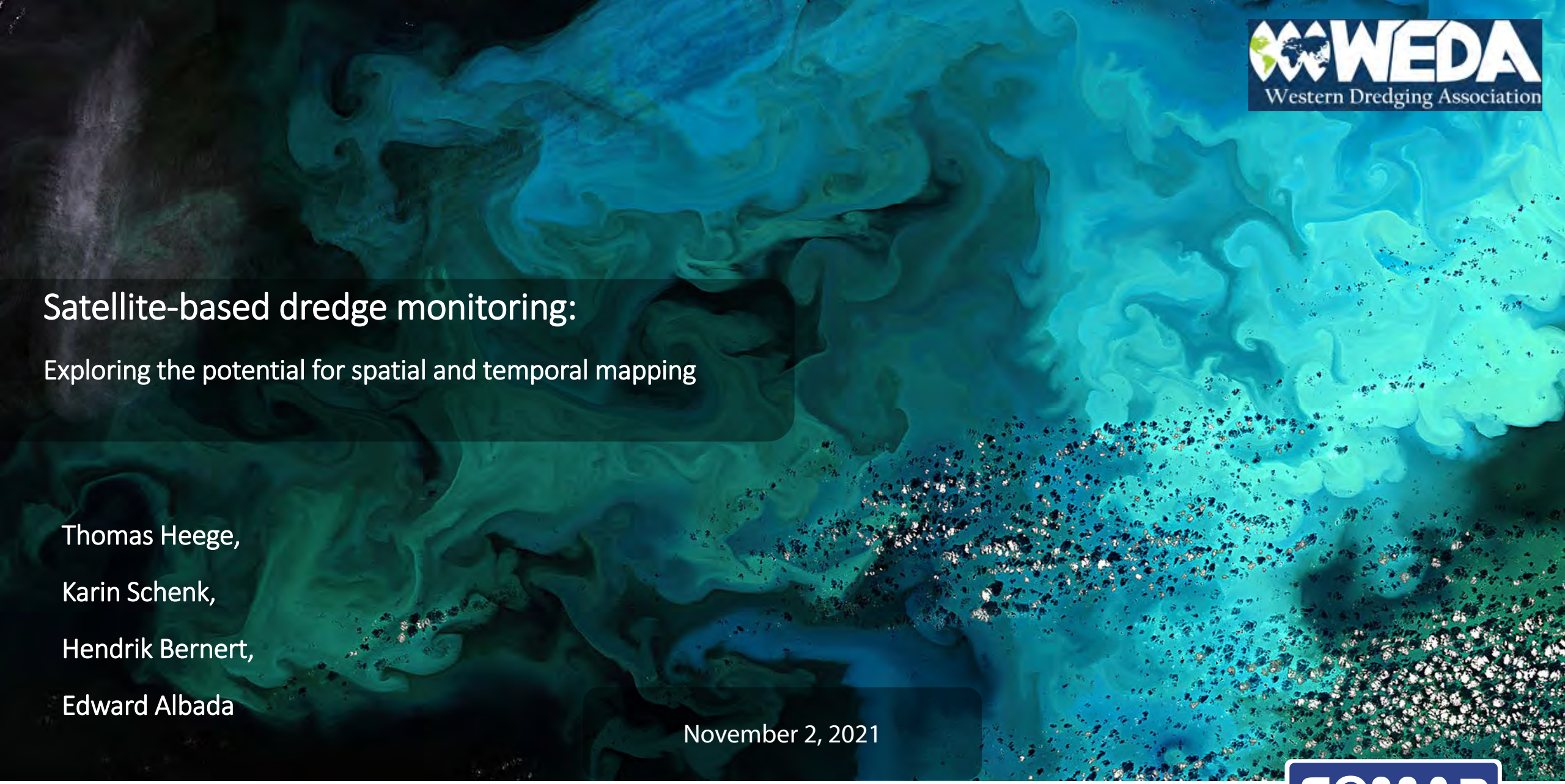


Satellite-based dredge monitoring:

Exploring the potential for spatial and temporal mapping

Thomas Heege,

Karin Schenk,

Hendrik Bernert,

Edward Albada

November 2, 2021

eomap.com

detect more.

About EOMAP

- **Mapping & monitoring** aquatic environments worldwide
- Established in 2006 with HQ in DE, offices in USA, AU, UAE and IN
- **Earth Observation** service provider for coastal and aquatic stakeholders
- 30 permanent employees covering all aspects from R&D to IT to provision of services

Seabed2030 partner

EU Copernicus awards for outstanding technology

Geospatial world award winner 2017

InformationProgram Partner

Solution partner

Data provider

detect more.

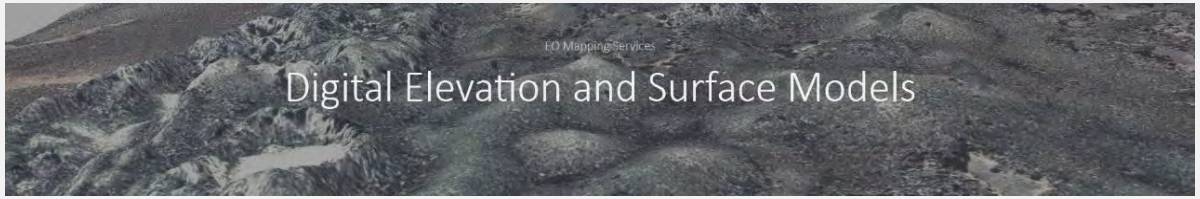
EO Mapping services and software solutions

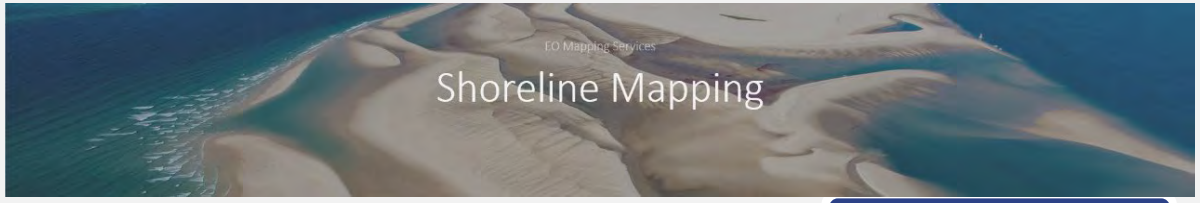
EO Mapping

- **EOMAP's data services** provide spatial and quantified data on aquatic environments
- We provide customised solutions and consultancy

EO Software

- **EOMAP's software services** provides clients the ability to generate SDB, Water Quality and reflectance data themselves, anytime and as required

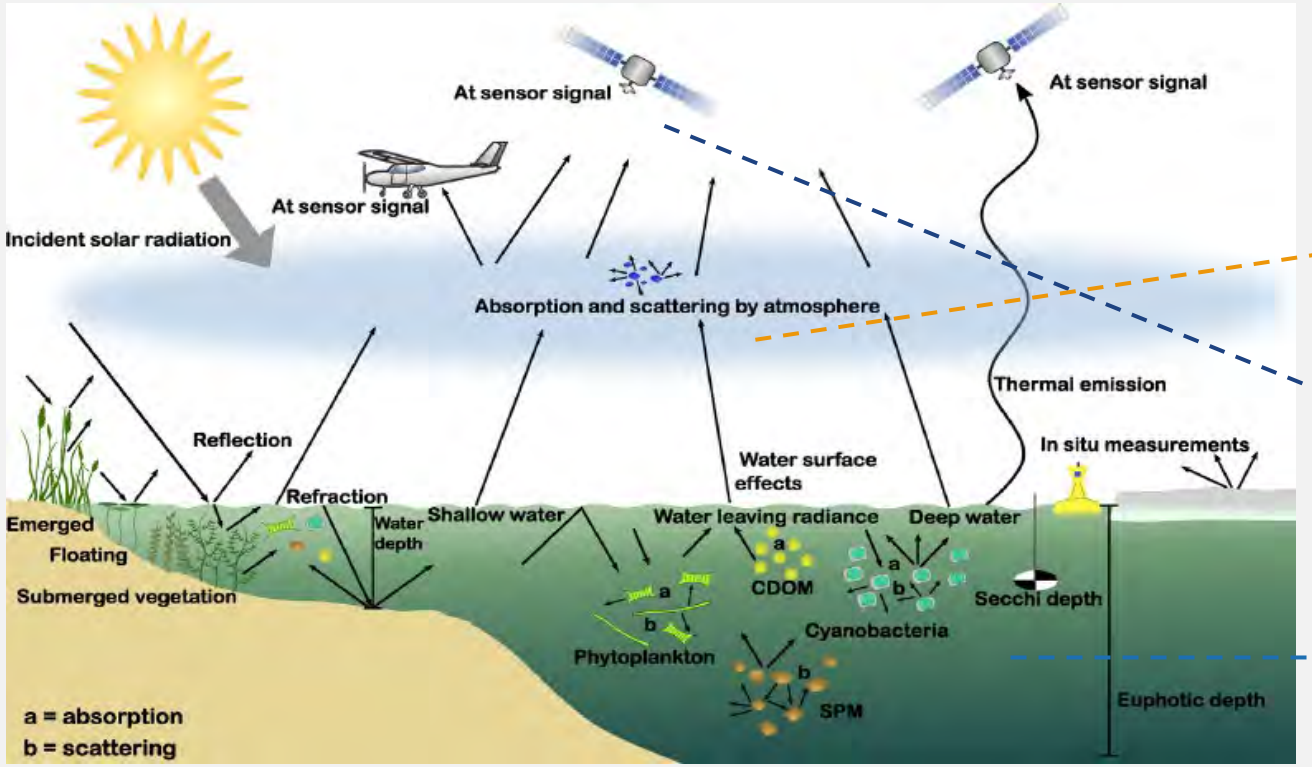




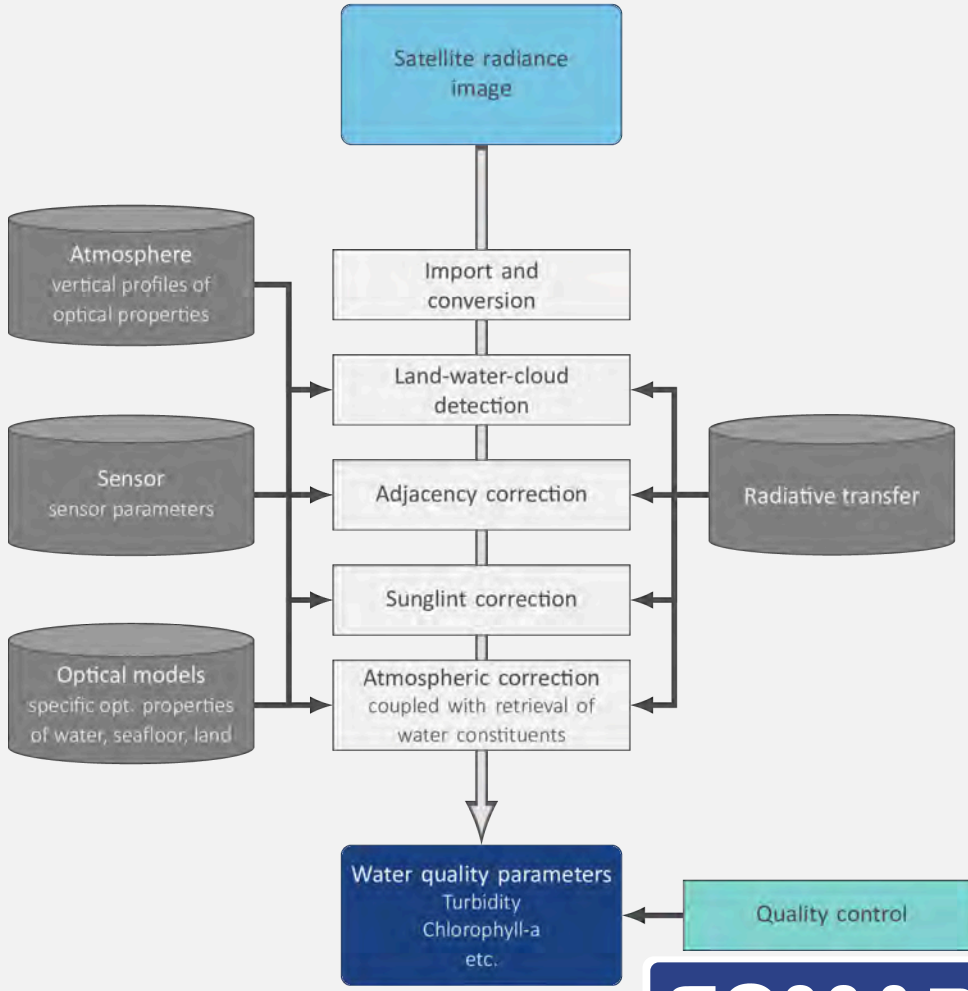
EOMAP
detect more.

Background - Methodology

Schema of EO-based water quality calculation



Sensor-agnostic MIP-EWS workflow

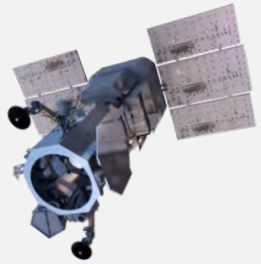


Benefits of physics-based algorithm:

- ✓ Harmonized over different water bodies globally
- ✓ No dependencies on local survey data
- ✓ Sensor agnostic

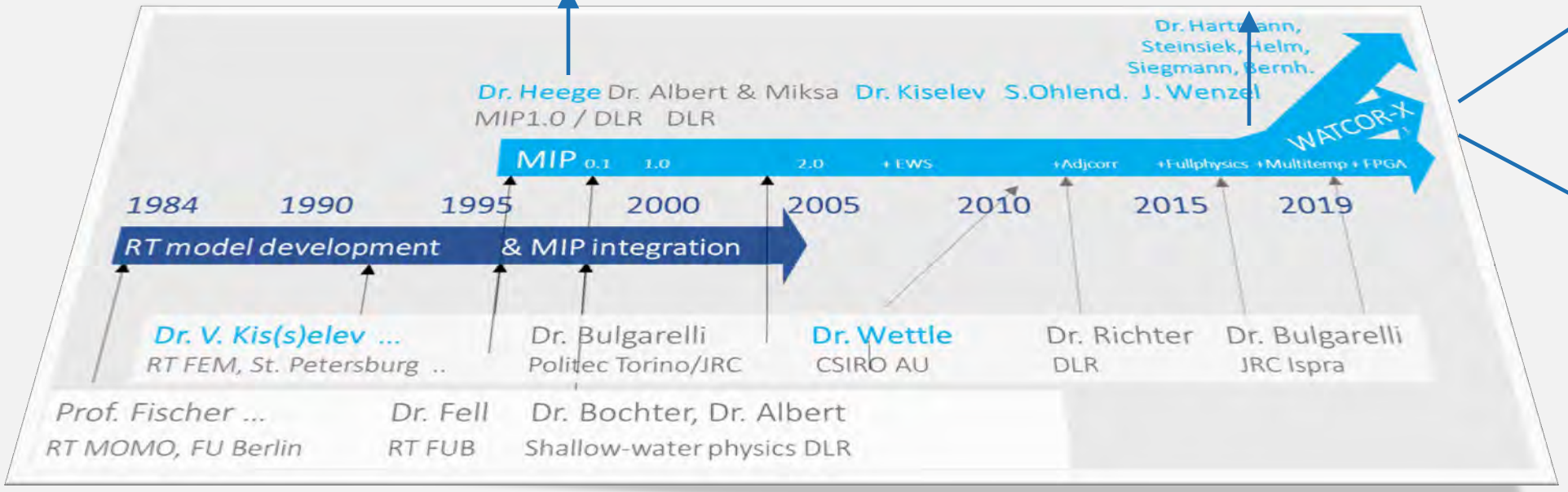
EOMAP
detect more.

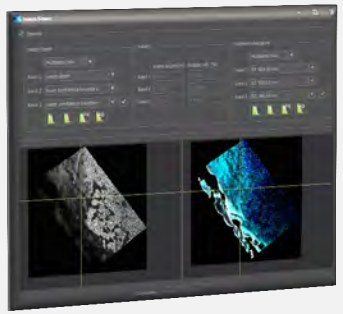
EOMAP physics based development



Single record analytics

Multi record, multi sensor analytics



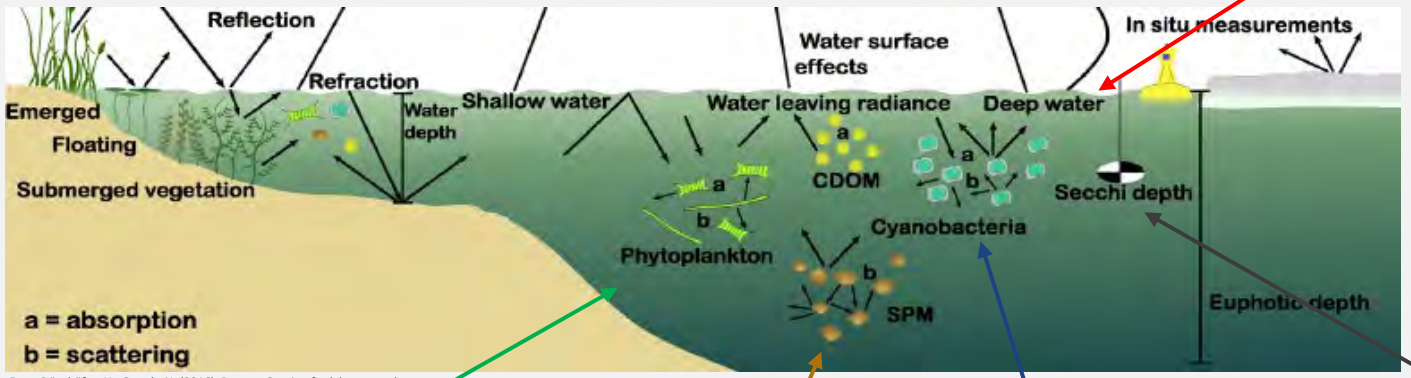


Desktop software

Online software

EOMAP
detect more.

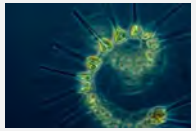
What can be measured from multispectral satellites?



From Dörnhöfer, N., Oppelt, N. (2016): Remote Sensing for lake research and monitoring – Recent advances. Ecological Indicators 64

Surface Temperature

Chlorophyll-a



Turbidity/

Suspended Matter

Harmful Algae Blooms

Secchi Depth

- ABS (Total Absorption)
- AOT (Aerosol Optical Thickness)
- CHL (Chlorophyll-a)
- CDM (Colored Dissolved Organic Matter / Yellow Substance)
- DIV (Ratio of Absorption and Scattering)
- HAB (Harmful Algae Bloom Indicator)
- EVA (Evaporation Rate)
- KDC (Diffuse Attenuation Coefficient)
- QUC (EOMAP Quality Coding)
- QUT (Total Quality)
- RGB ('True Color' Image)
- RRA (above-surface Remote Sensing Reflectance [0+])
- RRS (sub-surface Remote Sensing Reflectance [0-])
- RRW (Remote Sensing Reflectance at WISP angle [0+]
- SDD (Secchi Disc Depth)
- SIA (Sum of Inorganic Absorption)
- SOA (Sum of Organic Absorption
- SSR (Sub-surface Irradiance Reflectance [0-])
- SST (Water Surface Temperature)
- TUR (Turbidity)
- TSC (Trophic State Index)
- TSM (Total Suspended Matter)
- WEX (Water Extent)
- Z90 (Signal Depth)

EOMAP
detect more.

Data source and resolutions

Satellite/Sensor	Spatial Resolution (max)	Temporal resolution	Start and end date
Landsat 5	30m	16 days	1984 – 2012
Landsat 7	30m (15m)	16 days	1999-now
Landsat 8	30m (15m)	16 days	2013-now
Sentinel-2 A/B	10m	5 days	2015/2017 –now
Sentinel-3 A/B	300m	daily	2016/2018 –now
MODIS Aqua/Terra	250m	daily	1999/2002 –now
Planet Doves/SkySat	3m/1m (0.5m)	Up to multiple times daily	2014
WorldView 2/3	2m (0.5m)	daily	2009/2014

EOMAP
detect more.

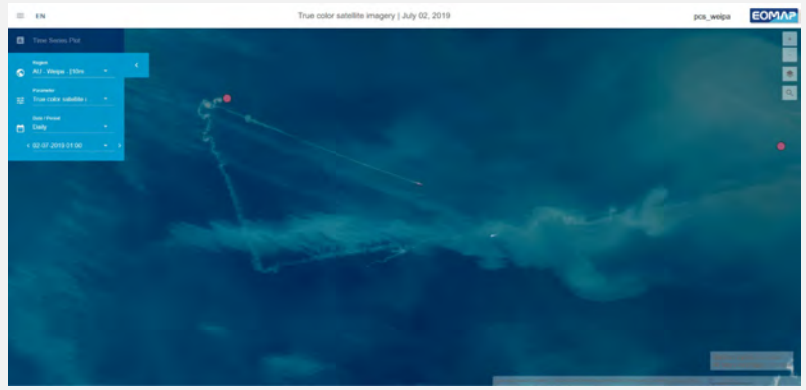
Water Quality – Dredging Operations Monitoring

Specifications

- ❑ Monitoring **imagery**, **turbidity** and **total suspended matter**
- ❑ 0.5-500m spatial resolution - up to **daily coverage**
- ❑ Quantitative measurements in NTU and mg/l

Benefits

- ❑ Cost effective monitoring due to reduction **HSE risks**
- ❑ Historic data available **from 1984 for baseline analysis**
- ❑ Multiple satellite systems to achieve **highest temporal resolutions**
- ❑ Fast delivery mechanisms and easily accessible **online platform**



EOMAP
detect more.

Turbidity Monitoring for Dredging: Australia

- Turbidity Monitoring:
- Adaptive management for dredging program
- Hay Point and Port of Weipa
  - Benthic turbidity loggers
  - Surface near-real time measurements
  - Synoptic satellite-derived turbidity maps

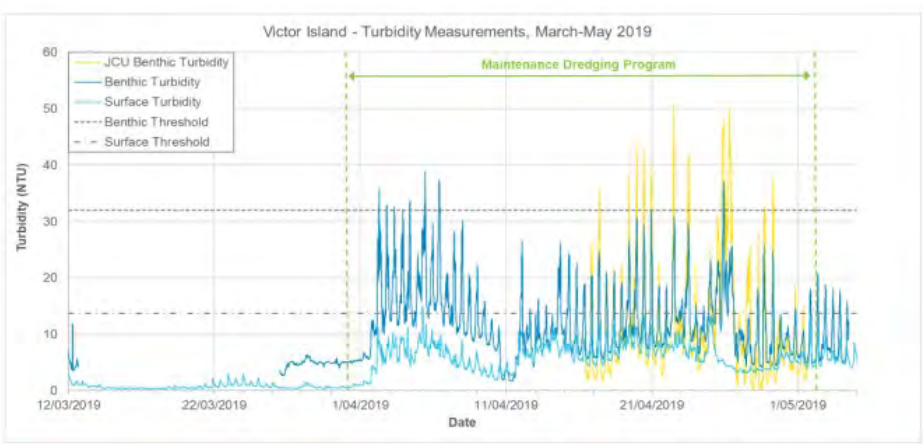
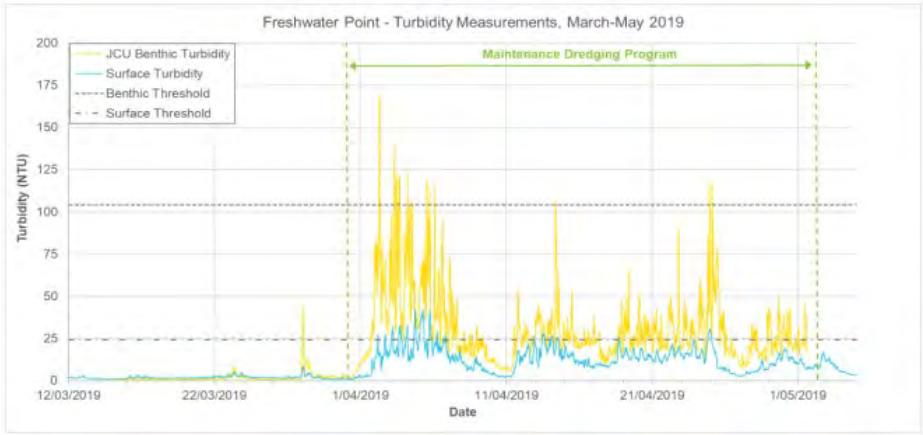


Figure 4. Hourly rolling average benthic and surface turbidity at Victor Island from 12th March to 5th May 2019. The data labelled Benthic Turbidity is the VE measured benthic turbidity data.



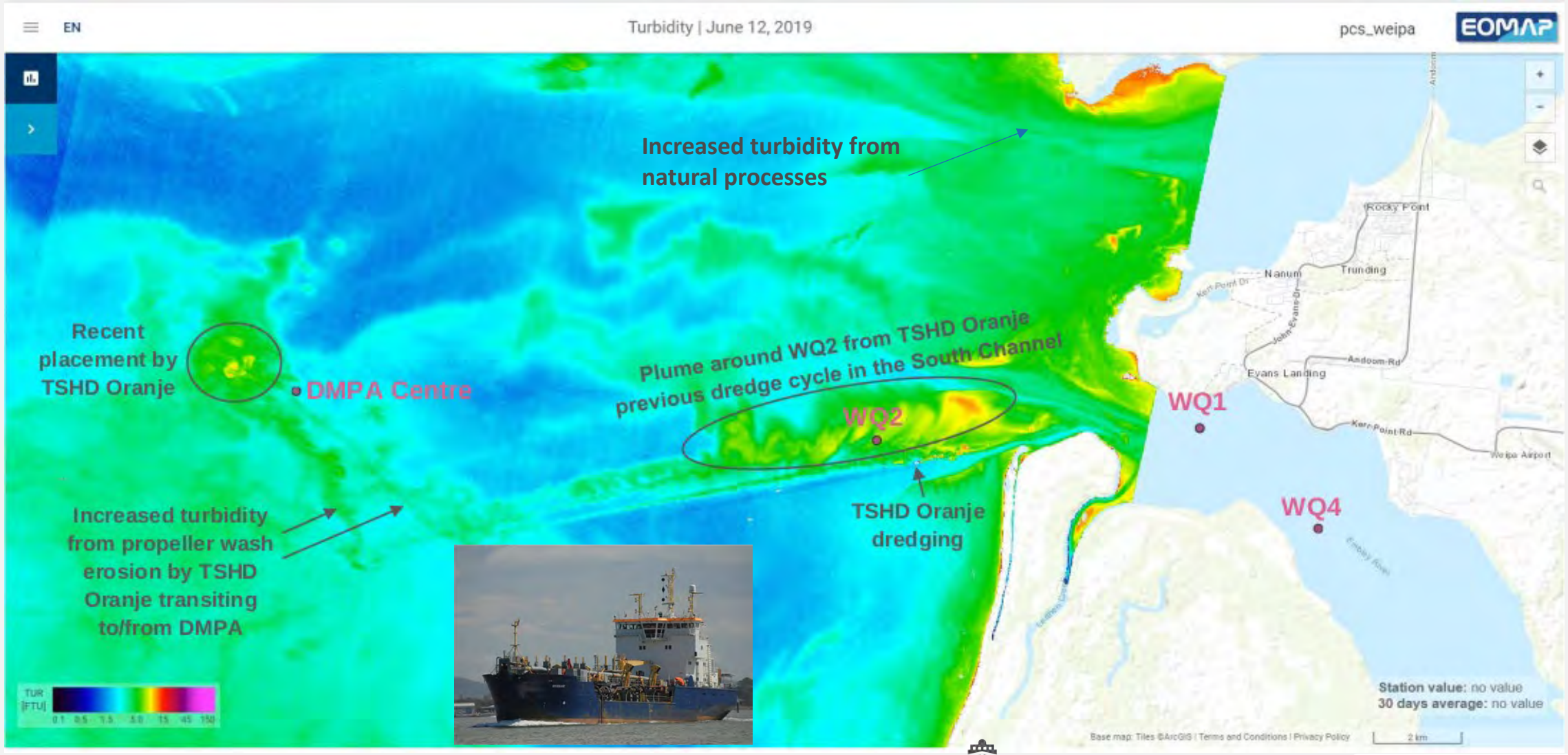
NORTH QUEENSLAND BULK PORTS CORPORATION

PORT & COASTAL SOLUTIONS

EOMAP detect more.

Turbidity Monitoring Port of Weipa

eoApp screenshot

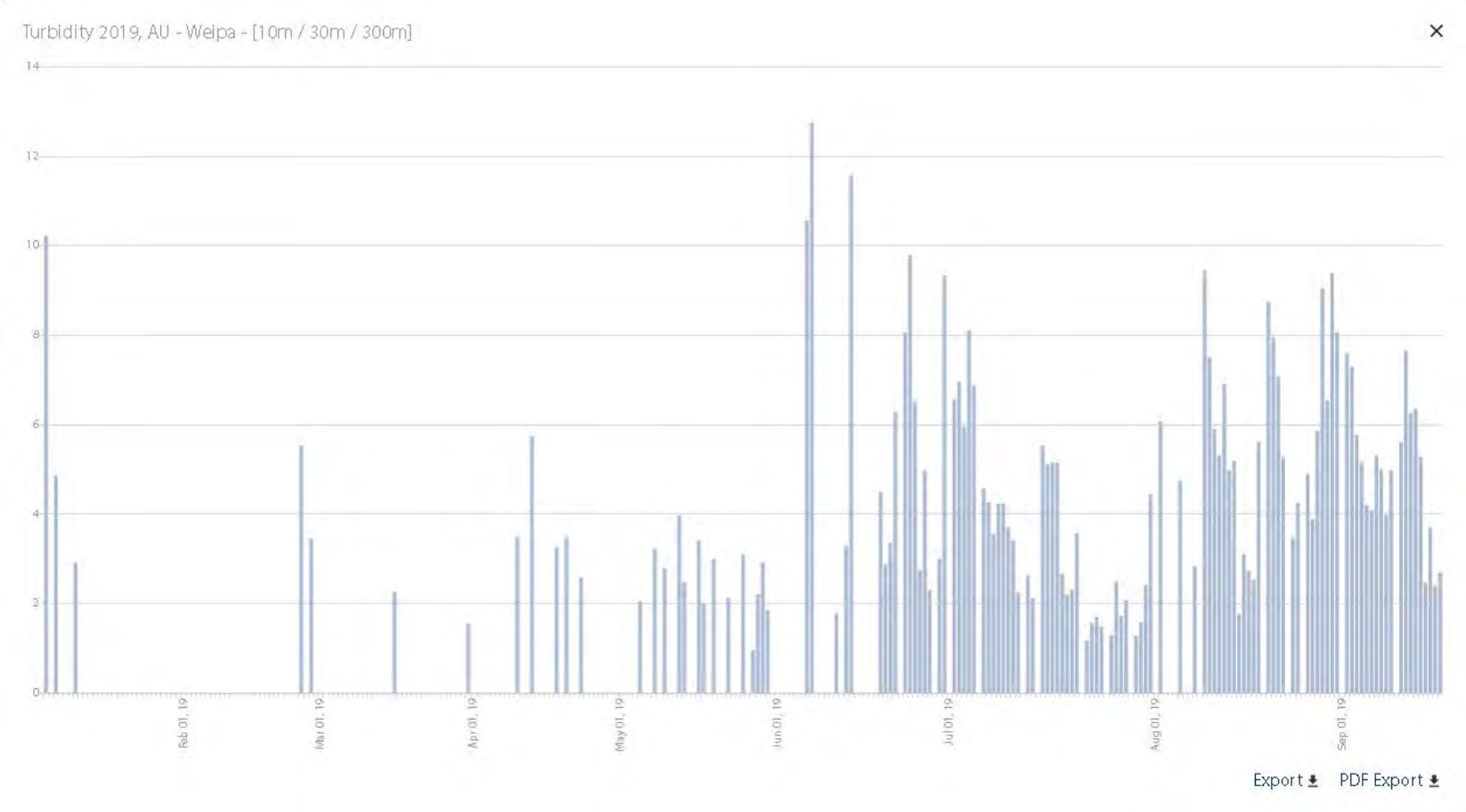


NORTH QUEENSLAND BULK PORTS CORPORATION

PORT & COASTAL SOLUTIONS

EOMAP detect more.

Turbidity Monitoring Port of Weipa



DredgingToday.com

MENU

Monitoring Dredging Plumes from Space

August 3, 2020, posted by savannahweeda

Emily Twiggs, Senior Project Scientist, EOMAP Australia

- https://www.linkedin.com/in/emily-twiggs-796989b5/
- www.eomap.com
- https://www.portandcoastalsolutions.com
- https://nqbp.com.au

EOMAP applies its satellite-derived turbidity monitoring capabilities to dredging programs run by the North Queensland Bulk Ports Corporation (NQBP).

Turbidity plumes are stirred-up sediment which can be transported long distances by currents. Understanding the full spatial and temporal variability of turbidity, whether from natural causes such as tidal currents and waves or from anthropogenic activity such as dredging, can be costly if done with in-situ monitoring. Typically, in-situ monitoring, although generally more precise, will be limited both temporally (from the time of installation and onwards) and spatially (point measurements). Furthermore, it requires mobilisation and ongoing maintenance of the equipment.

www.dredgingtoday.com/2020/08/03/monitoring-dredging-plumes-from-space/

EOMAP

detect more.

Turbidity Monitoring Hay Point

Client: PCS/NQBP, Australia

Task: Monitoring of nearshore dredging works at the Great Barrier Reef

Temporal frequency:

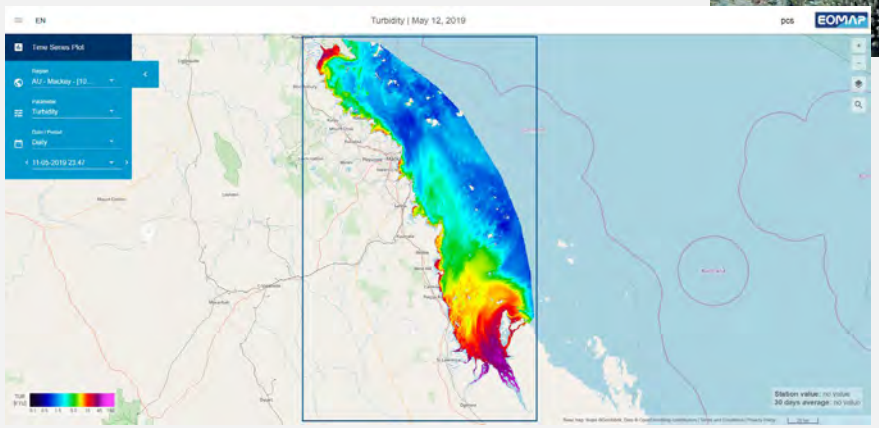
Up to several times a day with medium and high resolution sensors

Used Sensors:

Sentinel-2A/B (10m), Sentinel-3 A/B (300m), Landsat 8 (30m)

Parameters:

Turbidity and RGB



Time period:

Feb- May 2019

Delivery time

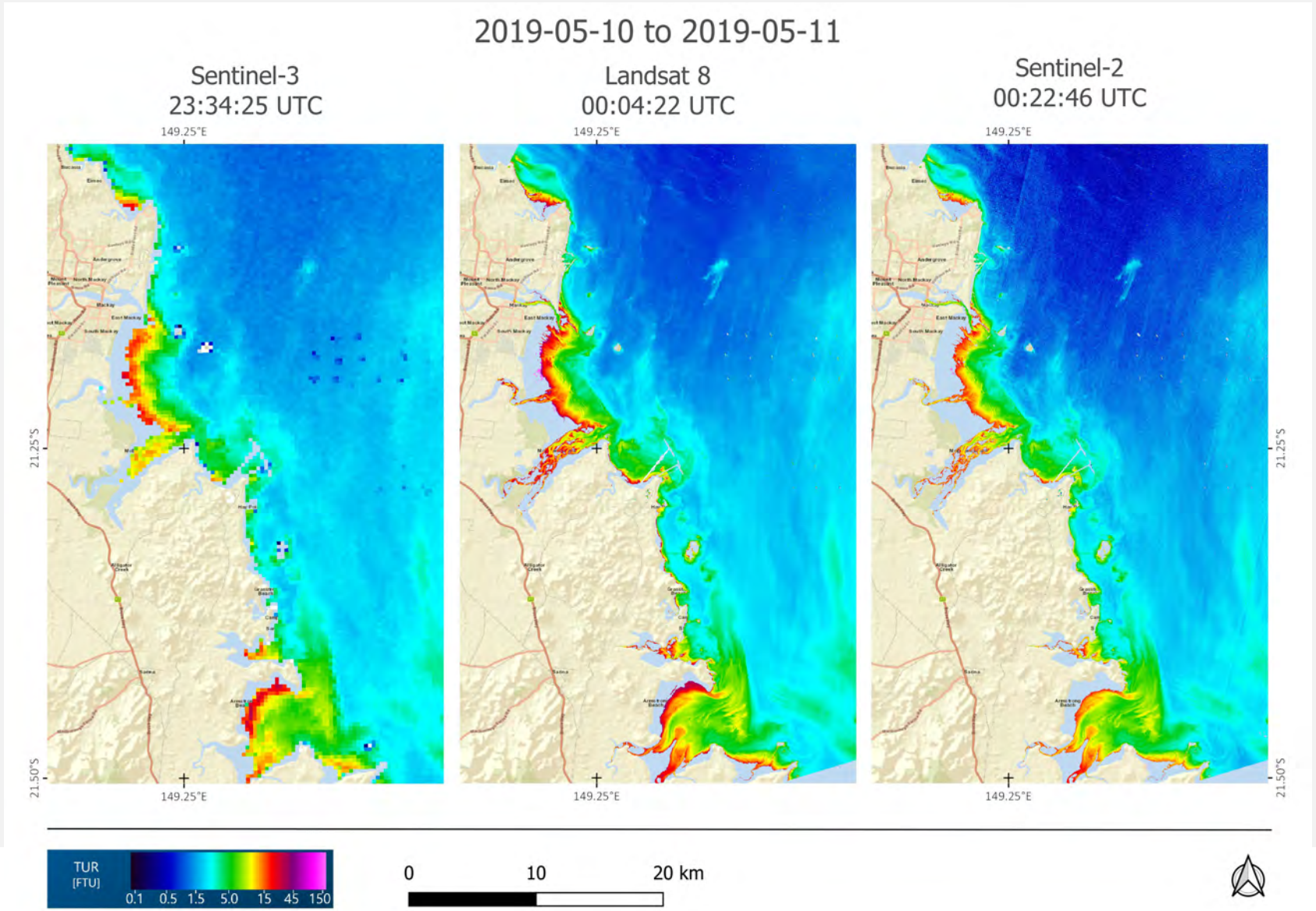
Between 3-12h (depending on data availability)

Delivery format

eoApp, GeoTIFF, Report

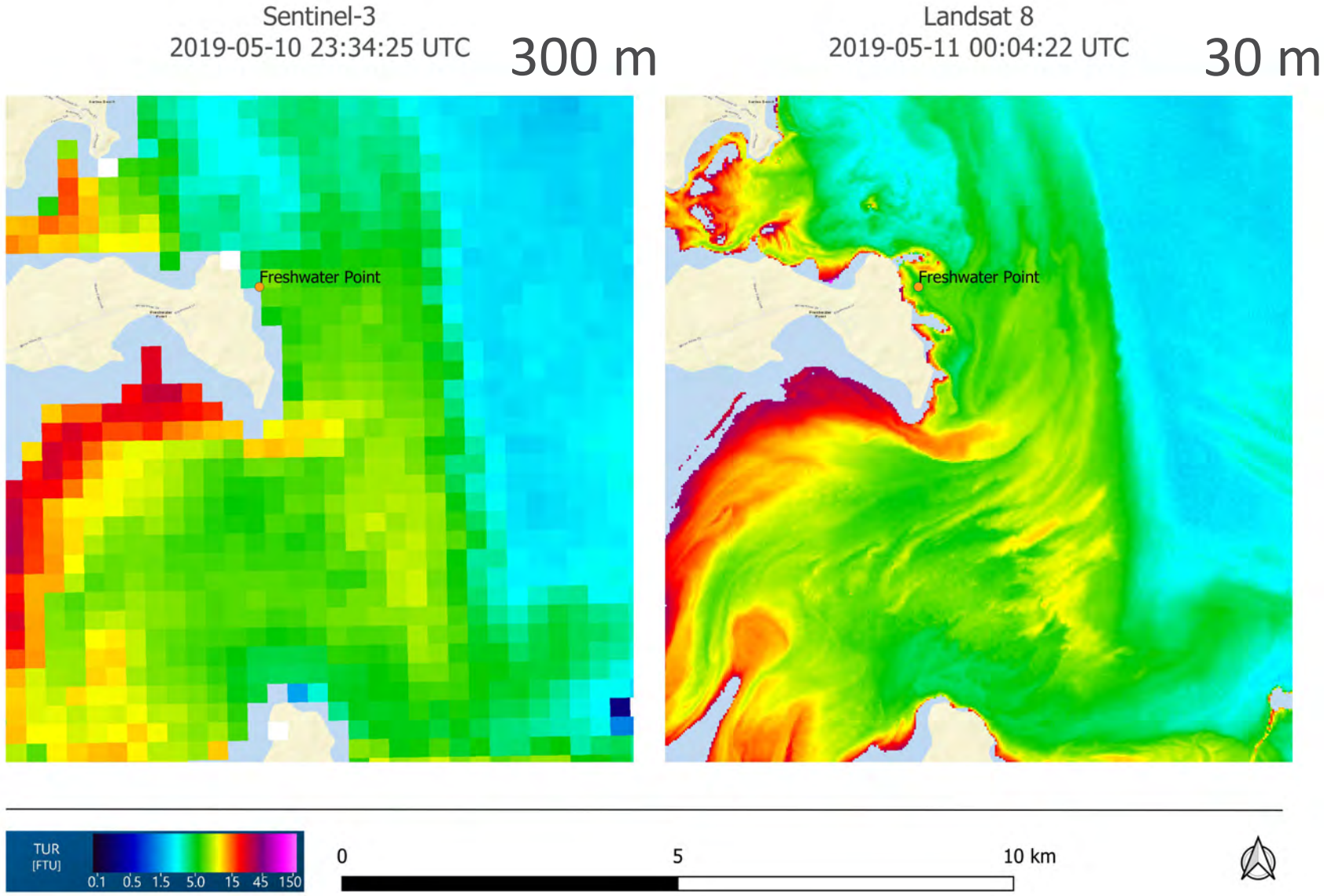
EOMAP
detect more.

Turbidity Monitoring Hay Point



EOMAP
detect more.

Turbidity Monitoring Hay Point



EOMAP
detect more.

Pipeline Construction Monitoring NordStream2

Client: NordStream2 AG

Task: Monitoring of pipeline construction Narva Bay

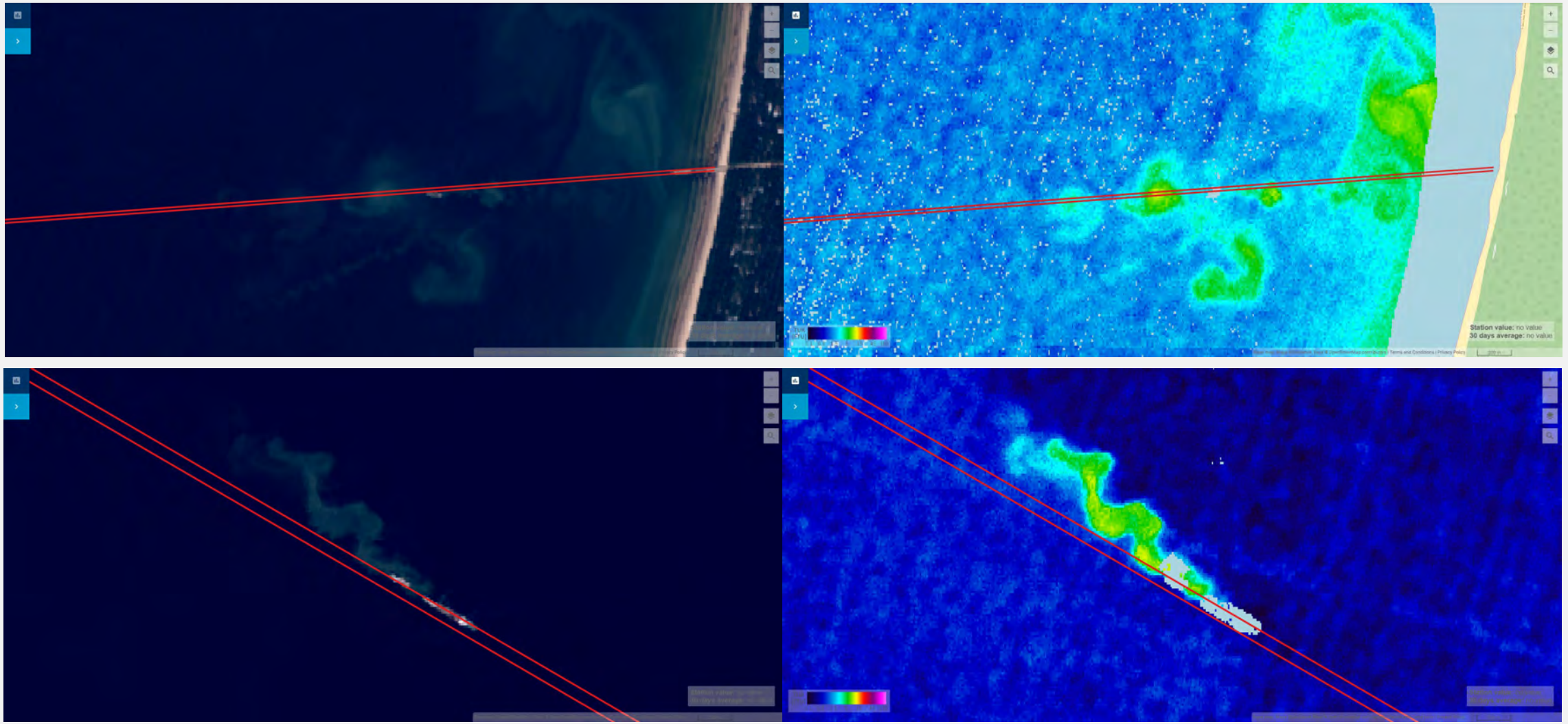
Key Features:

- ❑ up to every 2-3 days with high resolution sensors
- ❑ Sentinel-2A/B (10m), Sentinel-3 A/B (300m), Landsat 8 (30/15m)

  => 55 high/medium resolution images delivered
- ❑ Turbidity and calibrated Total Suspended Matter (based on in situ data)
- ❑ 2018 and 2019
- ❑ Online web application for easy access to the data

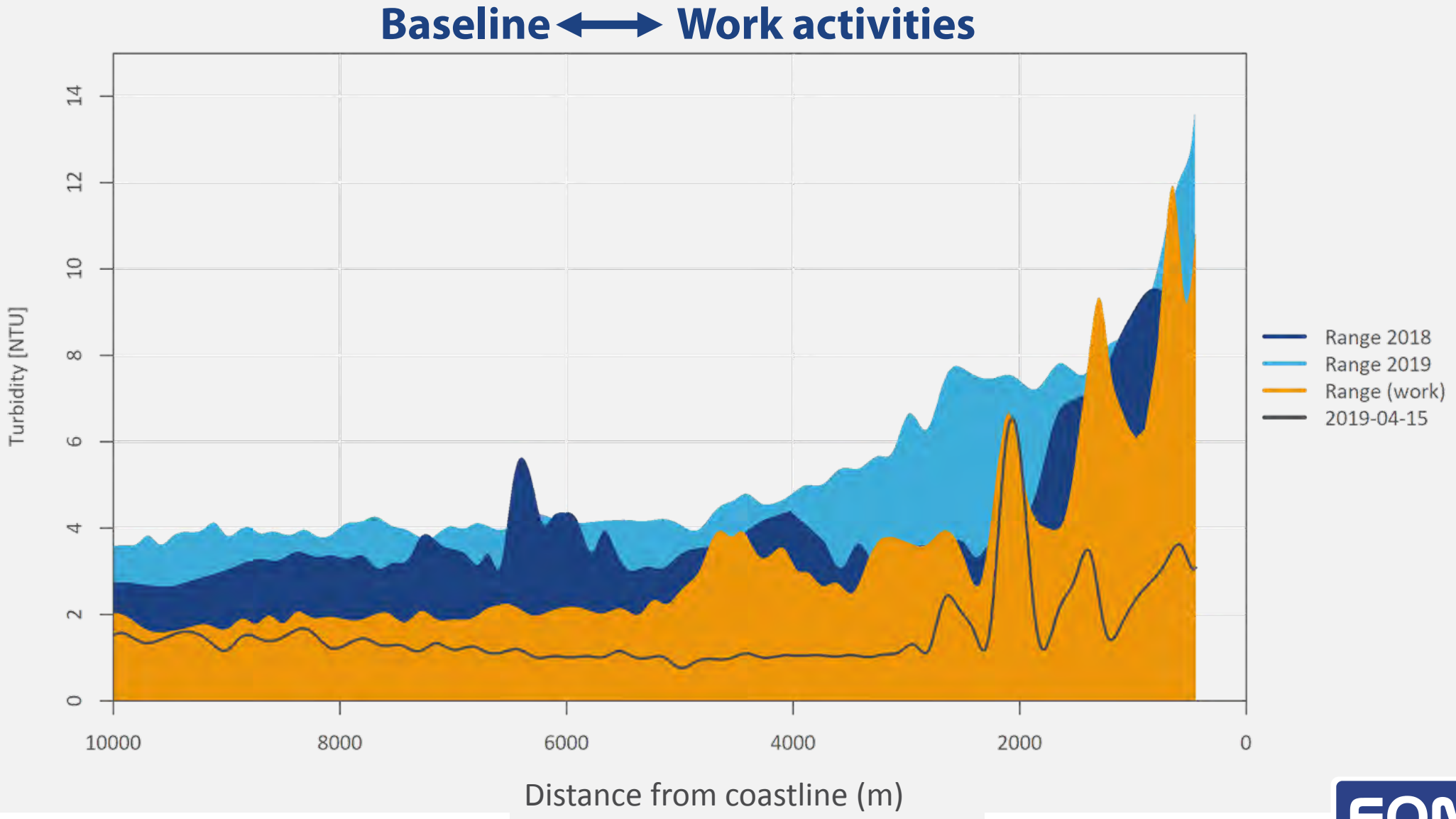
EOMAP
detect more.

Pipeline Construction Monitoring NordStream2



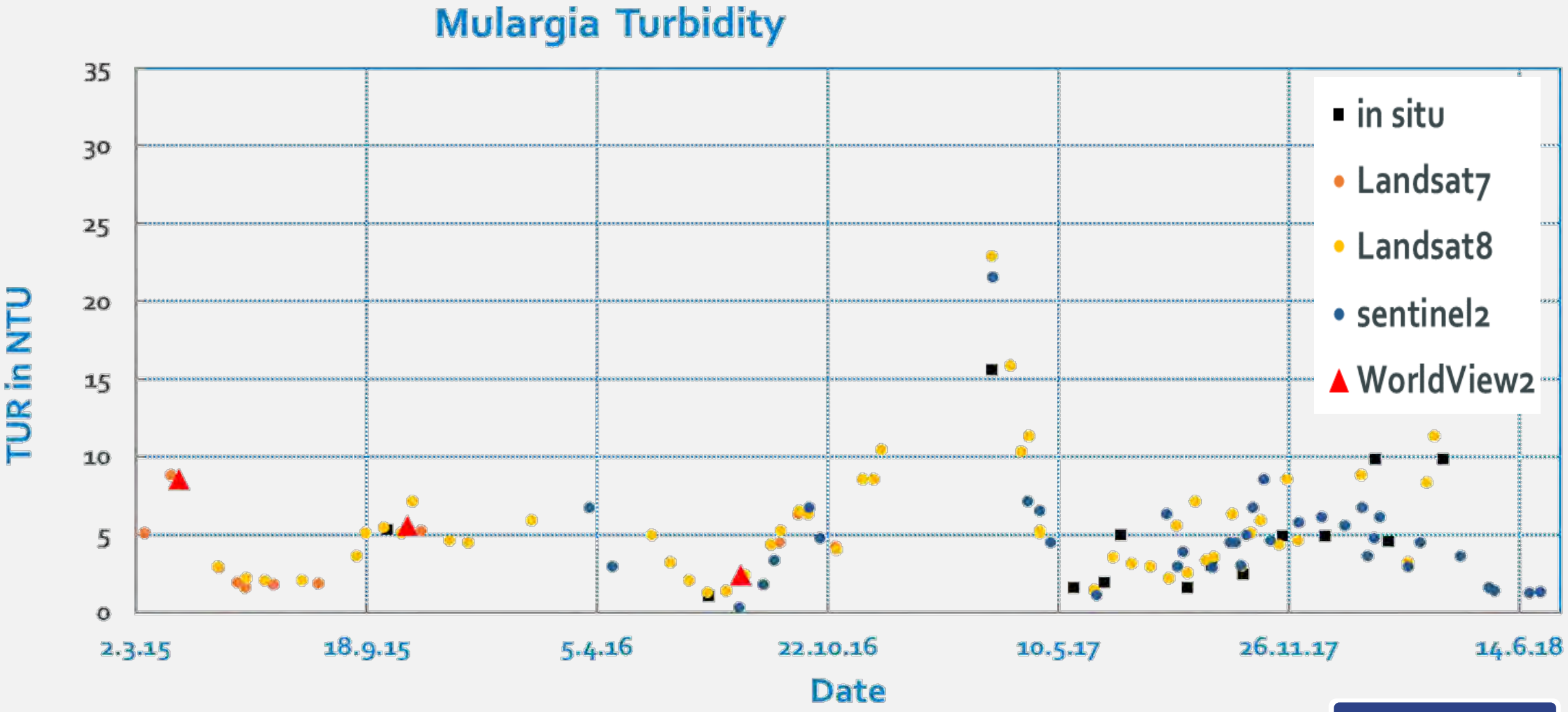
EOMAP
detect more.

Pipeline Construction Monitoring NordStream2



EOMAP
detect more.

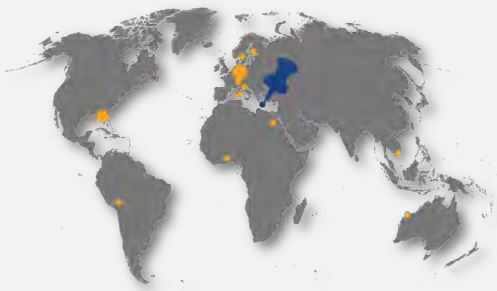
Turbidity Monitoring - Validation - Lake Mulargia, Italy

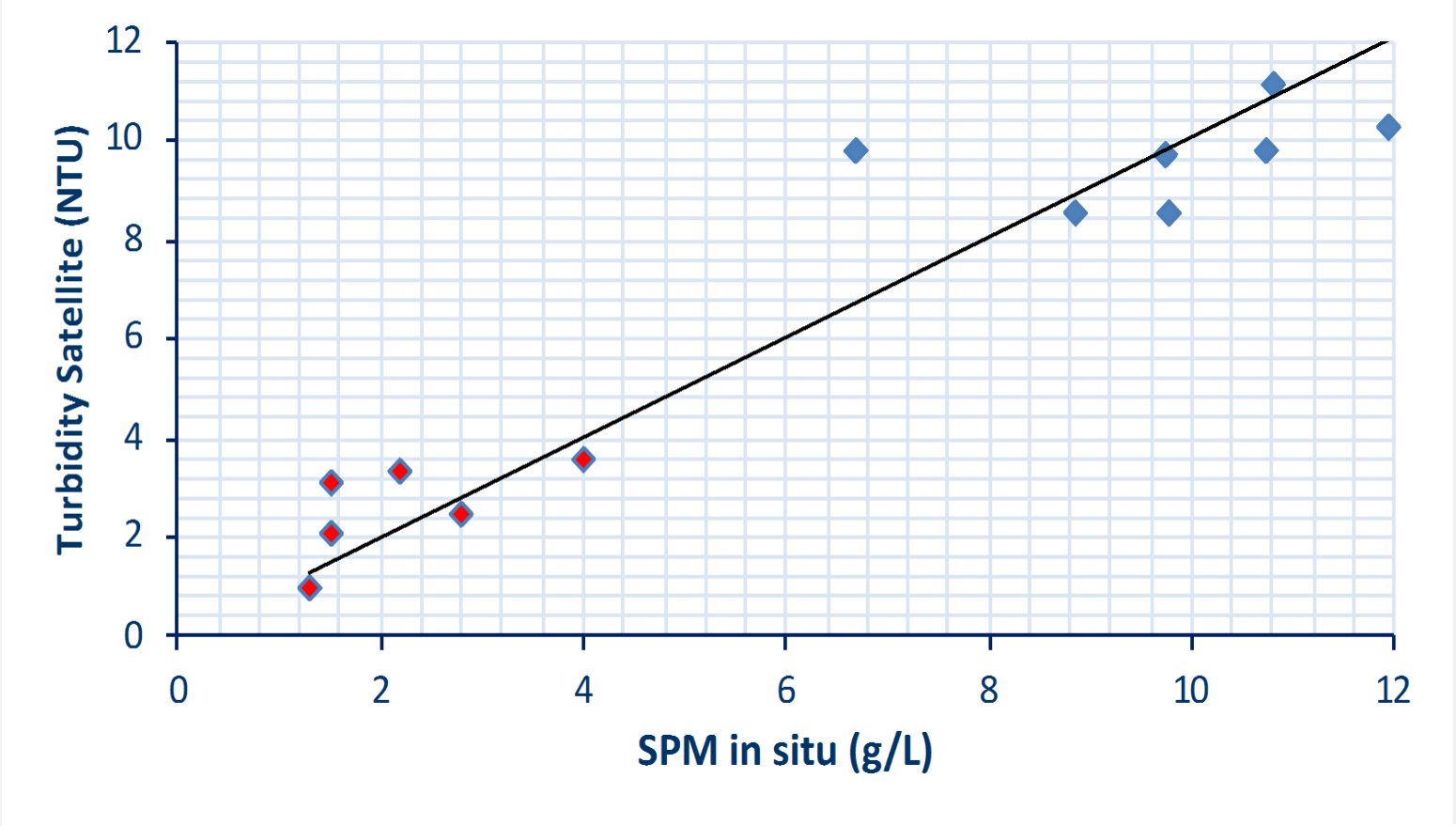


EOMAP
detect more.

Turbidity Monitoring - Validation Field Campaign

Parameter	RMSE	Slope	Intercept	R2	Av. In situ	Av. Sat
SPM (gL^{-1})/TUR	1.05	0.92	0.81	0.89	6.90	6.62





red diamonds are for Lake Mulargia, blue for Aposelemis dam

EOMAP
detect more.

Satellite-Derived Bathymetry – dredging phase

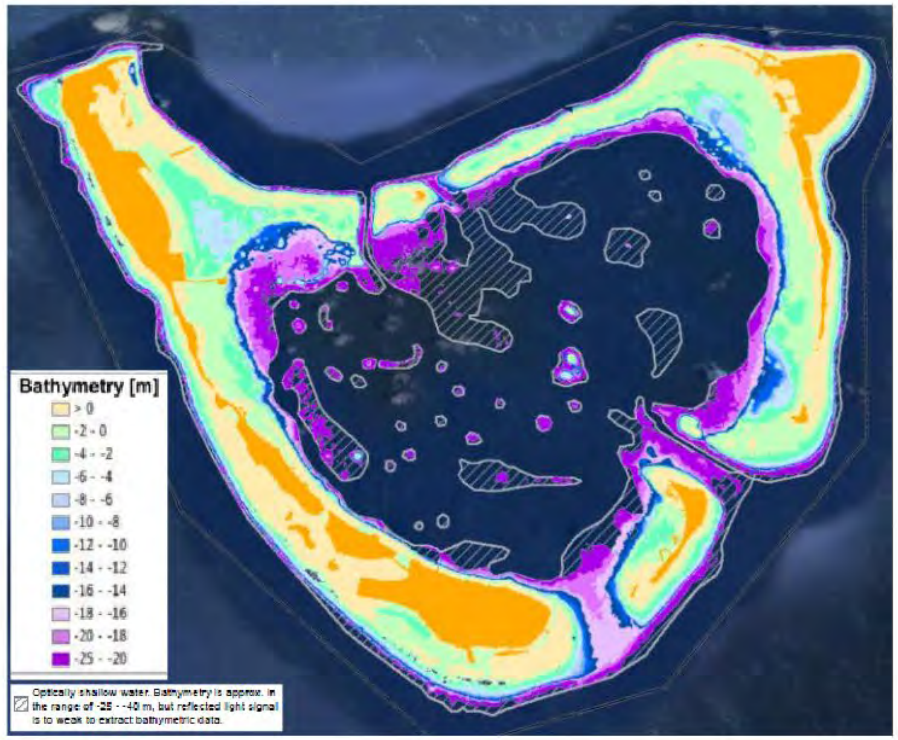
- Confirm safety of navigation
- Depth measure for sand dredging

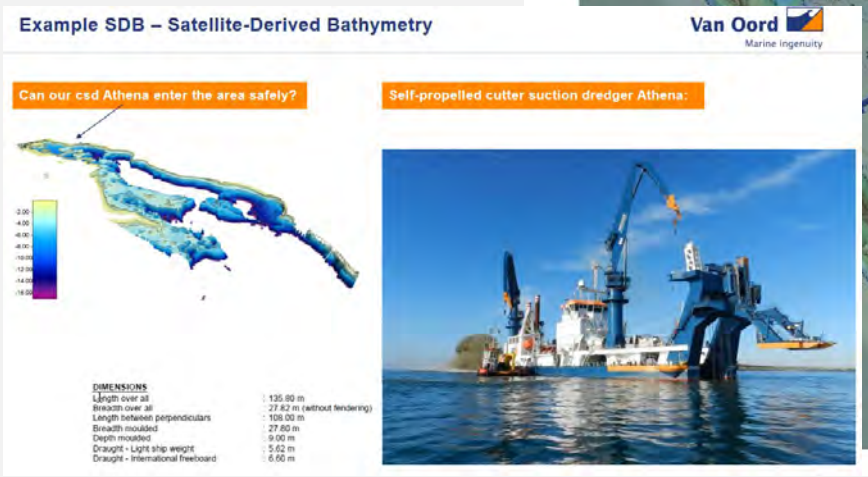
Example SDB – for planning purposes and safe navigation

Van Oord
Marine ingenuity

As obtained from existing electronic charts

As provided by EOMAP, area in total 200 sq km !!!!!





Frans Pijpers (VanOord)- http://sdbday.org/download/342/

EOMAP
detect more.

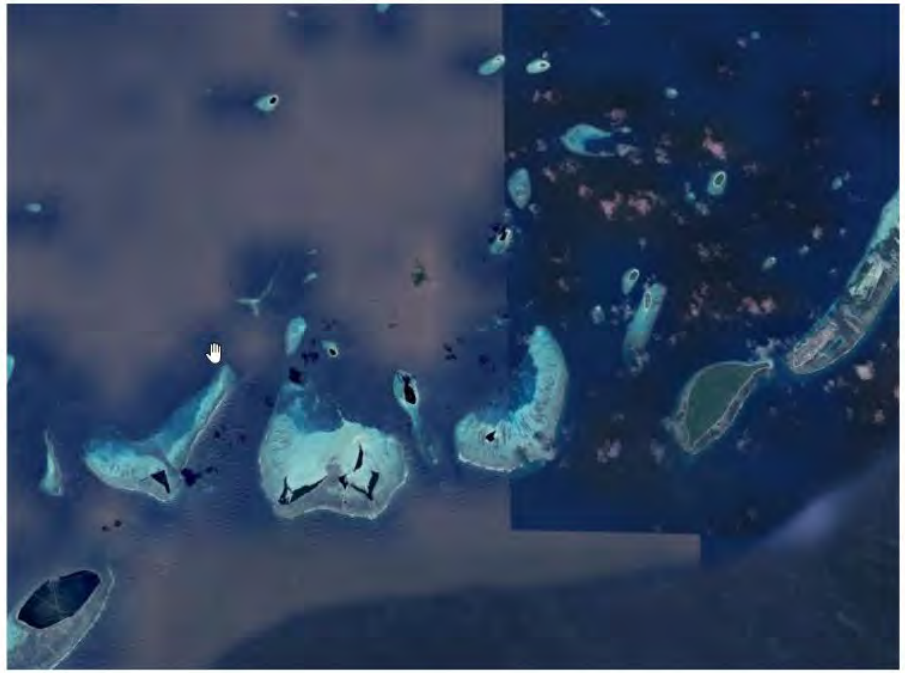
Seafloor Classification – dredging phase

- Identification of potential sandy layers
- Reduction on environmental impact

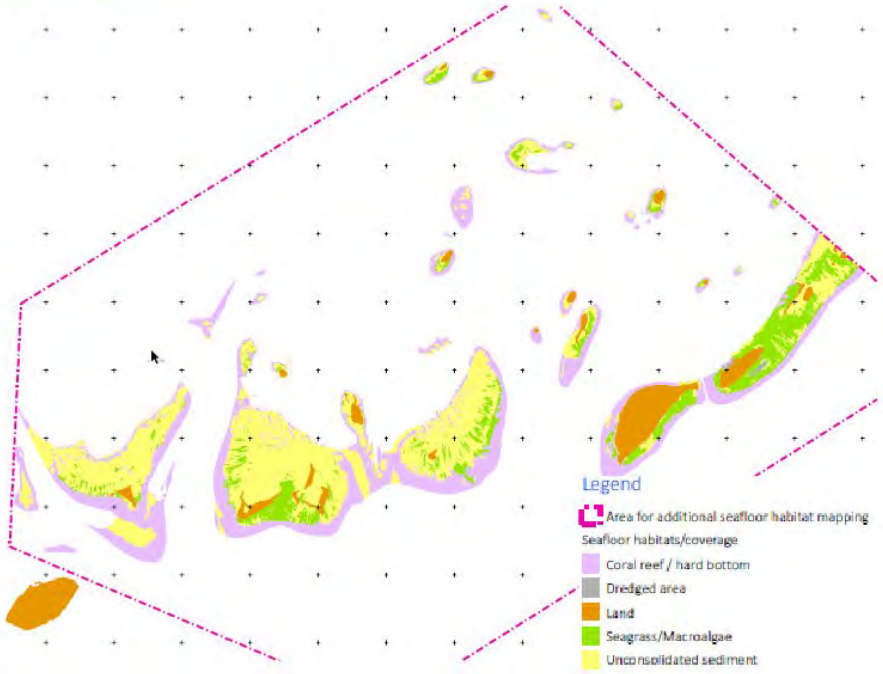
Example Google Earth and matching SFC

Van Oord
Marine ingenuity

Google Earth snapshot



SFC



EOMAP
detect more.

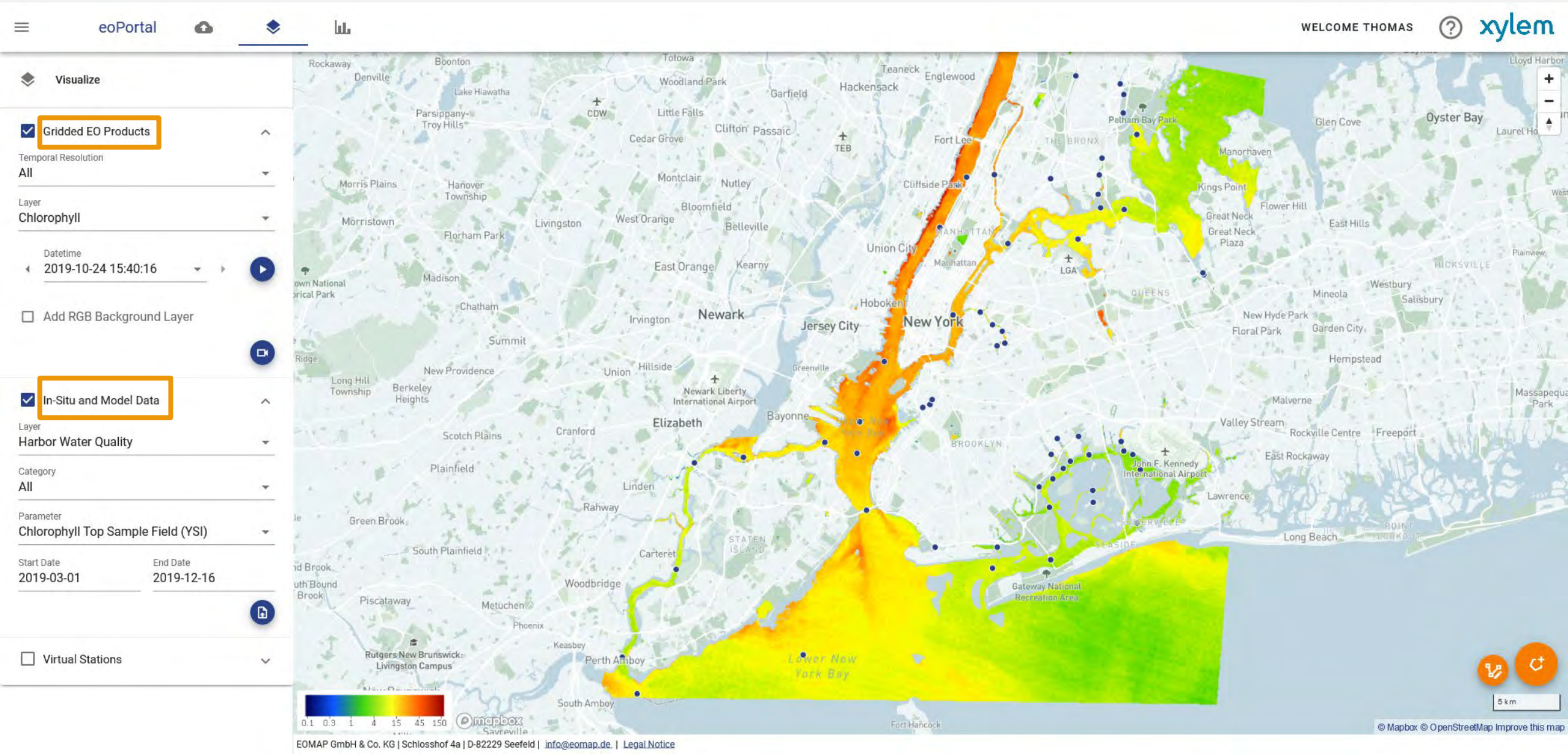
Seafloor Classification – tendering phase

- To support cost estimation during tendering phase
- Reduction on environmental impact

Frans Pijpers (VanOord)- http://sdbday.org/download/342/

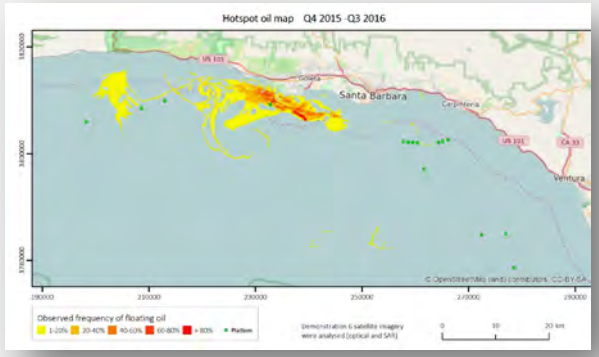
EOMAP
detect more.

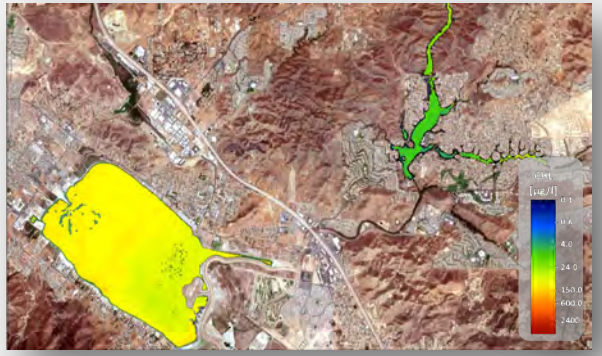
Data Access: eoPortal

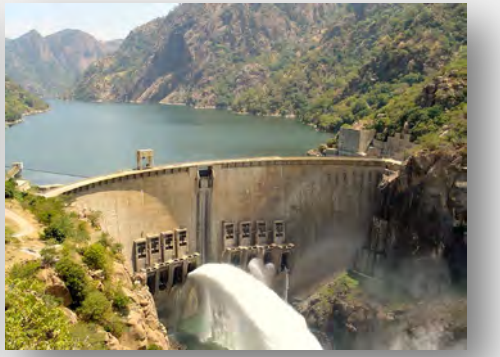


EOMAP Water Quality – Other uses

- Routine water monitoring for regulatory agencies:
  e.g. Mozambique Cahora Bassa, USA Water Sheds Auth., Lactec Brazil, German agency LUBW
- Disaster Impact assessment of Rio Doce disaster in Brazil
- Impact Monitoring of desalination plants in USA, Cyanobacteria in Germany
- Hydropower planning: e.g. Georgia river system for Stucky and Ministry of Energy
- Oil spill monitoring
- Wind farm construction monitoring







detect more.

Summary

- Validated aquatic products worldwide in optimal spatial/temporal resolution
  - proven by global project experiences and enabled through sensor-agnostic approach
- Quickly and easy data access
  - of very high-resolution data sets on web portals
- Targeted solutions for turbidity monitoring and environmental assessments
  - using multiple information layers
- Cost savings in testing requirements and reduction of risk

EOMAP
detect more.

Thank you!

edward.albada@eomap.com
+1-805-335-0495

eomap.com