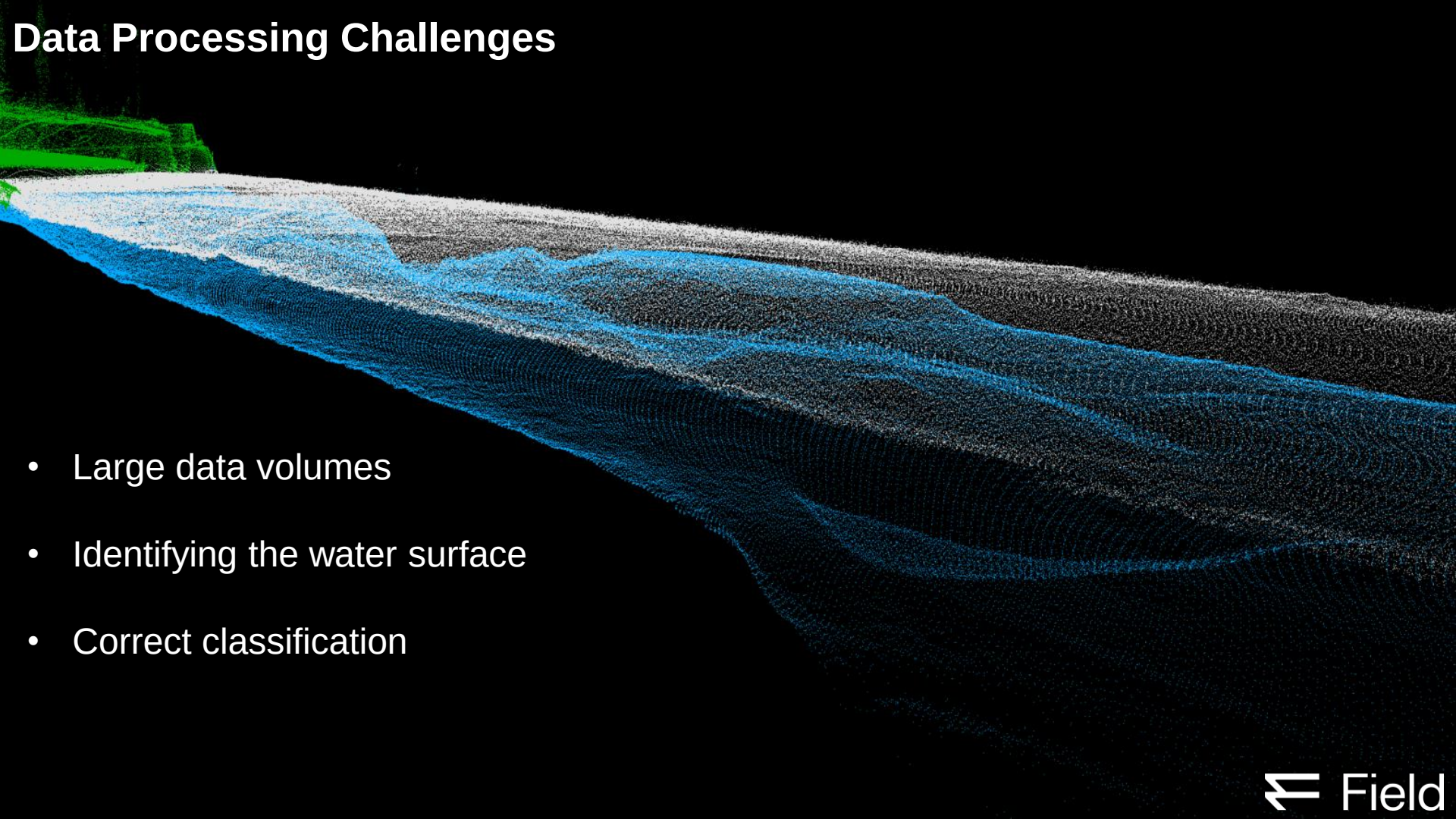
Approximate water depths that can be reached with the CZMIL SuperNova bathymetric lidar sensor:




Average turbidity based on diffuse attenuation coefficient for downwelling irradiance at 490 nm (Kd_490) in August 2022, derived from sensors on 4 satellites. Source: NOAA Star Ocean Color.

Field

# Data Processing Challenges



- Large data volumes
- Identifying the water surface
- Correct classification

Field

# Field – Airborne Bathymetric Lidar Surveys 2021-2025

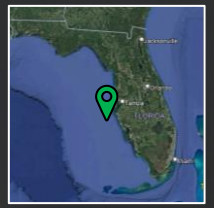
Types of ALB survey work:
- Coastal zone surveys
- River surveys
- Lake surveys
- Underwater construction sites

Executed

In progress/to be executed

Winter 2022-23: 2.250km$^2$ survey of Kiribati islands in the Pacific. Cooperation with IIC Technologies and Landpro.

Winter 2023-24: 6.500km$^2$ survey of the coastal zone in Florida, USA. Cooperation with Dewberry.



2021-'23: Several ALB Surveys for Norwegian Mapping Authorities

2023-'24: ALB river surveys for 6 different clients in Norway. Total 1000km of river length.

Autumn 2024: ALB Survey of 825km$^2$ lakes in Finland (Traficom).

2023-'24: ALB Survey of coastal zone of Northern Ireland. 700km$^2$.

2022-2024: Several smaller ALB surveys.

2025: Coastal zone of Pays de la Loire Survey for SHOM. 2250km$^2$.

2022: Coastal zone of Catalonia ALB Survey.

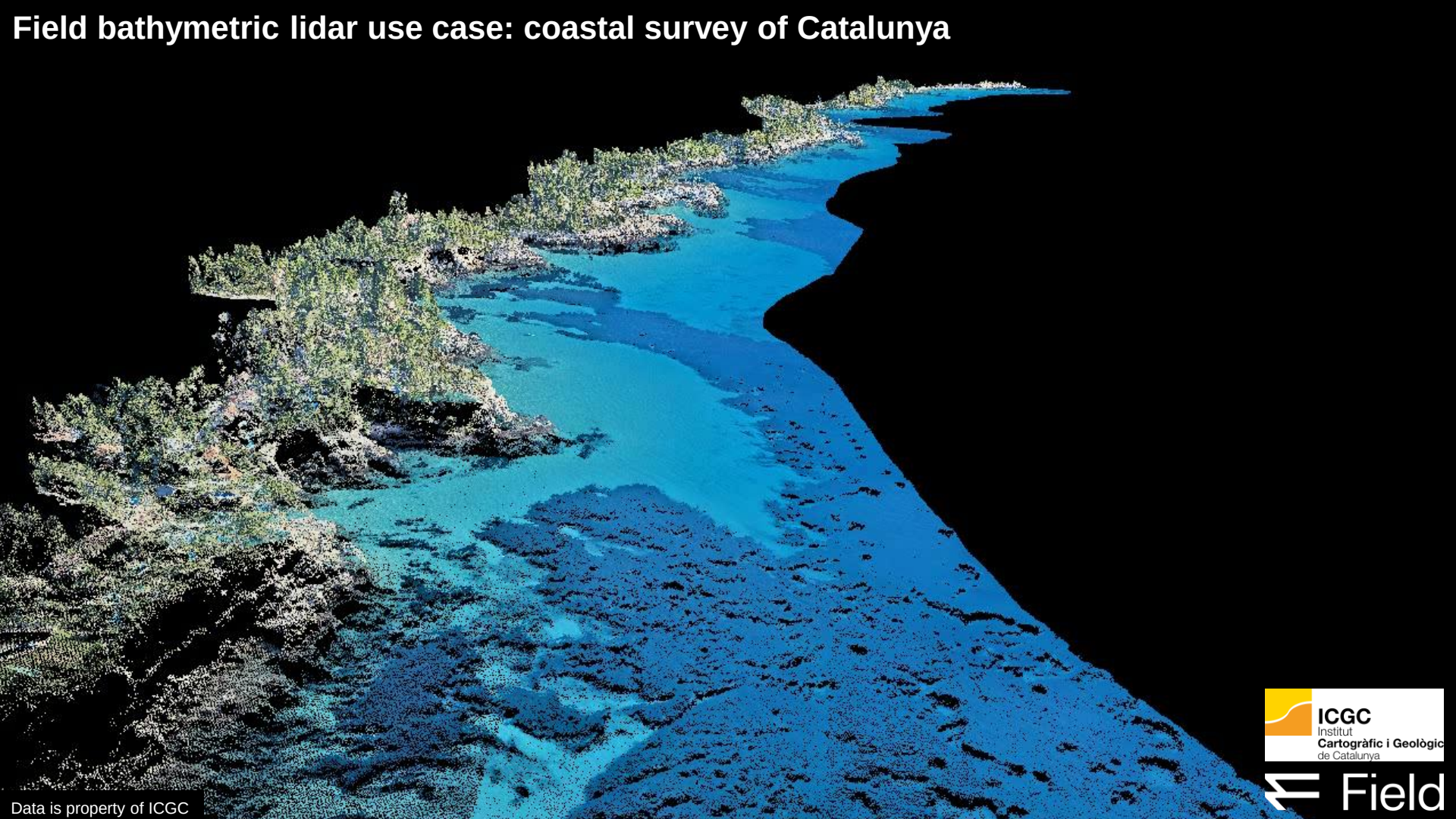
Field

# Field bathymetric lidar use case: coastal survey of Catalunya

ICGC
Institut
Cartogràfic i Geològic
de Catalunya


Field

# Field bathymetric lidar use case: coastal survey of Catalunya



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Field

Data is property of ICGC

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# Field bathymetric lidar use case: river mapping in Norway

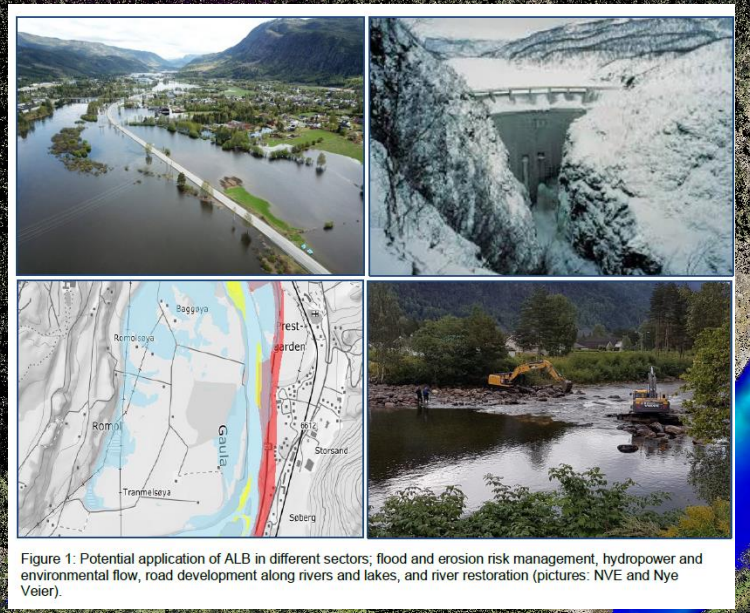



Figure 1: Potential application of ALB in different sectors; flood and erosion risk management, hydropower and environmental flow, road development along rivers and lakes, and river restoration (pictures: NVE and Nye Veier).

10 meters depth

Image of the Lærdalselva river - bathymetric lidar data combined with aerial images

NVE

Kartverket

Field

# Field bathymetric lidar use case: river mapping in Norway

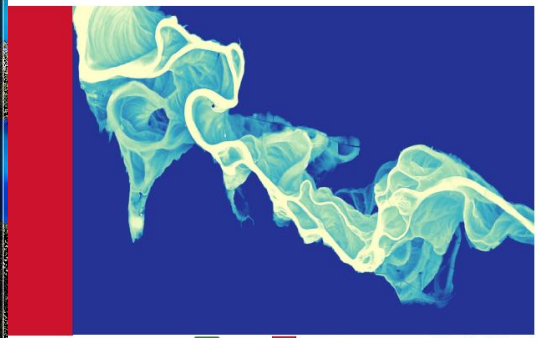
RAPPORT

Nr. 2/2023

**Validation and application of Airborne LiDAR Bathymetry (ALB) technology for improved management and monitoring of Norwegian rivers and lakes**

a pilot study 2021-2022

*Morten Stickler, Håkon Dåsnes, Christian Malmquist, Jon Moe, Amund Frogner Borge, Linn Fritsvold, Marius Øie, Steinar Sandøy og Bjørn Otto Dønnum*



Kartverket · Statens vegvesen · Norwegian Environment Agency · Hafslund Eco

publikasjoner.nve.no/rapport/2023/rapport2023_02.pdf

**Conclusion:**

*Results demonstrate that commercially available ALB sensors deliver accurate (+/-10 cm) and robust (similar accuracy across rivers and sensors) bathymetric data […]*

*Demonstration cases indicate that ALB technology can represent a radical and important change in future data acquisition of river bathymetry.*

*Thus, ALB can be a central technology and basis for future river management decisions.*

Image of the Lærdalselva river - bathymetric lidar data combined with aerial images

NVE

Kartverket

Field

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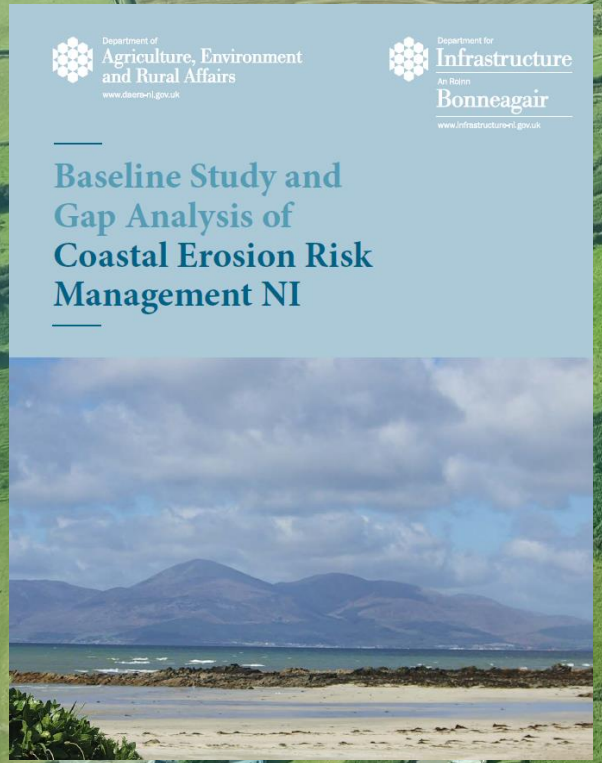
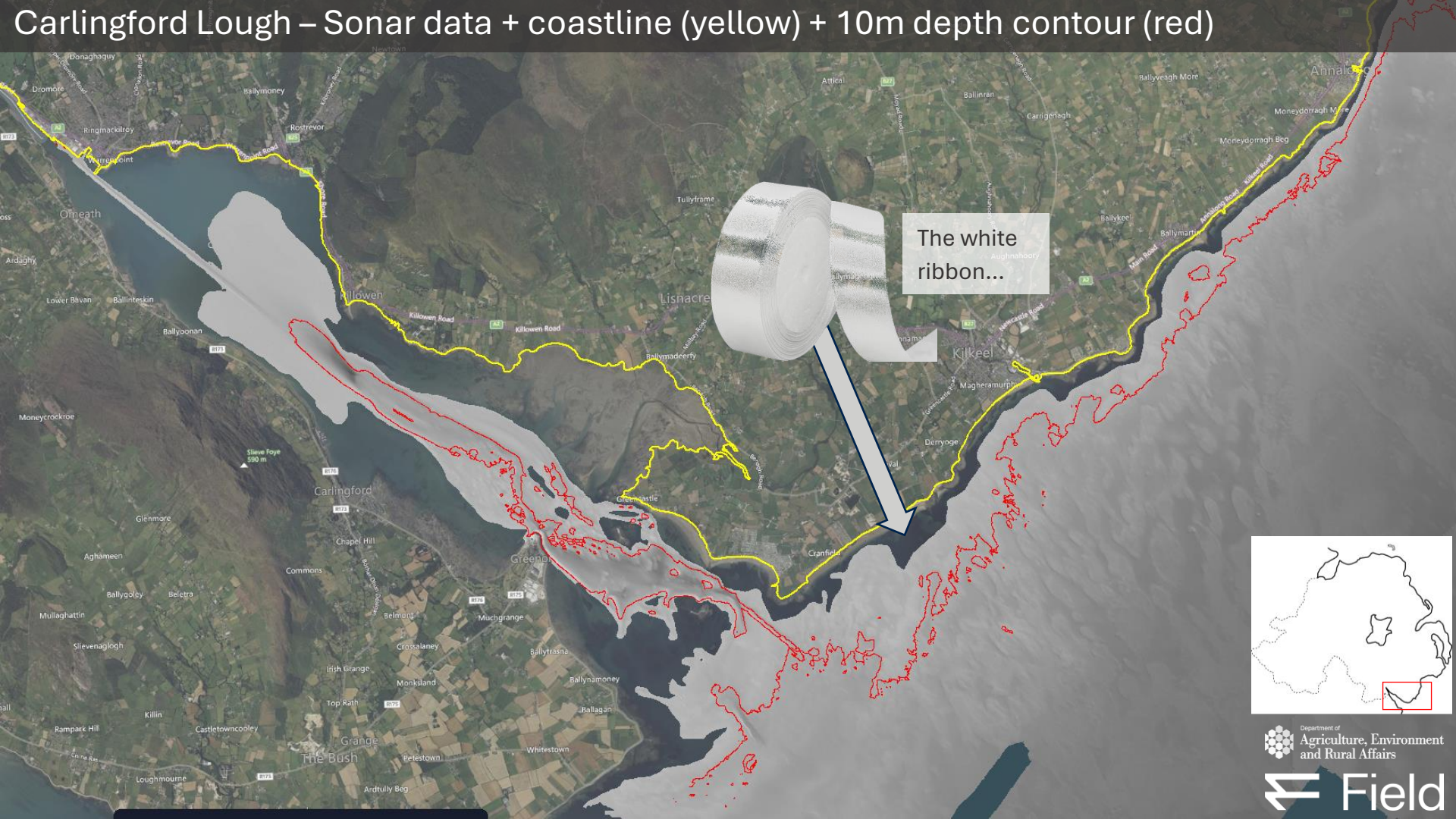


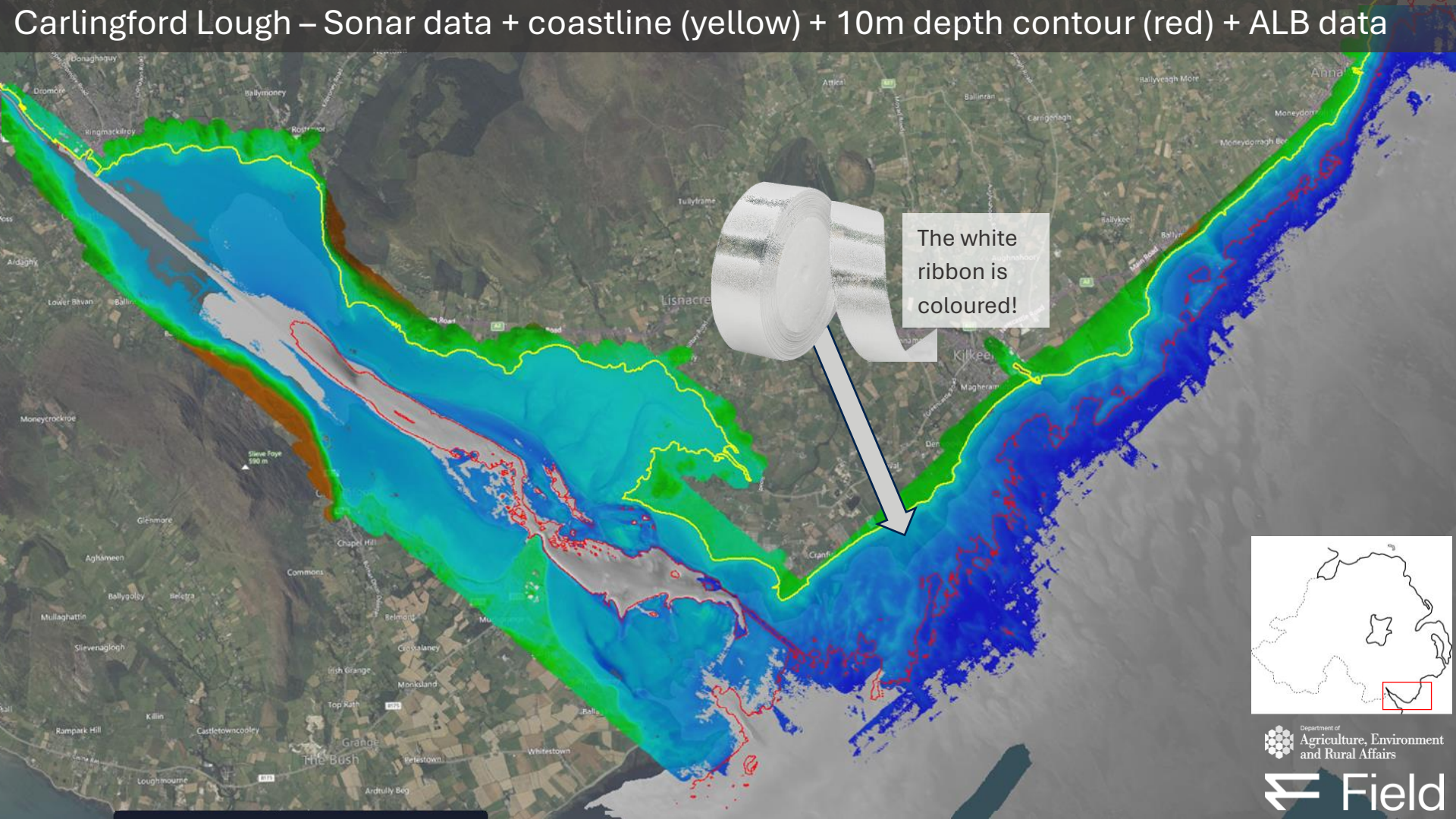

Department of
Agriculture, Environment
and Rural Affairs

Field

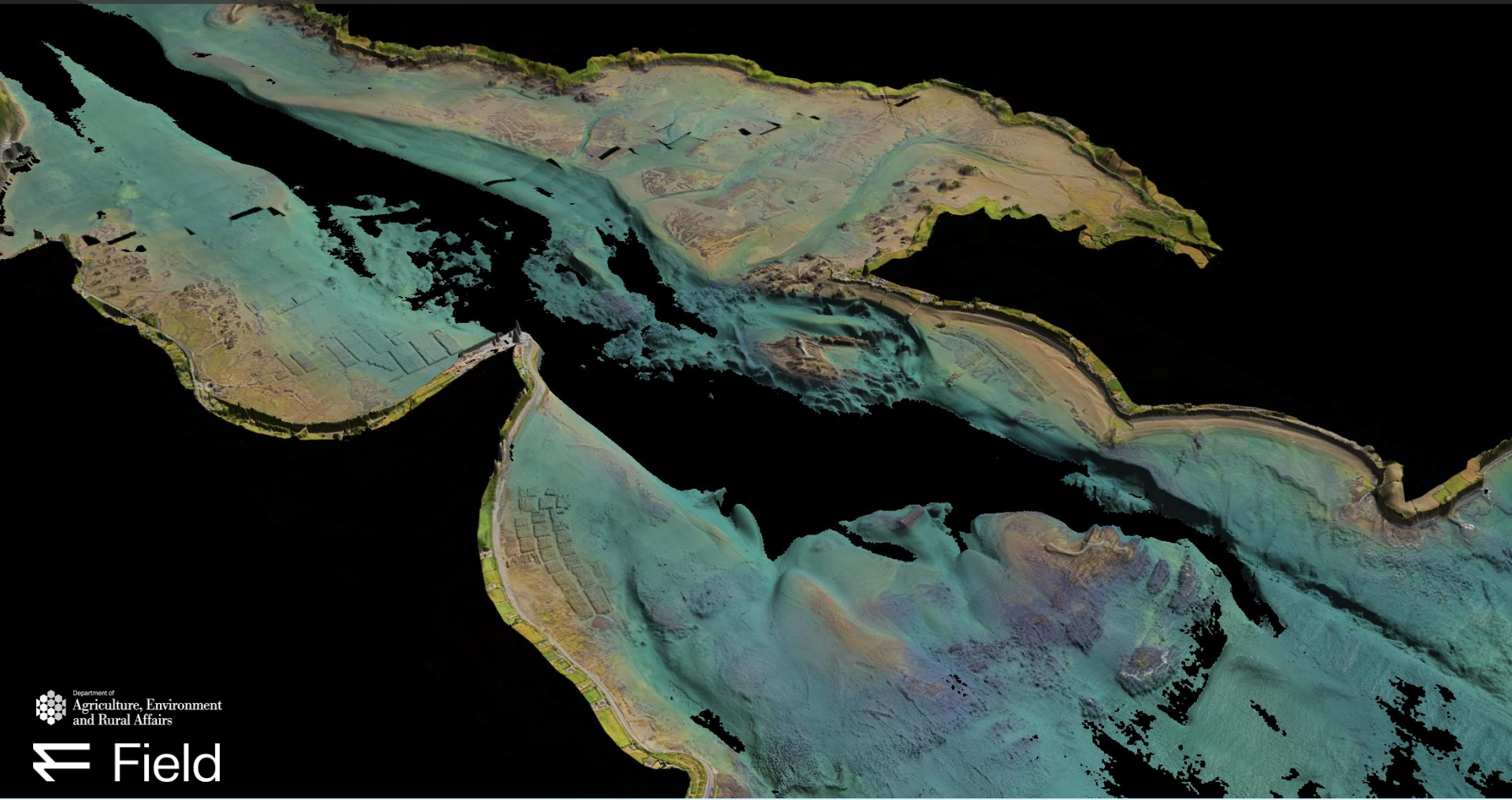
# Carlingford Lough – Sonar data + coastline (yellow) + 10m depth contour (red)



# Carlingford Lough – Sonar data + coastline (yellow) + 10m depth contour (red) + ALB data



# Carlingford Lough – Complementarity between ALB & MBES



Department of Agriculture, Environment and Rural Affairs

Field

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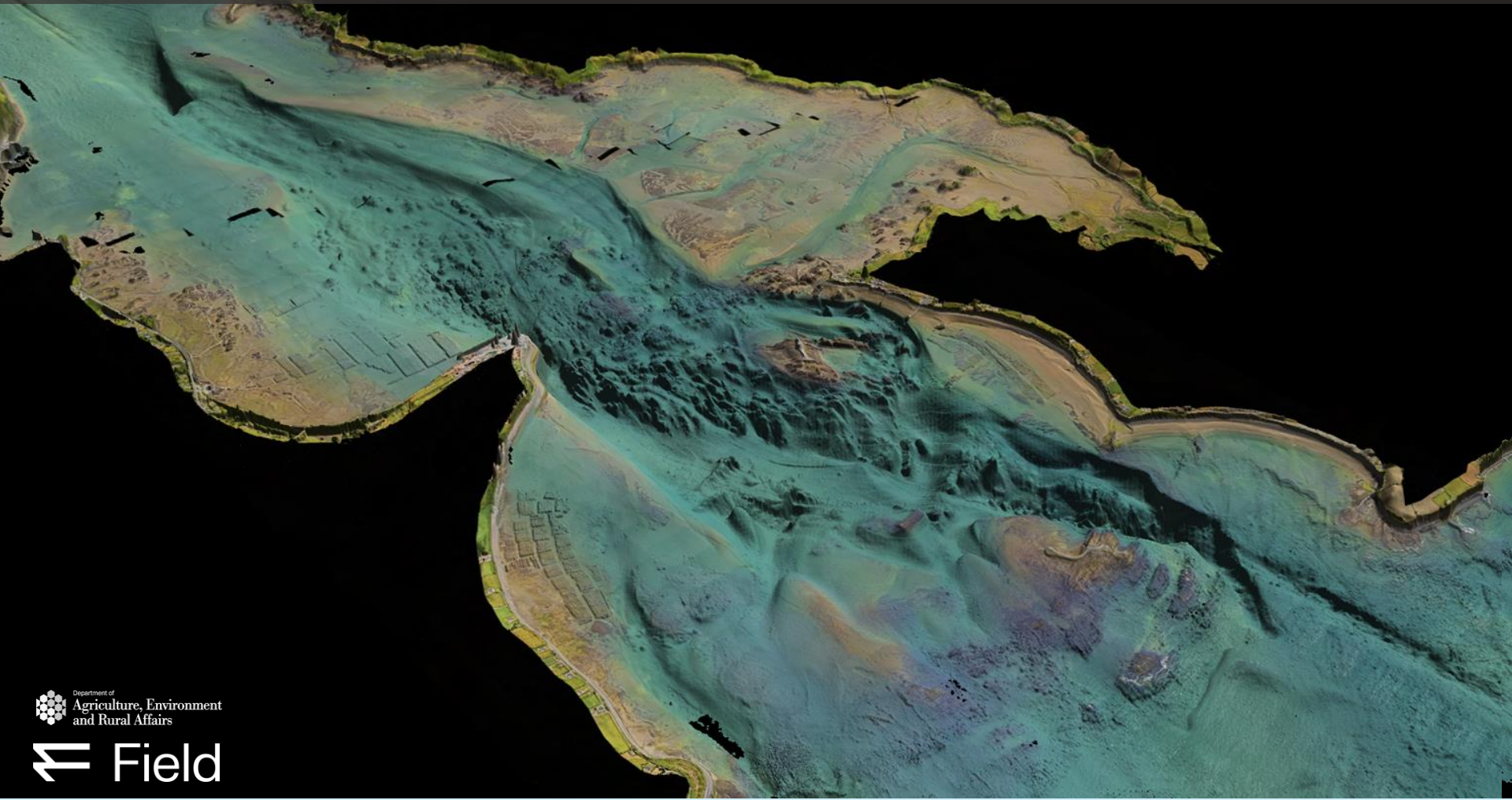
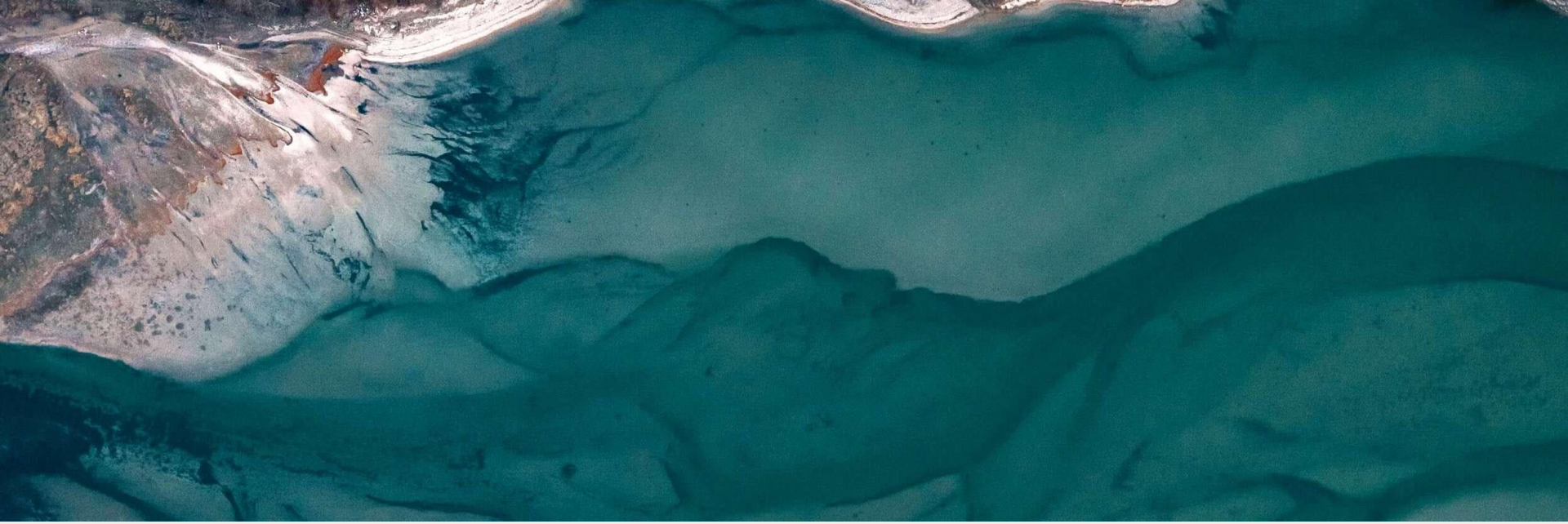


Department of Agriculture, Environment and Rural Affairs

Field



# Airborne Lidar Bathymetry

## Advantages & Challenges

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Field

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Website: Fieldgeo.com

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