
GWF
GEOSPATIAL WORLD FORUM
CLICK TO KNOW MORE

From Space to Seabed:

Mapping, modelling & monitoring blue carbon ecosystems at country scale

Pooja Mahapatra | May 2024

Climate change and nature-related risks pose significant threats – and opportunities to provide solutions.

40% of global population lives at or near a coastline.

Sea-level rise, **coastal flooding** and **storm surges** necessitate precise geo-data for effective risk assessment and mitigation.

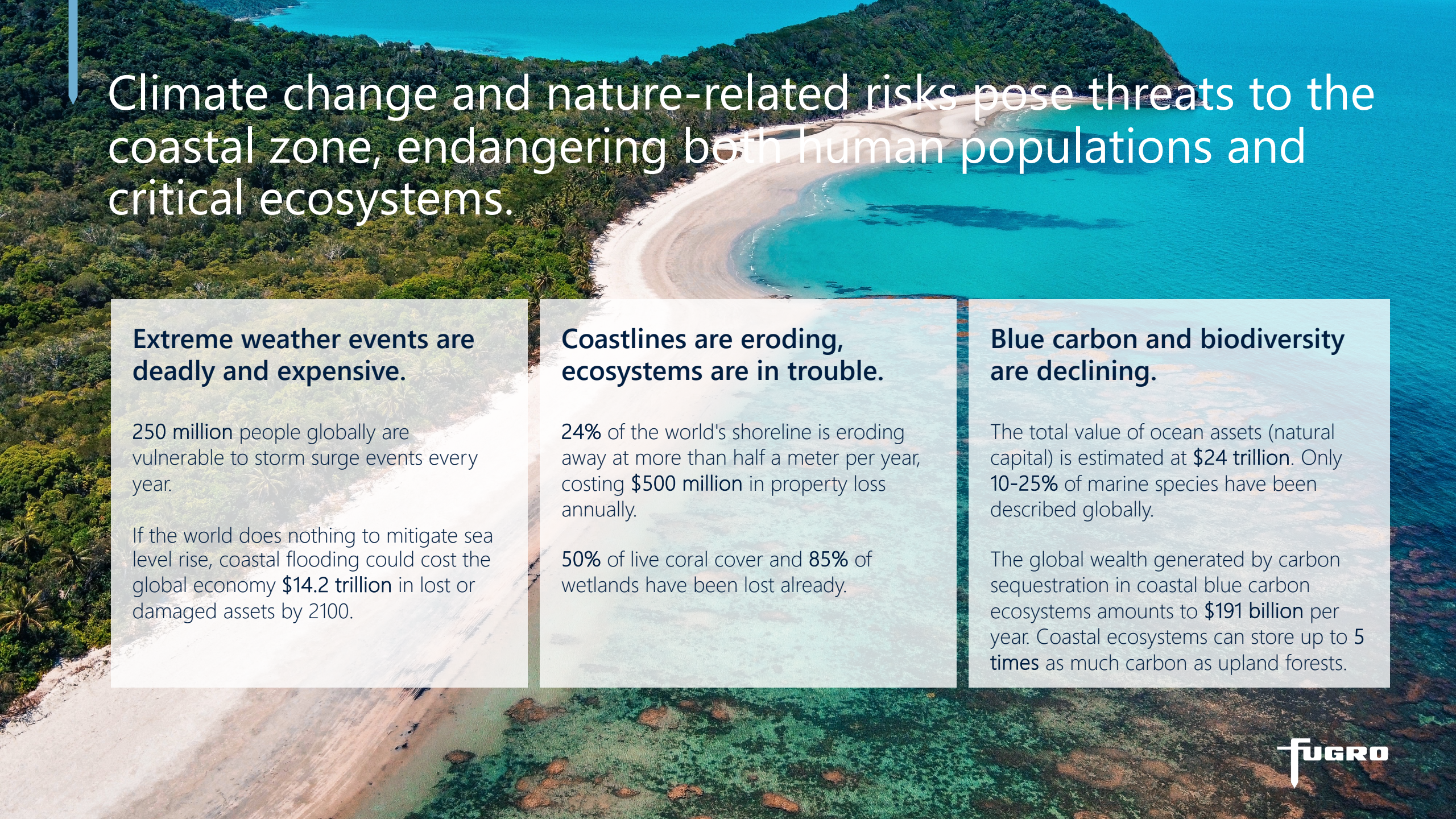
Opportunity to provide geo-data to support coastal resilience, disaster preparedness, sustainable coastal development and nature-based solutions.

Ocean economy is growing fast.

The blue economy is estimated to be worth **>$1.5 trillion** per year globally, doubling to **$3 trillion** in 2030. It provides over **30 million** jobs and supplies a vital source of protein to **>3 billion** people.

Opportunity to provide critical data and insights in a data-sparse environment, to support sustainable ocean resource management and preserve biodiversity.

FUGRO



Climate change and nature-related risks pose threats to the coastal zone, endangering both human populations and critical ecosystems.

Extreme weather events are deadly and expensive.

250 million people globally are vulnerable to storm surge events every year.

If the world does nothing to mitigate sea level rise, coastal flooding could cost the global economy **$14.2 trillion** in lost or damaged assets by 2100.

Coastlines are eroding, ecosystems are in trouble.

24% of the world's shoreline is eroding away at more than half a meter per year, costing **$500 million** in property loss annually.

50% of live coral cover and **85%** of wetlands have been lost already.

Blue carbon and biodiversity are declining.

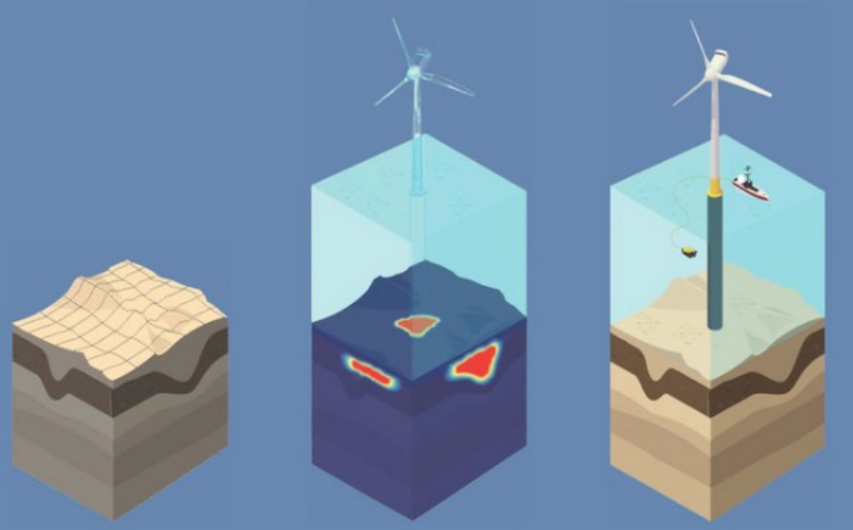
The total value of ocean assets (natural capital) is estimated at **$24 trillion**. Only **10-25%** of marine species have been described globally.

The global wealth generated by carbon sequestration in coastal blue carbon ecosystems amounts to **$191 billion** per year. Coastal ecosystems can store up to **5 times** as much carbon as upland forests.

FUGRO

Fugro is the world's leading Geo-data specialist

We map, model and monitor the built and natural environment



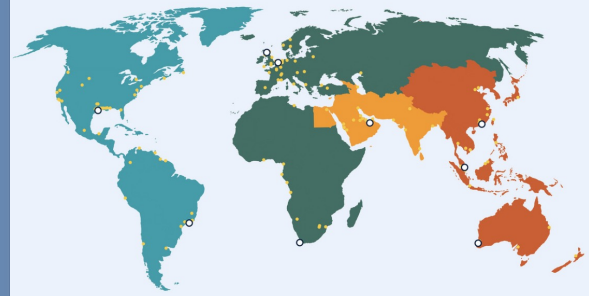
Map
Conduct technical studies and geographical surveys to map the (sub)surface

Model
Model Support construction with visualisation services and pinpoint positioning

Monitor
Scan, monitor and analyse structural integrity of assets and environments

Fugro's solutions are key to the energy transition, large-scale infrastructure development and climate change adaptation

Revenue 2023: EUR 2.2 billion



Employing 11000 talented people in 55 countries, Fugro serves clients around the globe, predominantly in the energy, infrastructure and water markets, both on land and at sea

Climate & Nature

Three focus areas

Inland water management

Sustainable management and utilisation of inland water resources through integrated hydrological services

Coastal resilience

Protection of coastal areas with large scale mapping, modelling and monitoring

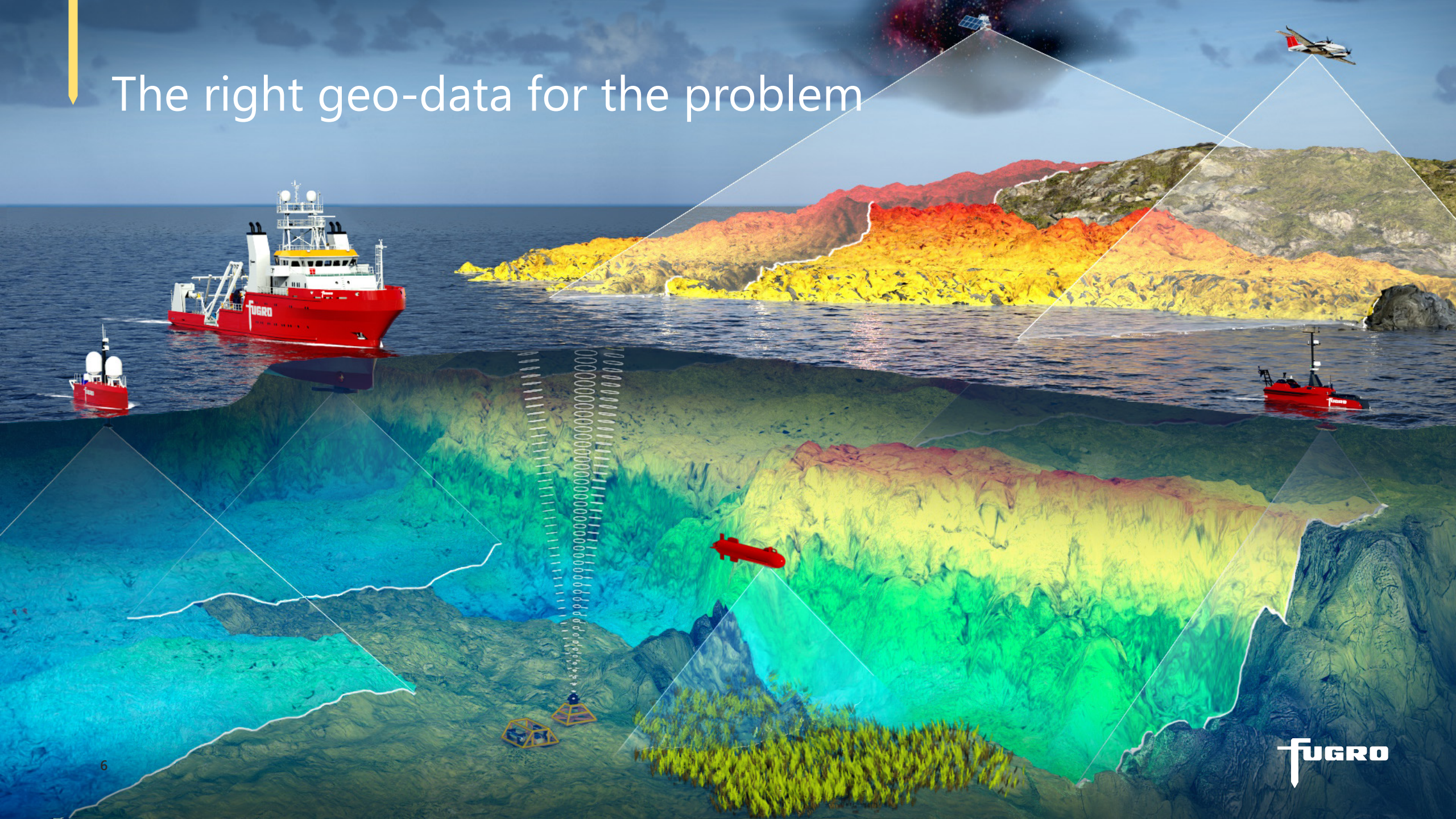
Ocean health

Mapping ocean conditions and biodiversity, and enabling the blue economy

Expand existing propositions
- Map, model and monitor

Enhanced by
- Technology development
- Strategic partnerships
- Selective M&A

The right geo-data for the problem



Case study
Seagrass mapping in Italy

Why is seagrass important?

- Incredible ally in fighting climate change
- Captures carbon up to 35 times faster than tropical rainforests
- Accounts for more than 10% of the total ocean carbon storage despite covering only 0.2% of the seafloor
- Provides nutrition and is habitat for other marine life
- Only about 20% of global seagrass has been mapped
- 7% of this key marine habitat is being lost worldwide per year, which is equivalent to a football field of seagrass lost every 30 minutes

Italy

National Mapping of *Posidonia Oceanica* and *Cymodocea Nodosa* woodlands through hydrospatial technologies.

P. oceanica

C. nodosa

MER - Project

Investments to combat climate change and hydrogeological instability

Make areas prone to landslides or floods more secure and revitalise them through redevelopment, monitoring and prevention work.

View the investments →

Ecological restoration of 6 large priority areas

and particularly in the Po river area to promote ecological connection and adapt to climate change.

90% of marine and coastal systems mapped and monitored

to protect the seabed and marine habitats.

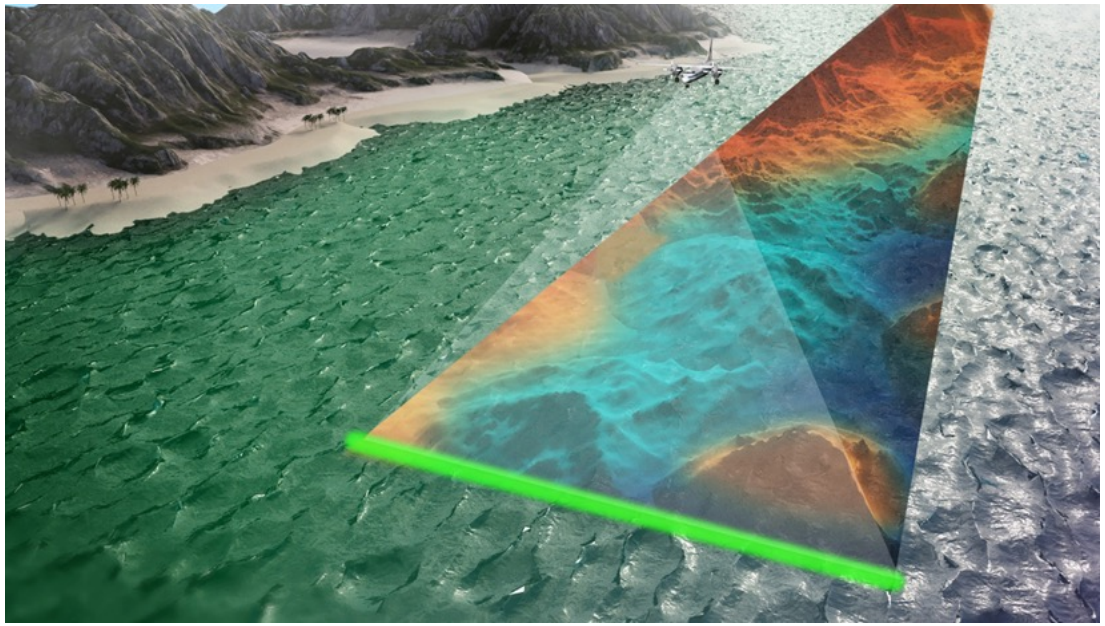
ISPRA

The Italian Institute for Environmental Protection and Research

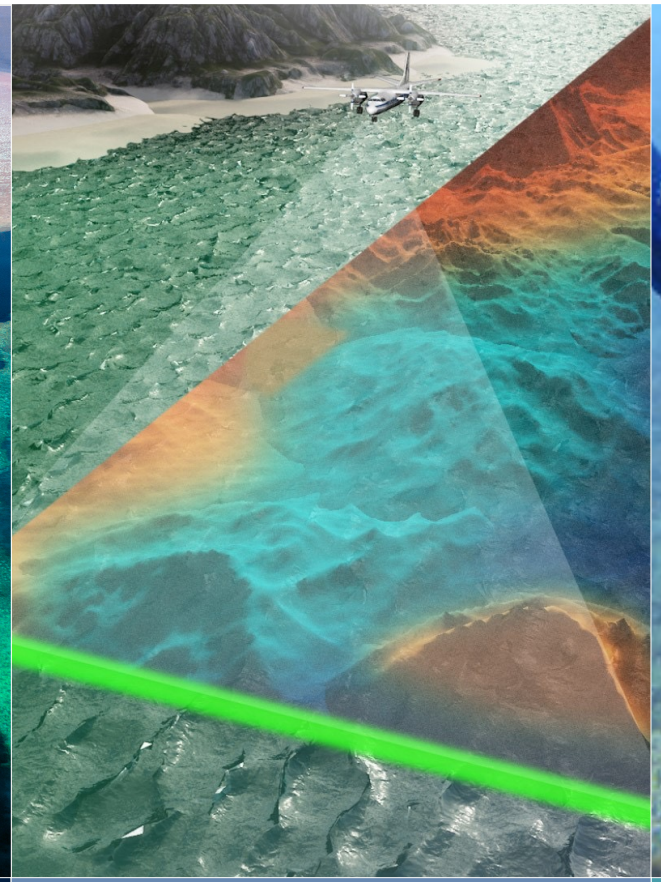
ISPRA performs, with the inherent financial resources, equipment and personnel, the duties of:

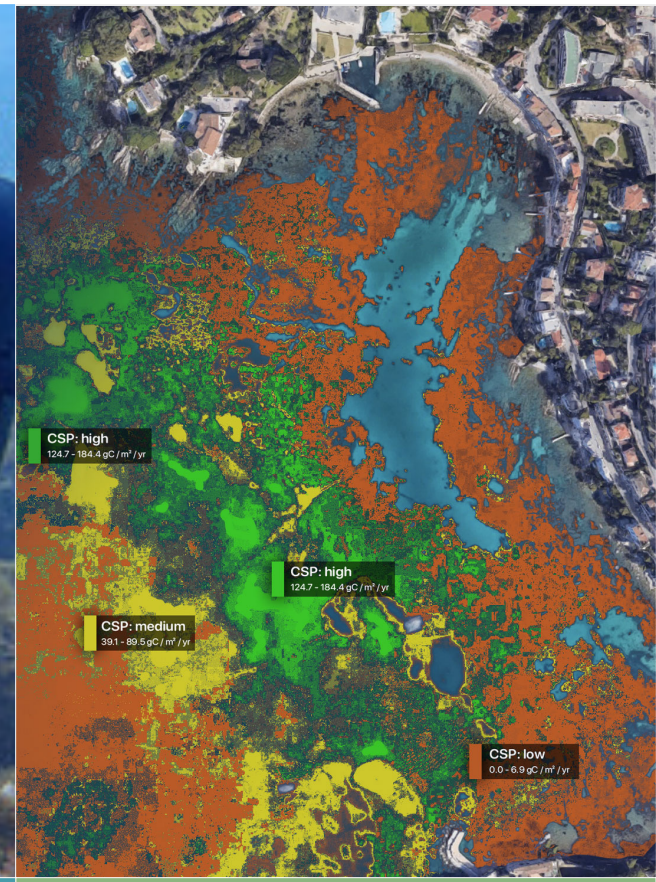
- Italian Environment Protection and Technical Services Agency
- National Institute for Wildlife
- Central Institute for Scientific and Technological Research applied to the Sea

The Institute acts under the vigilance and policy guidance of the **Italian Ministry for the Environment** and the **Protection of Land and Sea**



Large-scale → Tiered approach to habitat mapping → Localised





Satellite EO

Hindcasting, global and near-realtime monitoring, pilots

Airborne bathymetry (lidar/hyperspectral), vessel MBES

High-res regional baselining

AUV/ROV-mounted (hyperspectral) cameras

Localised ground-truthing, training data

AI analytics e.g. carbon sequestration potential, delivered through

FUGRO VIRGEO®

Solution for seagrass

Map – model - monitor

Remote sensing:

- Satellite EO (EOMAP), airborne hyperspectral, airborne lidar and vessel MBES
- Extent, variety, density

Validation:

- Field sampling of soil carbon pools
- Soil depth, coring & subsampling
- Laboratory analysis

Minimize need for *in situ* sampling: partnership with PlanBlue

- Hyperspectral & RGB imaging (SeaCat AUV)
- Machine learning (AI): seagrass health
- Scalable

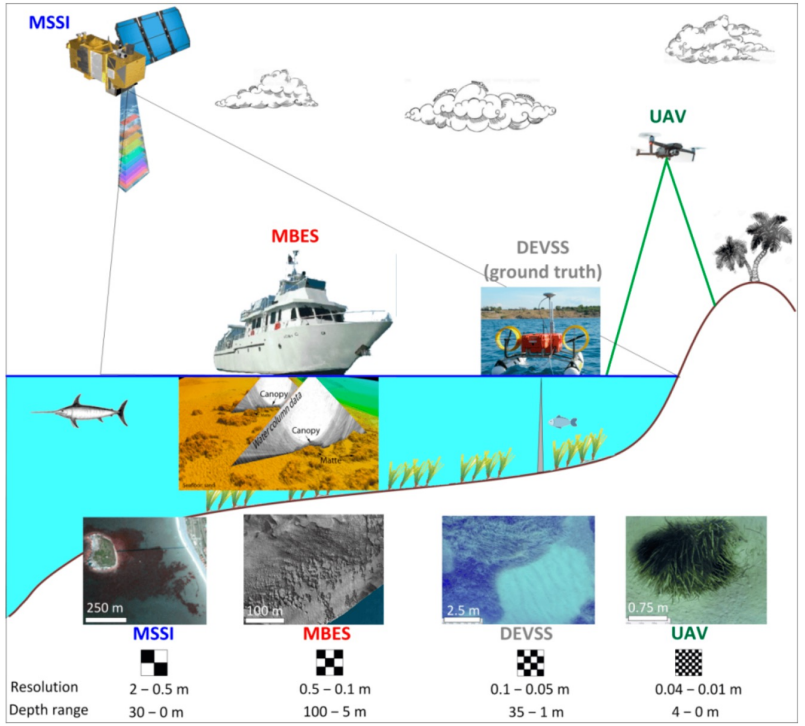
BLUE CARBON ECOSYSTEM MATRIX

Overview of aforementioned technologies and their applicability to BCE. Focus is on small to medium-scale projects, since satellite technology is the only viable option for large-scale projects. Colour coordination refers to recommendations for use: HIGH, MEDIUM, LOW.

	Mangroves	Seagrass	Salt marsh	Macroalgae	Seabed sediment
Satellite imagery	**Data:** Presence, variety, density, height **Cost:** Low **Notes:** Less effective for small-scale	**Data:** Presence **Cost:** Low **Notes:** Less effective in low water clarity	**Data:** Presence, variety, density **Cost:** Low **Notes:** Temporal resolution needed for dynamic ecosystem	**Data:** Presence **Cost:** Low **Notes:** Temporal resolution needed for dynamic ecosystem	N/A
Hyperspectral imagery	**Data:** Presence, variety, density, health **Cost:** Medium **Notes:** Airborne	**Data:** Presence, variety, density, health **Cost:** High **Notes:** Underwater and effective combined with other sensors	**Data:** Presence, variety, density, health **Cost:** Medium **Notes:** Airborne and effective with other sensors	**Data:** Presence **Cost:** Medium **Notes:** Airborne and less effective in low water clarity	N/A
LiDAR	**Data:** Height **Cost:** High **Notes:** Effective with other sensors	**Data:** Presence, height **Cost:** High **Notes:** Effective with other sensors	**Data:** Presence, height **Cost:** High **Notes:** Effective with other sensors	**Data:** Presence **Cost:** High **Notes:** Effective with other sensors	N/A
Sonar	**Data:** Presence, density, height, soil carbon **Cost:** High **Notes:** Echosounder for soil carbon untested in mangroves	**Data:** Presence, density, height, soil carbon **Cost:** High **Notes:** Echosounder effective for soil carbon data	**Data:** Presence, density, height, soil carbon **Cost:** High **Notes:** Echosounder for soil carbon untested in salt marsh	**Data:** Presence, density **Cost:** High **Notes:** Soil carbon less applicable to kelp	**Data:** Soil carbon **Cost:** High **Notes:** Echosounder effective for soil carbon data
Drones	**Data:** Presence, variety, density, height **Cost:** Medium **Notes:** Recommended for small-scale	**Data:** Presence, variety, density, height **Cost:** Medium **Notes:** Recommended for small-scale	**Data:** Presence, variety, density, height **Cost:** Medium **Notes:** Recommended for small-scale	**Data:** Presence, variety, density **Cost:** Medium **Notes:** Recommended for small-scale	N/A

Project overview

Sensor	Mapped area/length
Topographic lidar / RGB-NIR	5147 km^2
Bathymetric lidar / RGB-NIR	12600 km^2
Satellite multispectral	9232 km^2
Hyperspectral	977 km^2
Multibeam echosounder	3798 km^2
Gravimeter	Required for connecting various datasets along the coastal strip
Autonomous Underwater Vehicle (AUV)	4000 km



Reference: Rende, S.F.; Bosman, A.; Di Mento, R.; Bruno, F.; Lagudi, A.; Irving, A.D.; Dattola, L.; Giambattista, L.D.; Lanera, P.; Proietti, R.; et al. Ultra-High-Resolution Mapping of *Posidonia oceanica* (L.) Delile Meadows through Acoustic, Optical Data and Object-based Image Classification. *J. Mar. Sci. Eng.* **2020**, *8*, 647. https://doi.org/10.3390/jmse8090647

FUGRO

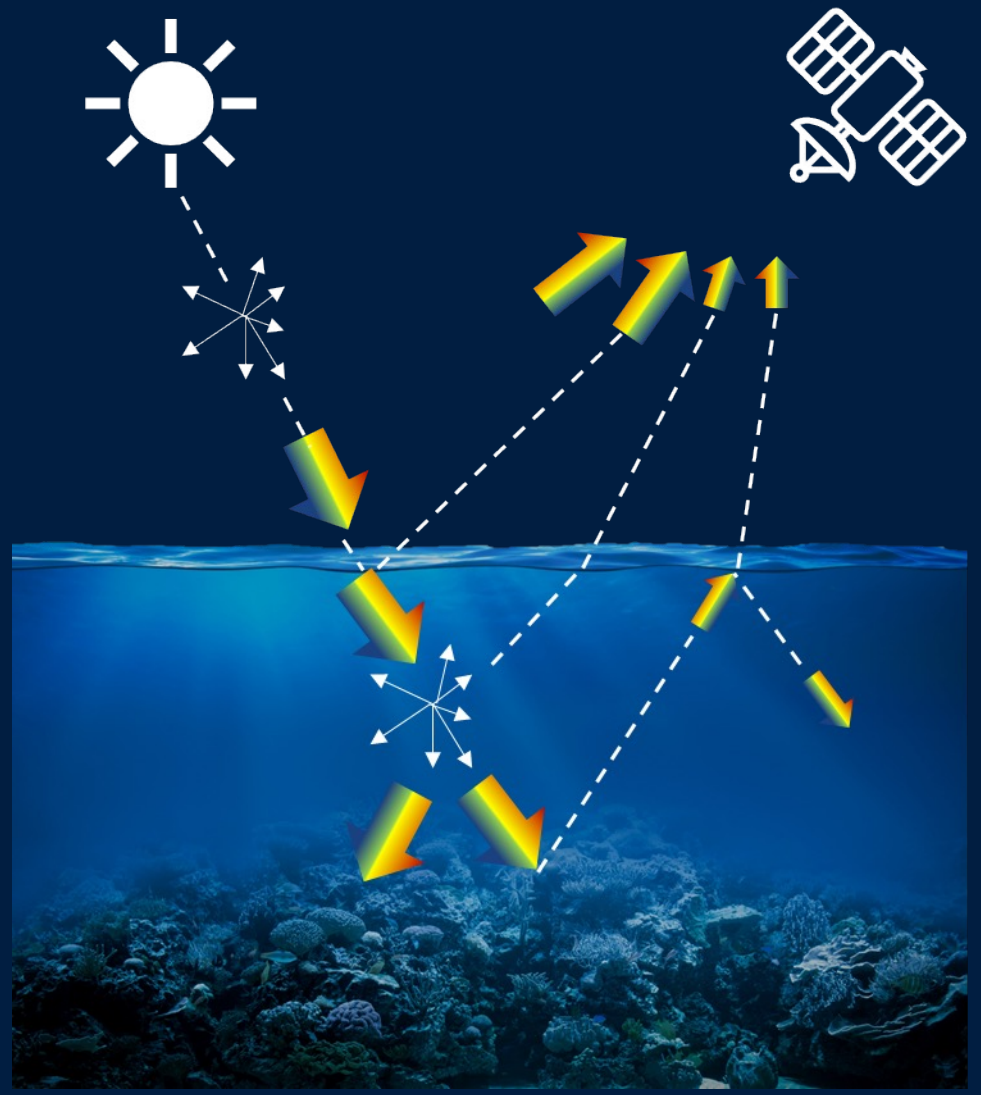
Satellite EO

Multi-/hyperspectral

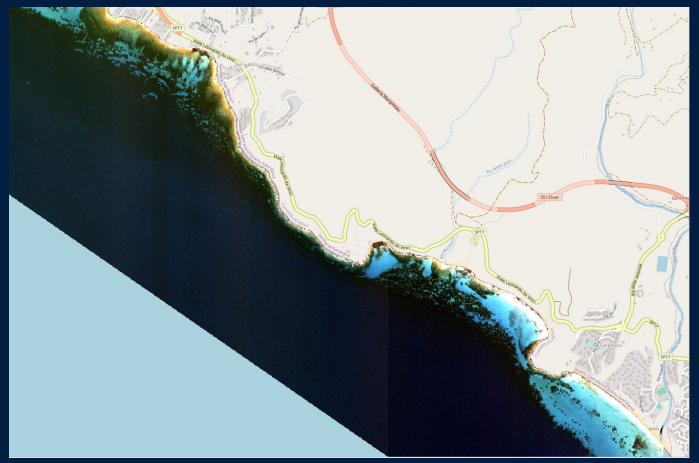
Seagrass and shallow waters absorb and reflect sunlight. It can have unique texture or shape, used to train satellite-based models

1st phase: Satellite based analysis without in-situ data

2nd phase: Integration of in-situ measurements and refinement



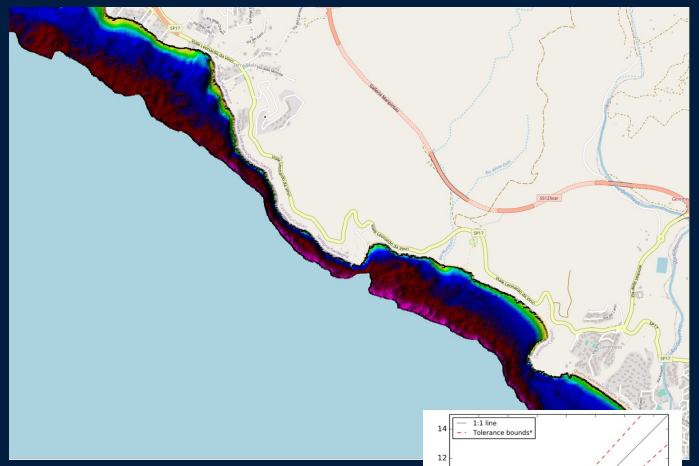
Satellite-derived satasets, example Sardinia



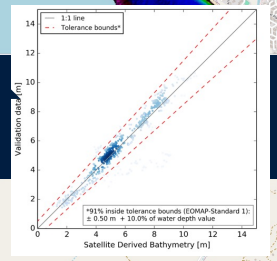
Multispectral satellite image (© Maxar, 2024)

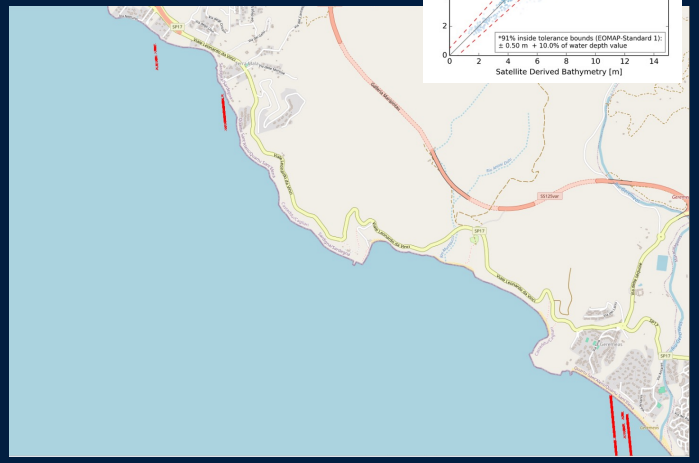
EOMAP's SDB and seabed model

Satellite-Derived Bathymetry (SDB)



EOMAP's SLB model comparison





Satellite-Lidar Bathymetry (SLB)

Seabed Reflectance (SFR)

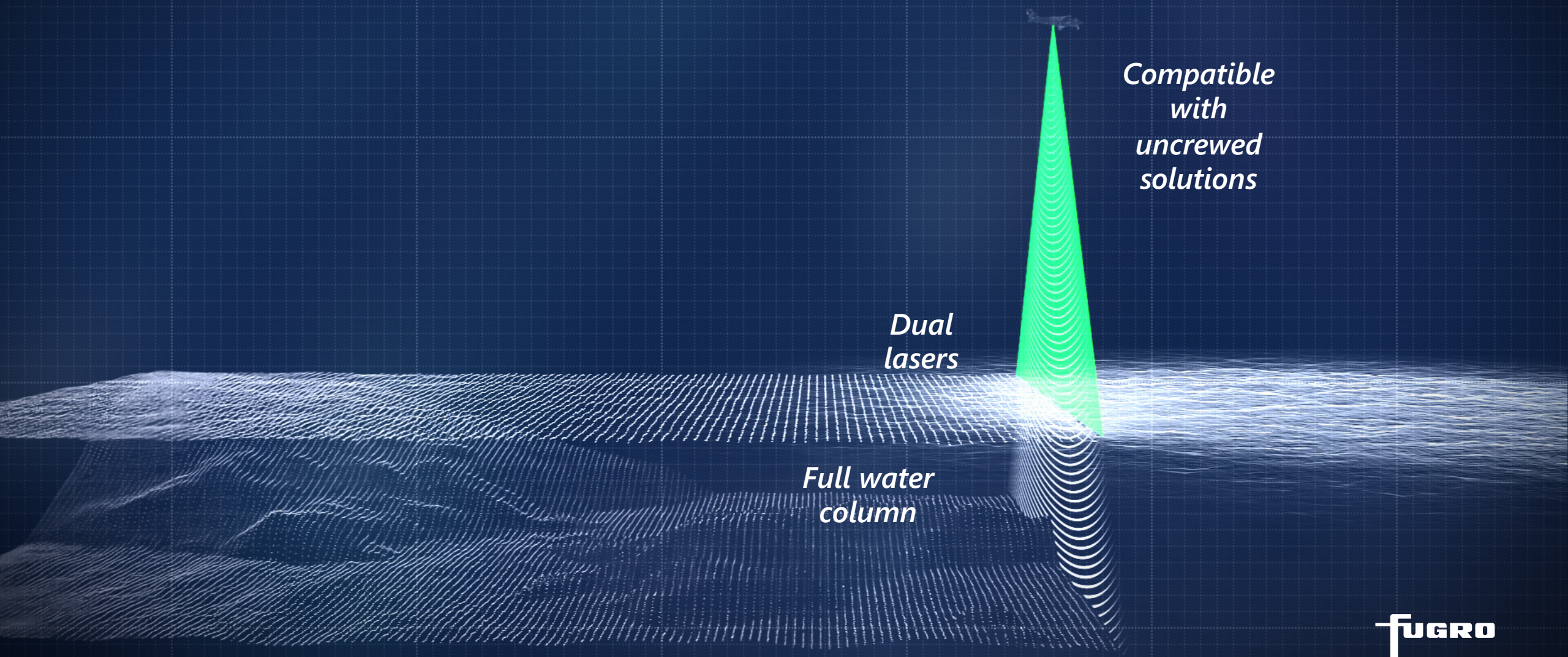
ML based seabed classification

Seabed classification (SFC)

Revolutionising tomorrow – pioneering innovations shaping the future landscape

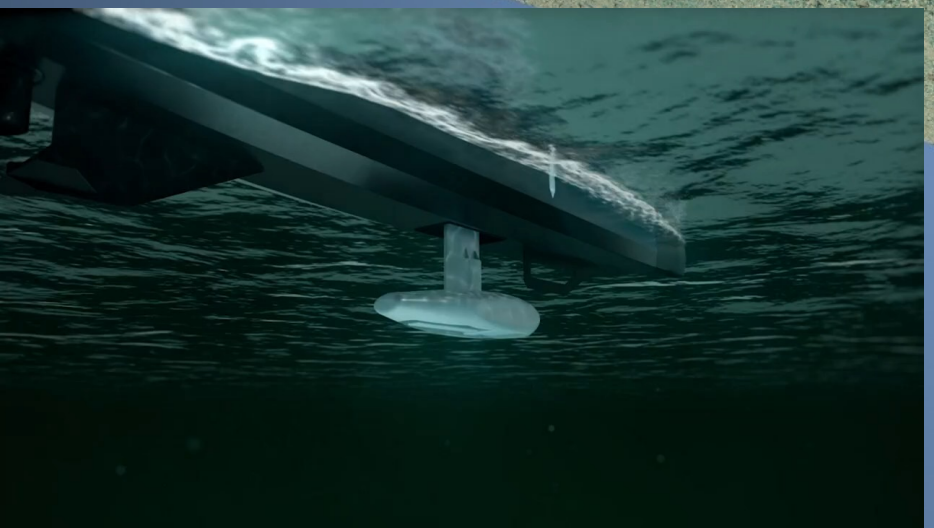
Ensuring hydrographic confidence

Airborne Lidar Bathymetry and target detection for IHO standards



Only scratching the surface with the full water column capability

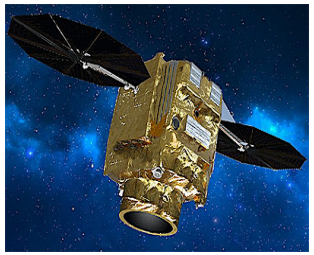
MBES: Multibeam echo sounding



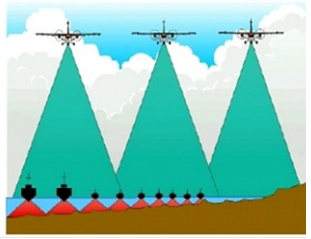
Integrated solution

Lidar bathymetry

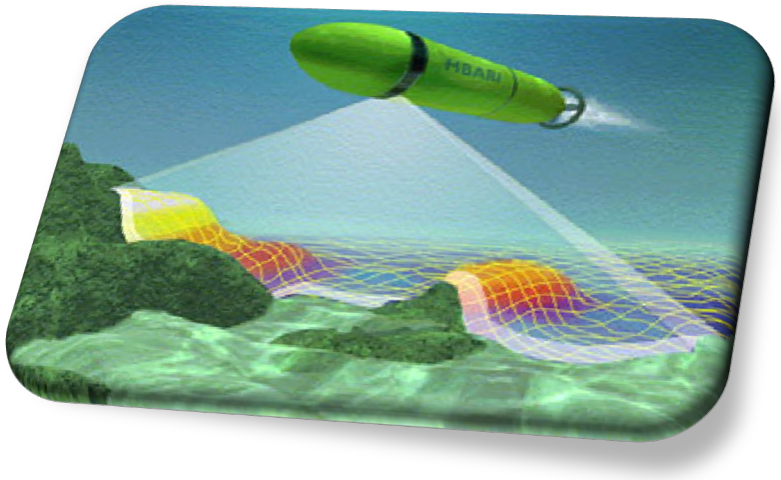
Satellite EO

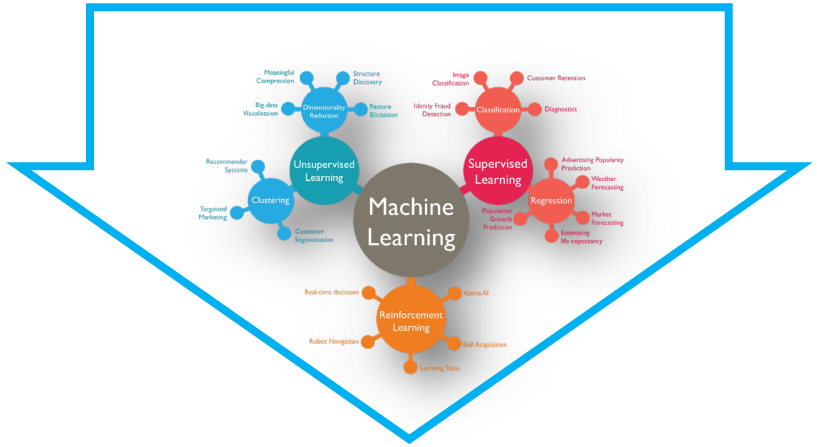


MBES



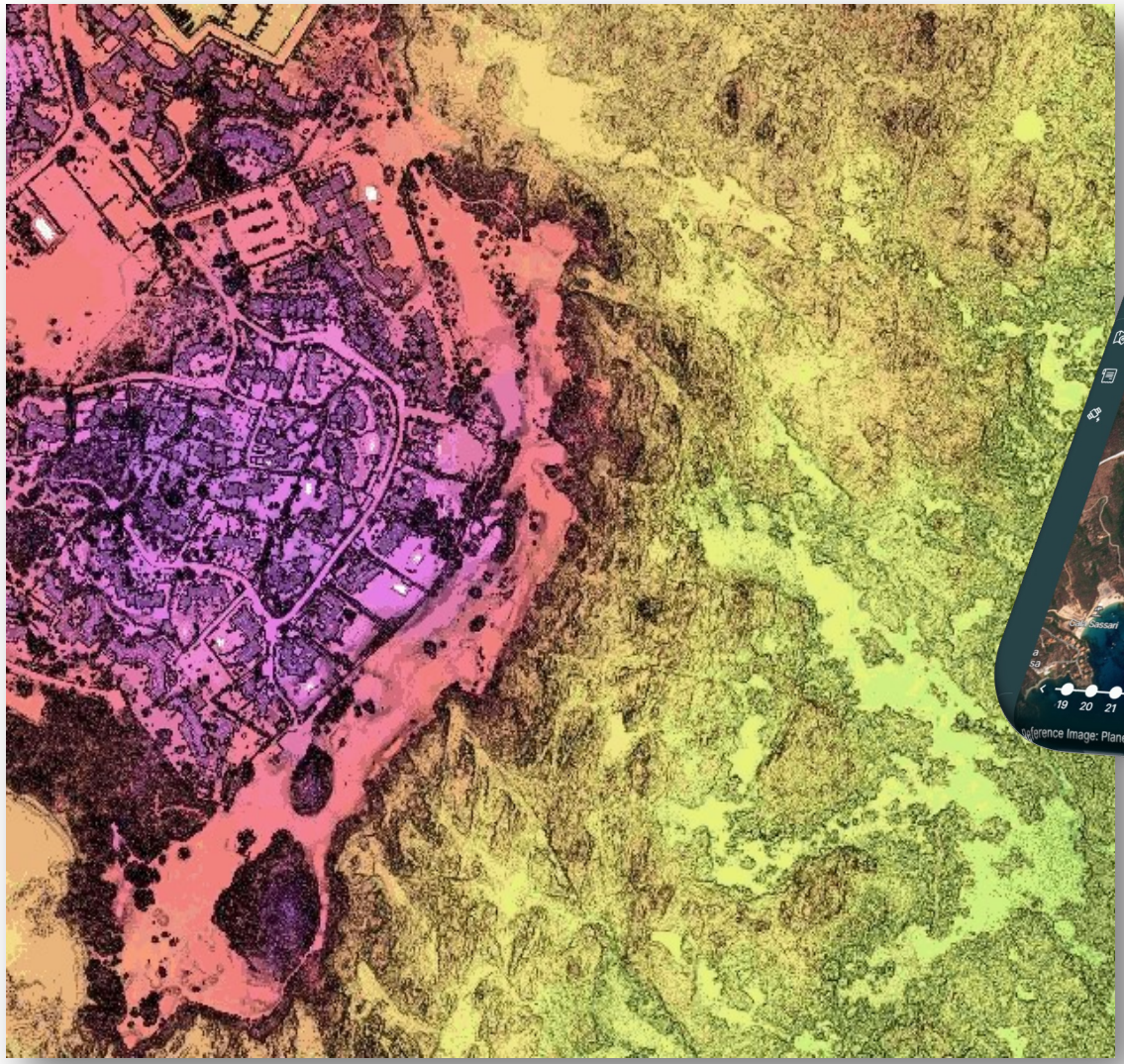
Ground Truthing





EUNIS Code	Descrizione
A5.53	Sublittoral seagrass beds
A5.5313	Mediterranean Cymodocea beds
A5.53131	Association with Cymodocea nodosa on well sorted fine sands
A5.535	Posidonia beds
A5.5351	Ecomorphosis of striped Posidonia oceanica meadows
A5.5352	Ecomorphosis of "barrier-reef" Posidonia oceanica meadows
A5.5353	Facies of dead "mattes" of Posidonia oceanica without much epiflora
A5.5354	Association with Caulerpa prolifera on Posidonia beds
A2.131	Facies of banks of dead leaves of Posidonia oceanica and other phanerogams

Engagement portal – VirGeo



Thank you

p.mahapatra@fugro.com
www.fugro.com