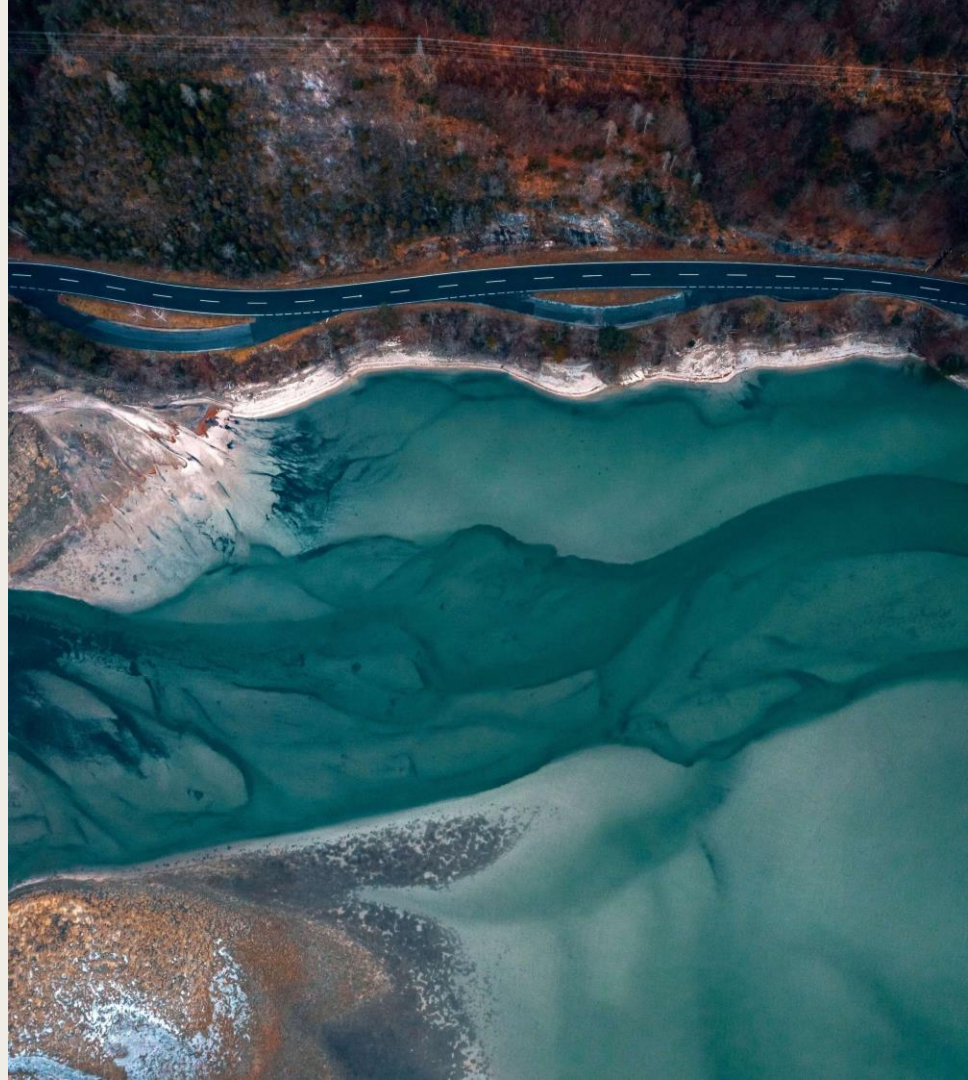




# Airborne Lidar Bathymetry

## Advantages & Challenges

Charles de Jongh



# Field



Field (formerly Terratec & Blom) delivers geodata acquisition, analysis and visualization services.



~250 employees, 12 offices in 5 countries.  
Headquarters in Oslo, Norway.



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



State-of-the-art lidar- and camera sensors.

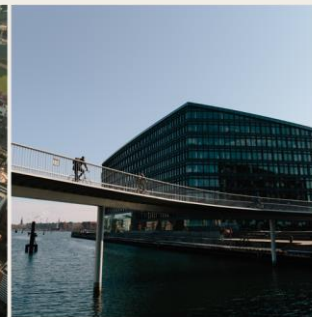


In 2023 Field acquired ~ 1 000 000 images  
and ~82.000 km<sup>2</sup> of lidar-data

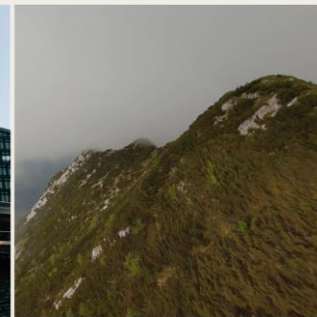
Cities



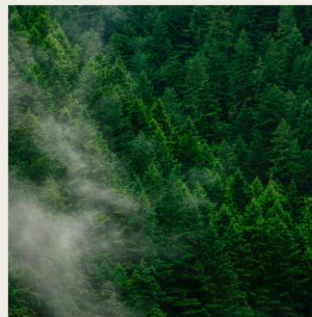
Municipalities



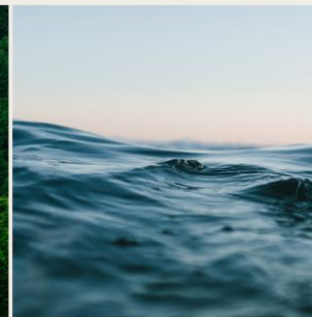
State



Forest



Coastal



Agriculture



Buildings & properties



Energy & Utilities



Road & Rail



# Field Airborne Lidar Bathymetry Services: From Data to Knowledge

Data Acquisition

Data Processing

Product Creation

Information

Knowledge

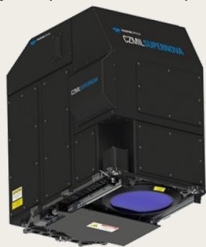
## Aircraft

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:

Topo-Bathy DEM

Seafloor Reflectance

Shoreline & elevation contours

RGB Imagery & Orthophoto

## Many ALB use cases:

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

# 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 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.

Water

Direct light  
Dispersed light

Enlightened bottom area

Bottom

# 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

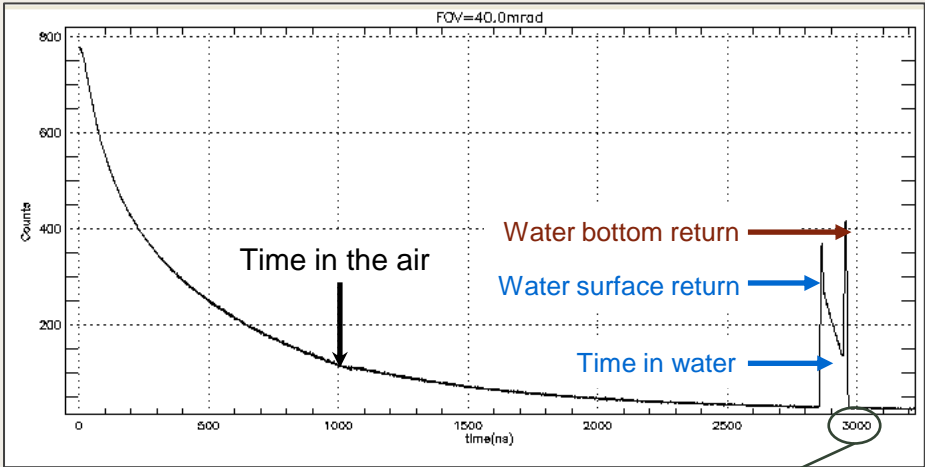
Bottom

Enlightened bottom area

# 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 nano seconds =  
0,000003 seconds

Water

Bottom

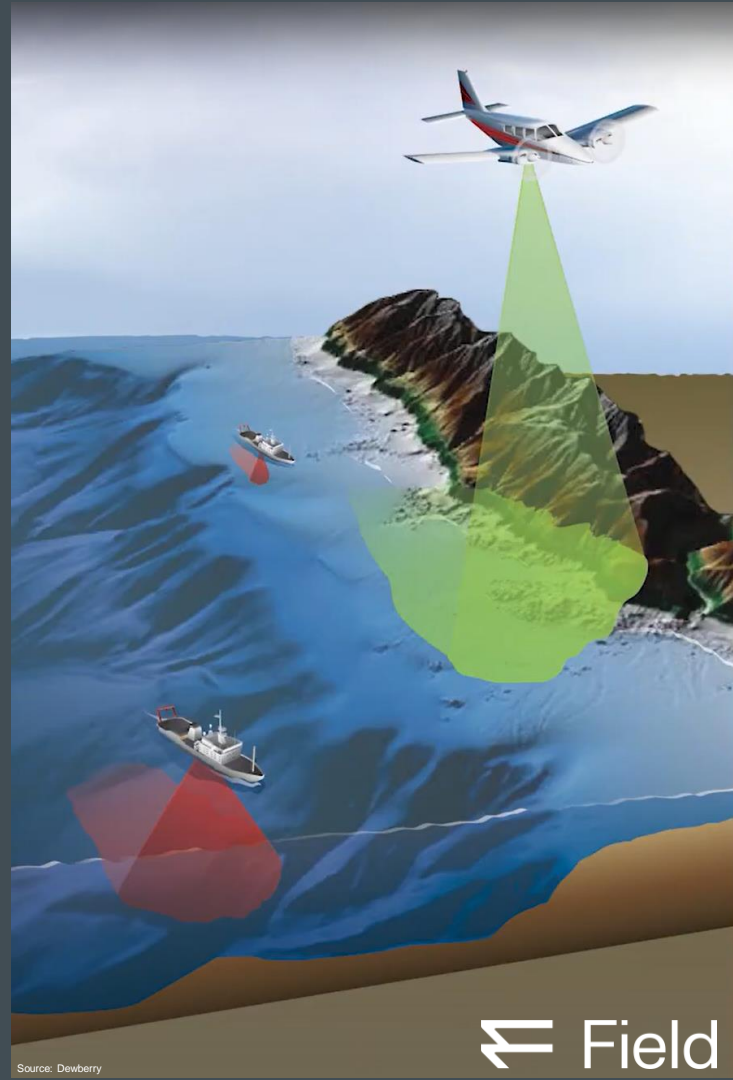
Enlightened bottom area

# Airborne Lidar Bathymetry nightly survey



# 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.



Source: Dewberry

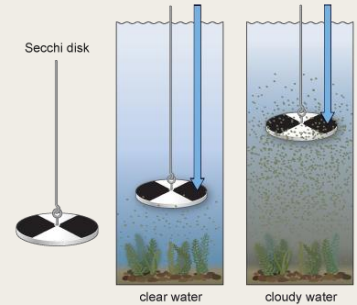
# Airborne Lidar Bathymetry – Challenges

## Operational challenges:

- Flight permits for the survey area
- Availability of aircraft, sensor, pilot and operator.

## Weather and climate challenges:

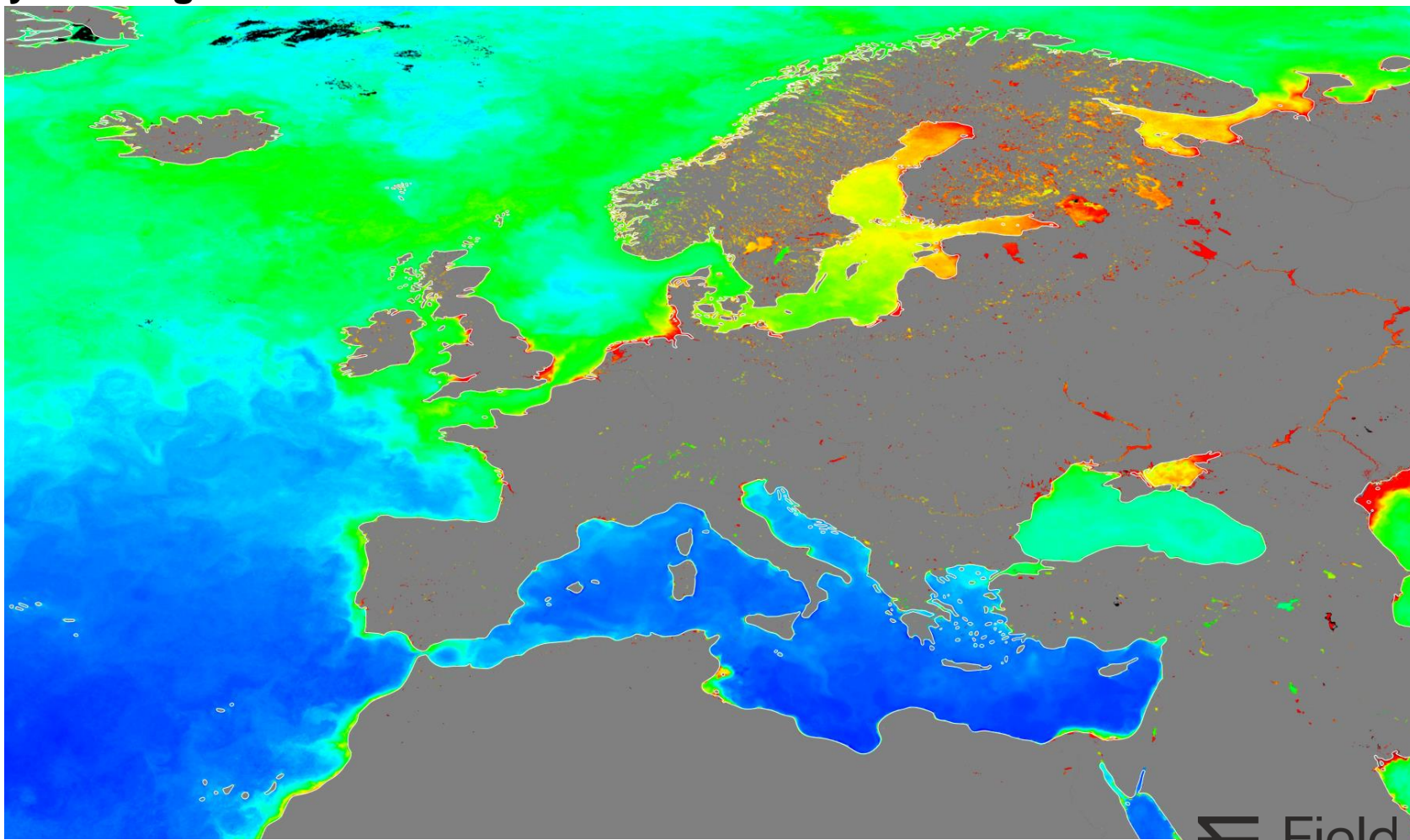
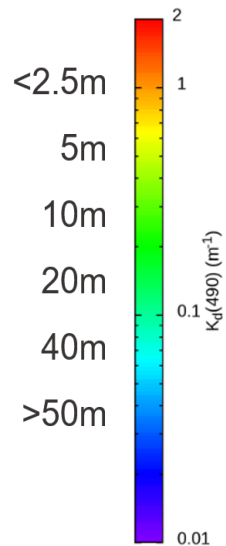
- No rain, snow and ice
- Not too windy (Beaufort 0-4)
- Not too much turbidity (seasonal and daily variations)



⇌ Field

# The turbidity challenge

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



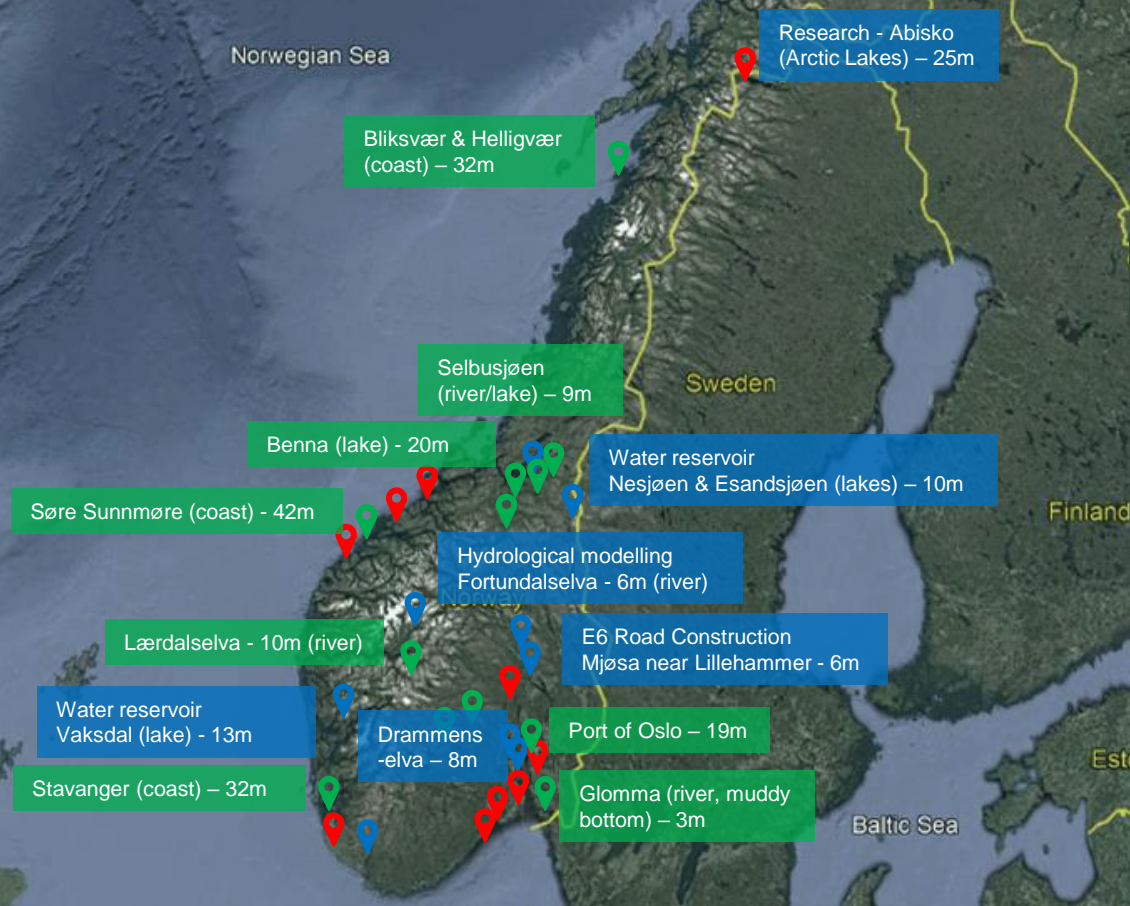
Average turbidity based on diffuse attenuation coefficient for downwelling irradiance at 490 nm ( $K_d_{490}$ ) in August 2022, derived from sensors on 4 satellites. Source: NOAA Star Ocean Color.

# Field Bathymetric Lidar Surveys in Norway

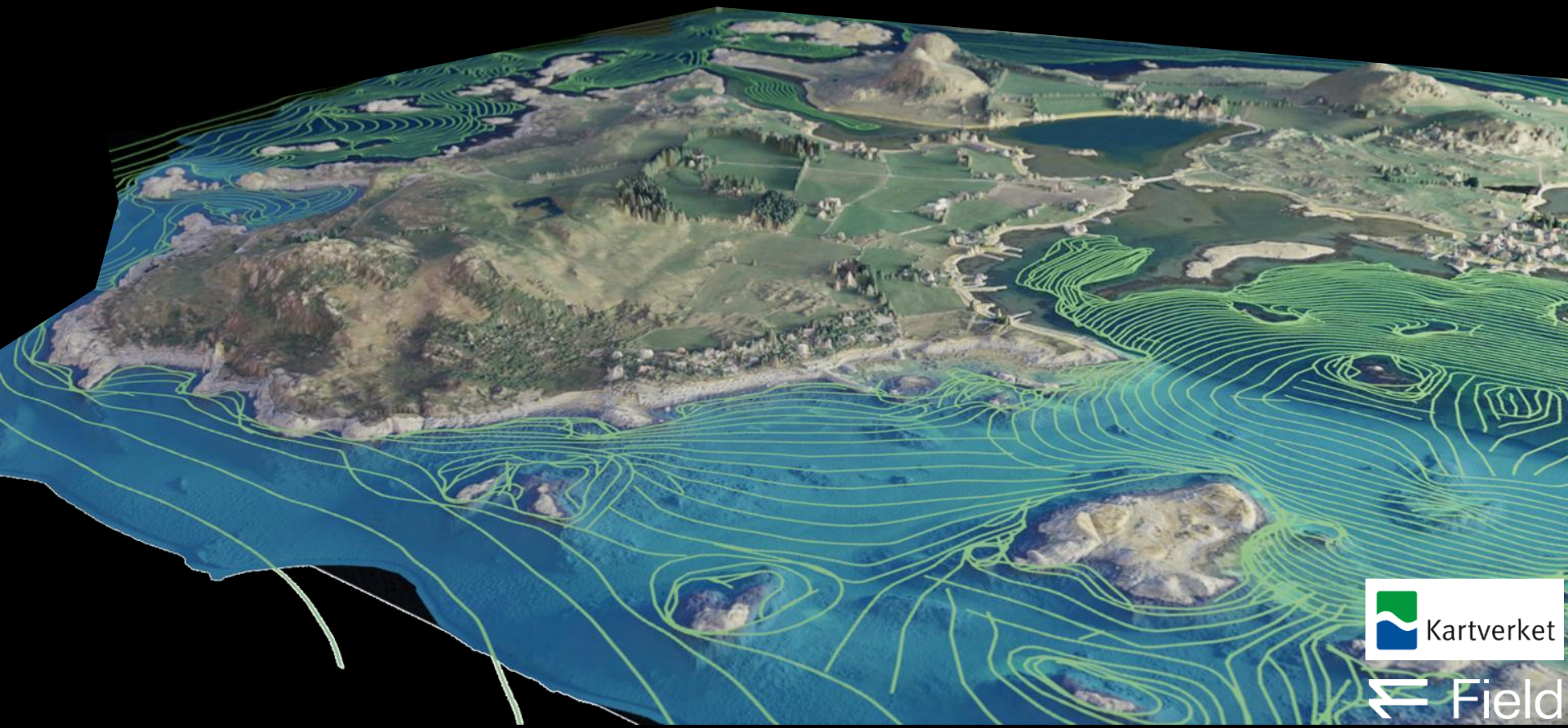
Customer: Government.  
Purpose: bathymetric and  
topographic mapping of coast,  
lakes & rivers.

Customer: Private.  
Purpose: e.g. mapping of  
reservoirs, infrastructure  
construction along rivers,  
hydrological modelling.

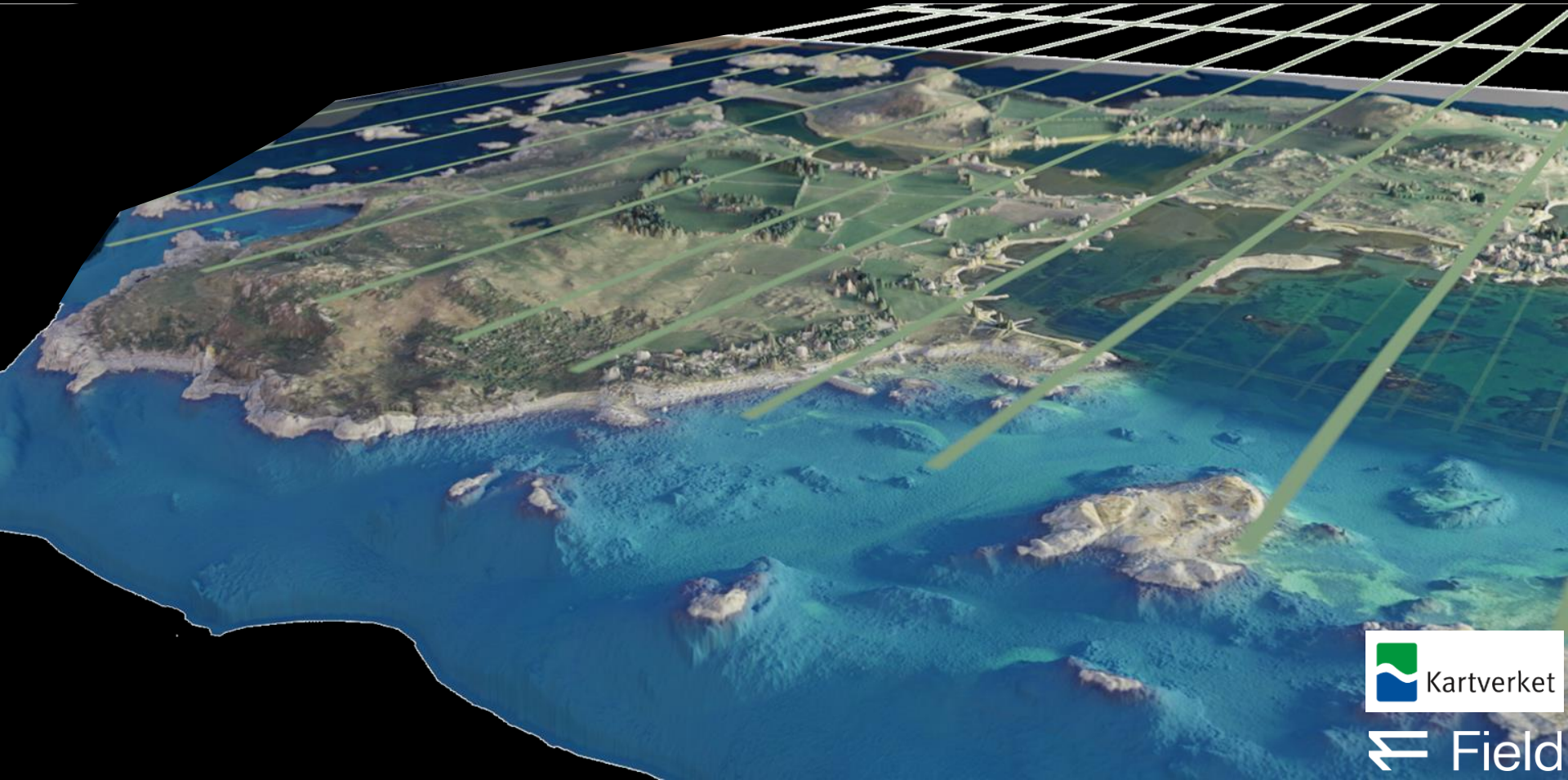
The maximum achieved depth is  
indicated for all surveys.



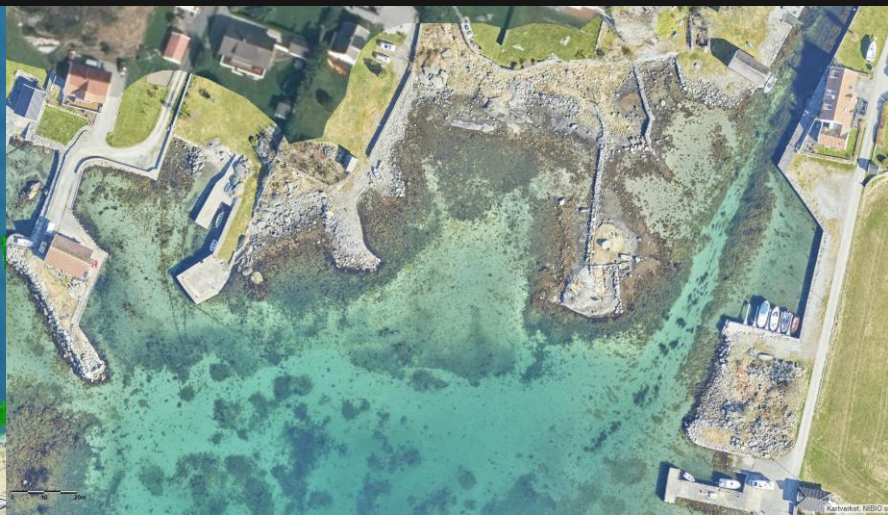
Survey area with multibeam echosounder: ~8 survey days



Survey same area with airborne lidar bathymetry: ~2 survey hours – very efficient



# ALB added value: mapping of marine vegetation and high-resolution imagery



Field

# Field bathymetric lidar use case: Helligvær archipelago (northern Norway)



# Pilot project: lake and riverbed mapping with bathymetric lidar technology



10 meters  
depth



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).

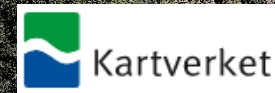


Image of the Lærdalselva river - bathymetric lidar data combined with aerial images

# Pilot project: lake and riverbed mapping with bathymetric lidar technology



 **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 Dannum

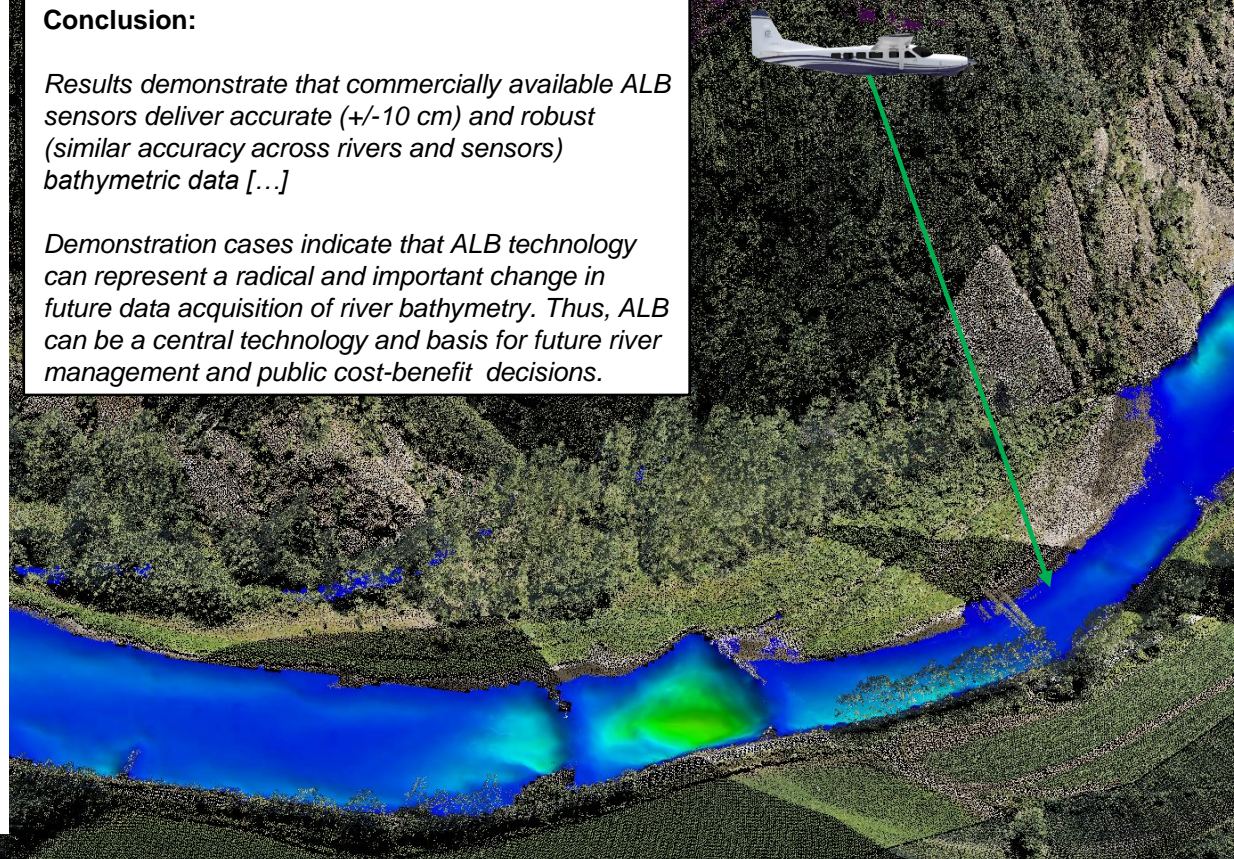


## Conclusion:

*Results demonstrate that commercially available ALB sensors deliver accurate ( $\pm 10$  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 and public cost-benefit decisions.*



[publikasjoner.nve.no/rapport/2023/rapport2023\\_02.pdf](https://publikasjoner.nve.no/rapport/2023/rapport2023_02.pdf)

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

# Field airborne bathymetric lidar surveys in rest of Europe 2021-2023

Full coastal zone of Northern Ireland (ongoing)

Survey of Lake Vänern in Sweden

Survey of several lakes in Finland

ALB Pilot project in Estonia

Survey of cable landing sites in Denmark

Survey of German island Sylt

ALB Pilot project in The Netherlands

Full coastal zone of Catalonia

# Field bathymetric lidar use case: coastal survey of Catalunya



# Field bathymetric lidar use case: coastal survey of Catalunya



Data is property of ICGC



Field

# Airborne Lidar Bathymetry

## Advantages & Challenges

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