

HAZRUNOFF

PROJECT

Pollution detection and flood alerting using remote sensing

EOMAP

Christian BÖDINGER
Karin SCHENK



Funded by
European Union
Civil Protection
and Humanitarian Aid

Structure

I. Introduction

Satellite sensors, resolution, data availability

EOMAPs contribution to HazRunOff

II. Detecting Pollution and Flooding from Space

State-of-the-art

HazRunOff results: Water coverage, turbidity and oil spill monitoring products

III. Using Drones in Pollution Mapping

What to expect from drone pollution mapping?

Research and example projects

IV. Conclusions and Outlook

Summary of capabilities, limitations and advantages

Future developments

About EOMAP

- Mapping & monitoring aquatic environments worldwide
- Founded in 2006 with HQ in Germany and office in Australia
- Service provider for coastal and offshore industry, academia and govern. entities
- Top ranked framework provider for UK Hydrographic Office
- Award winning cutting edge technology



EU SME
champion



Copernicus awards for
outstanding technology



Geospatial world
award winner 2017



Information
Program Partner



Solution
partnership



Data
Provider



The Ocean...



www.eomap.com

02/06/2020

MEETING

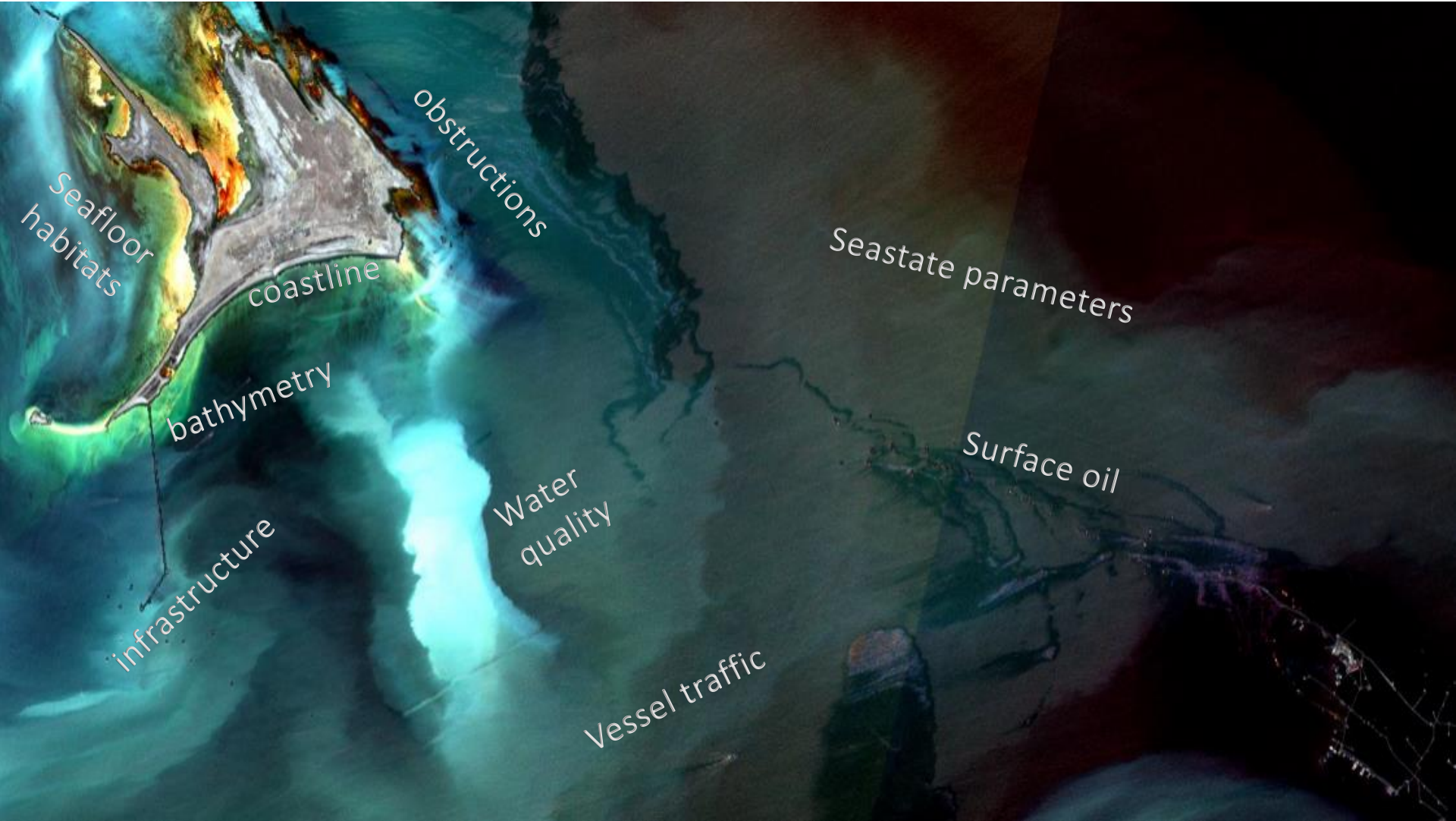


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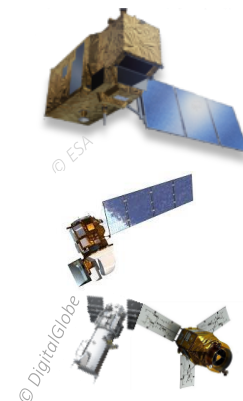
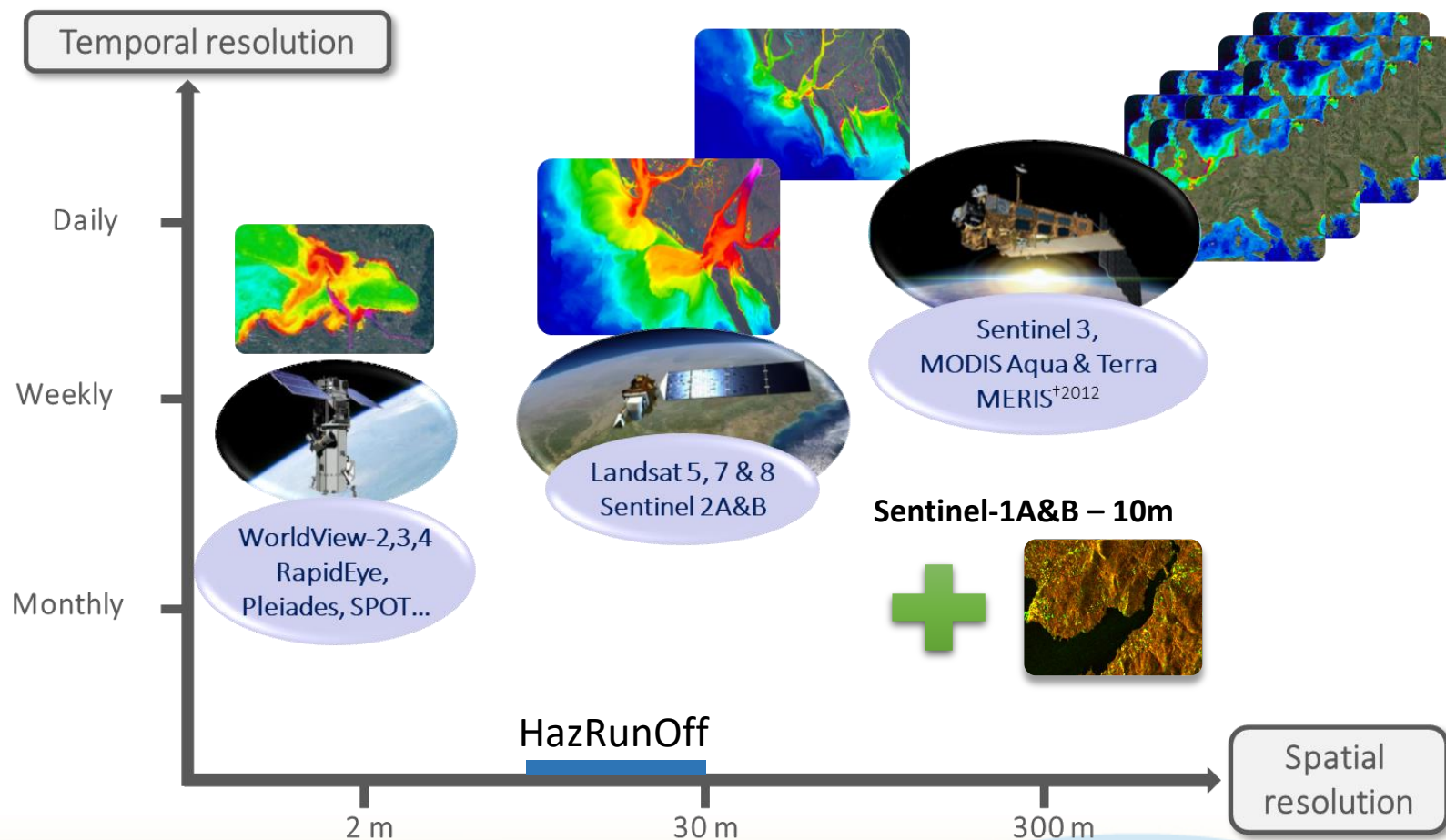


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... a sea of possibilities for remote sensing



Satellite missions frequently used

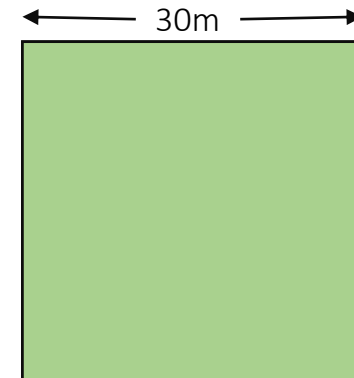


Landsat 8

Satellite owner	NASA/USGS
In orbit since	early 2013
Data policy	free&open data policy

Technical specifications

Spatial resolution	30m, 100m, 15m depending on wavelengths/bands
Spectral bands	11 bands
Revisit time	16 days

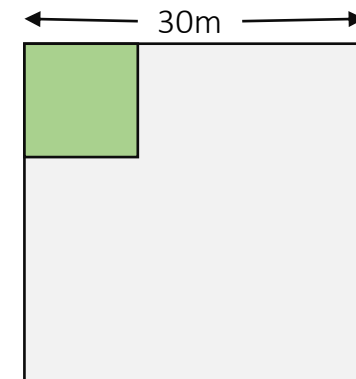
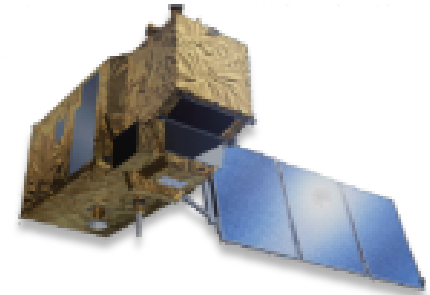


Sentinel 2a and 2b

Satellite owner	European Space Agency
In orbit since	mid 2015 (Sentinel 2a), end 2016 (Sentinel 2b)
Data policy	free&open data policy

Technical specifications

Spatial resolution	10m, 20m, 60m depending on wavelengths/bands
Spectral bands	13 bands
Revisit time	3-5 days



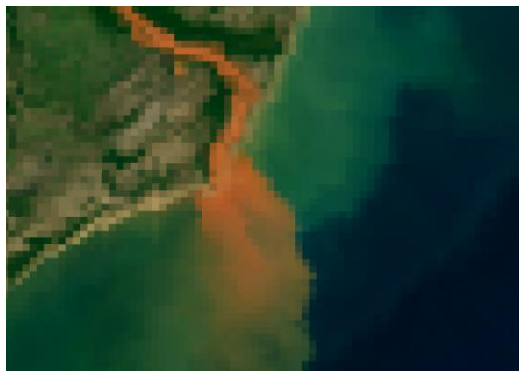
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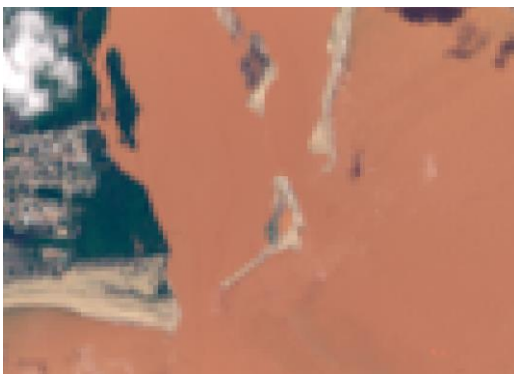
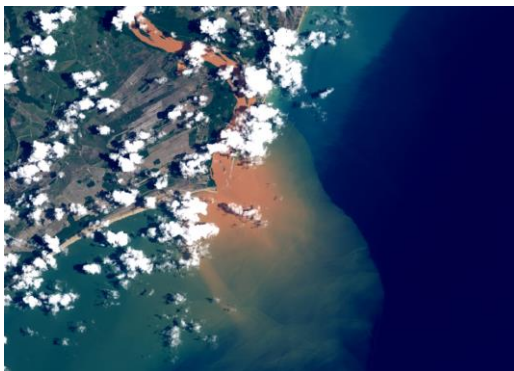
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Spatial resolution matters

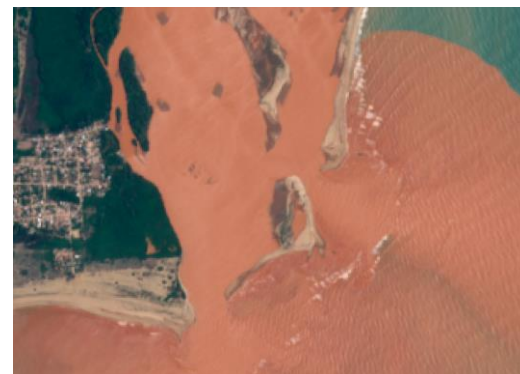
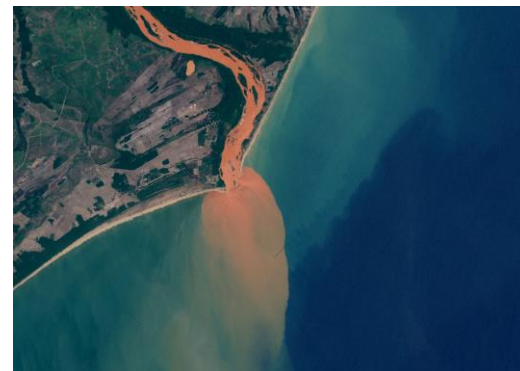
MODIS (500m)



Landsat 8 (30m)



Sentinel-2 (10m)





Optical:

- Sentinel-2 – 10m
- Landsat 8 – 30m



Some Pros:

- *Intuitive („true color“)*
- *Spectral information*

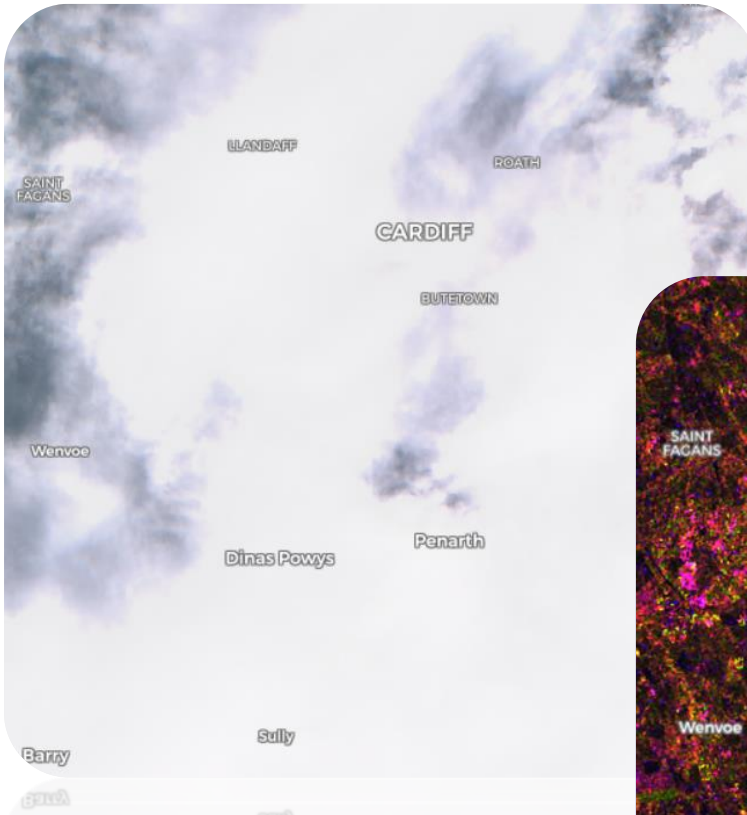
The Con:

- *Cloudiness*



... simply use Radar!

Sentinel-1 C-Band Radar

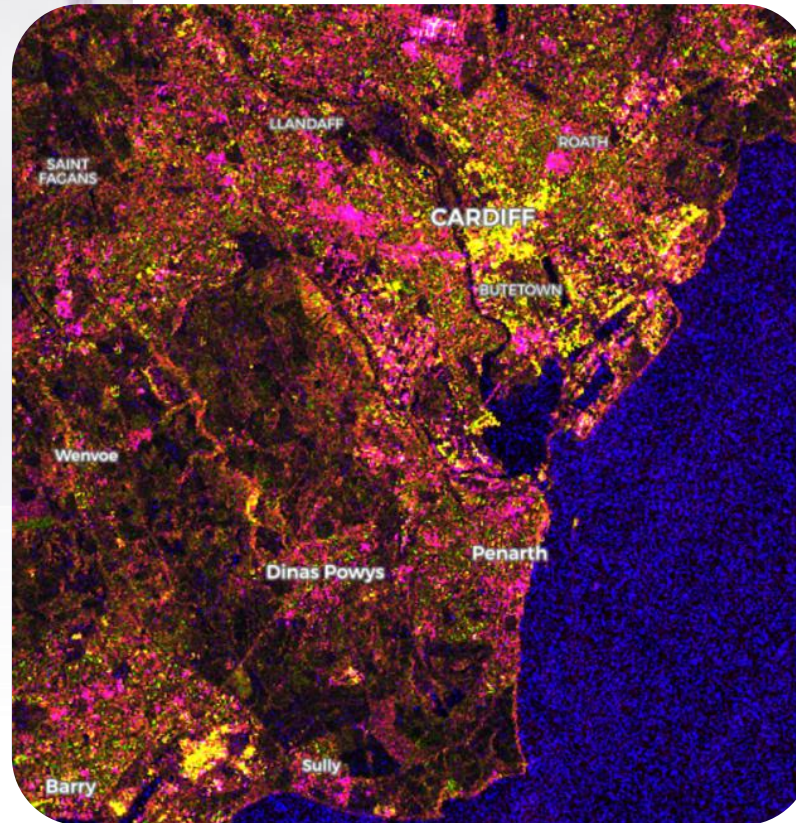


Sentinel-2 Optical



Images every
2-3 days!

02.06.2020



Images every
1-2 days!

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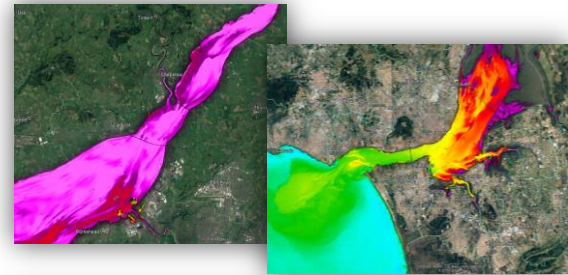


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Our tasks in HazRunOff

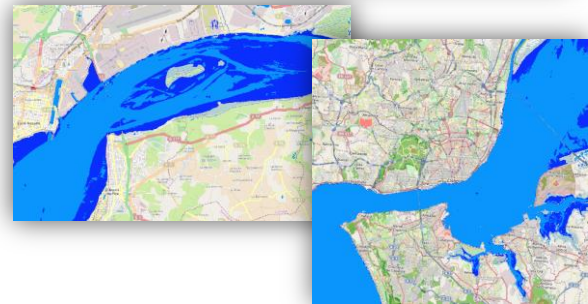
1. Turbidity

Monitoring Turbidity in river estuaries



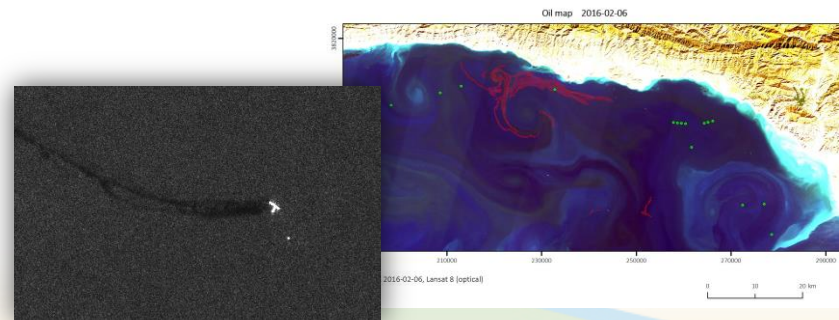
2. Water Level and Extent

Monitoring Water Level and Extent with both optical and radar satellites



3. Oil and Chemical Spill

Working towards an improved Oil and Chemical detection system



II. Detecting Pollution and Flooding from Space

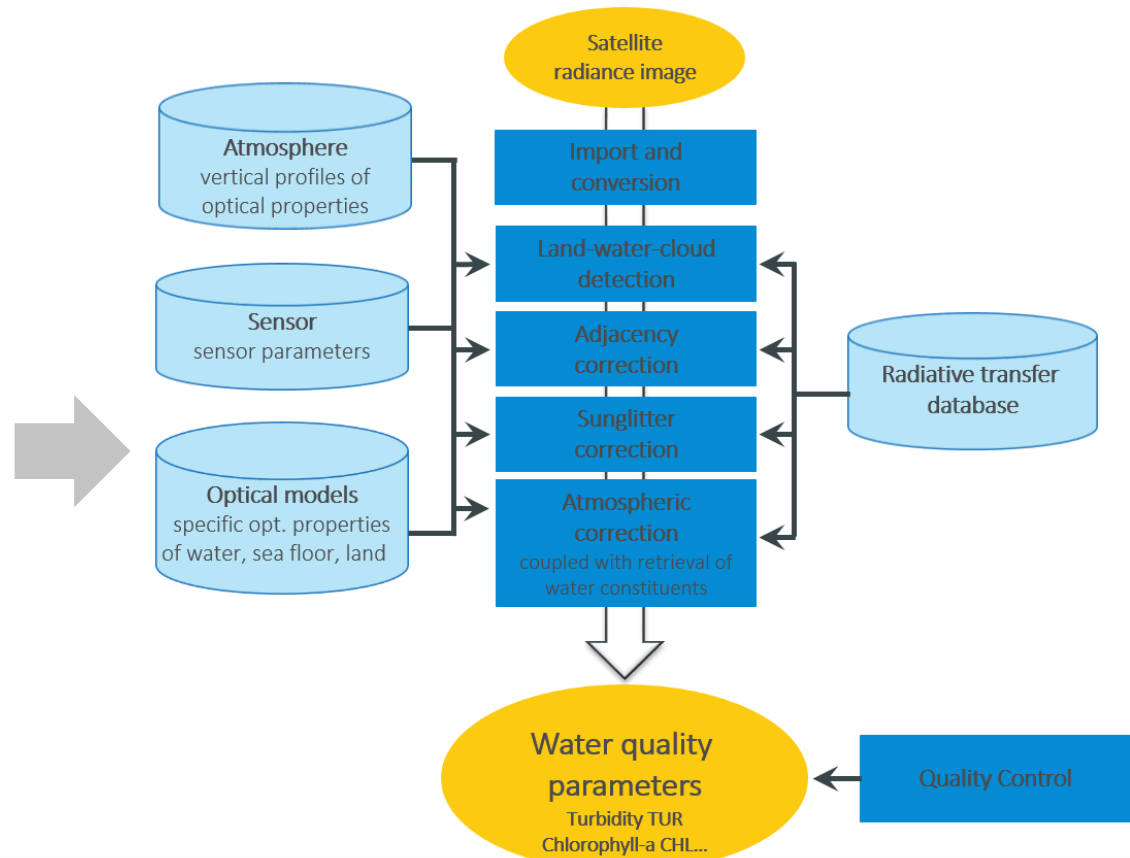
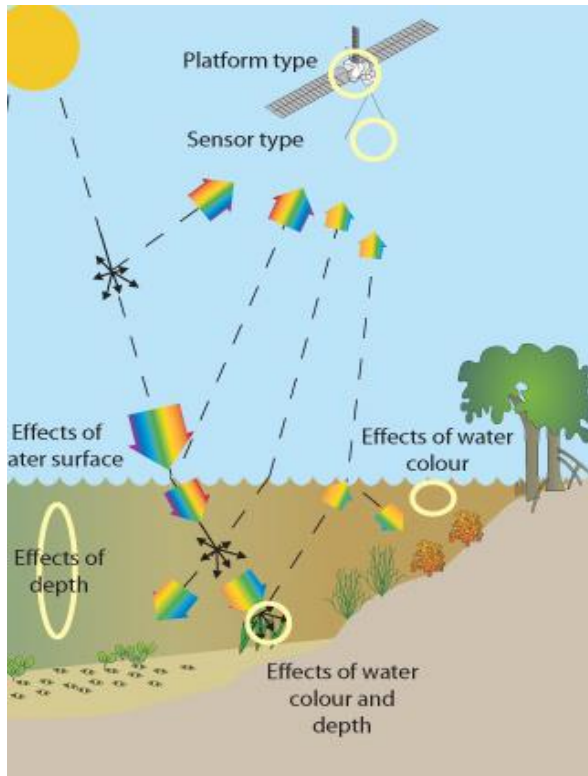


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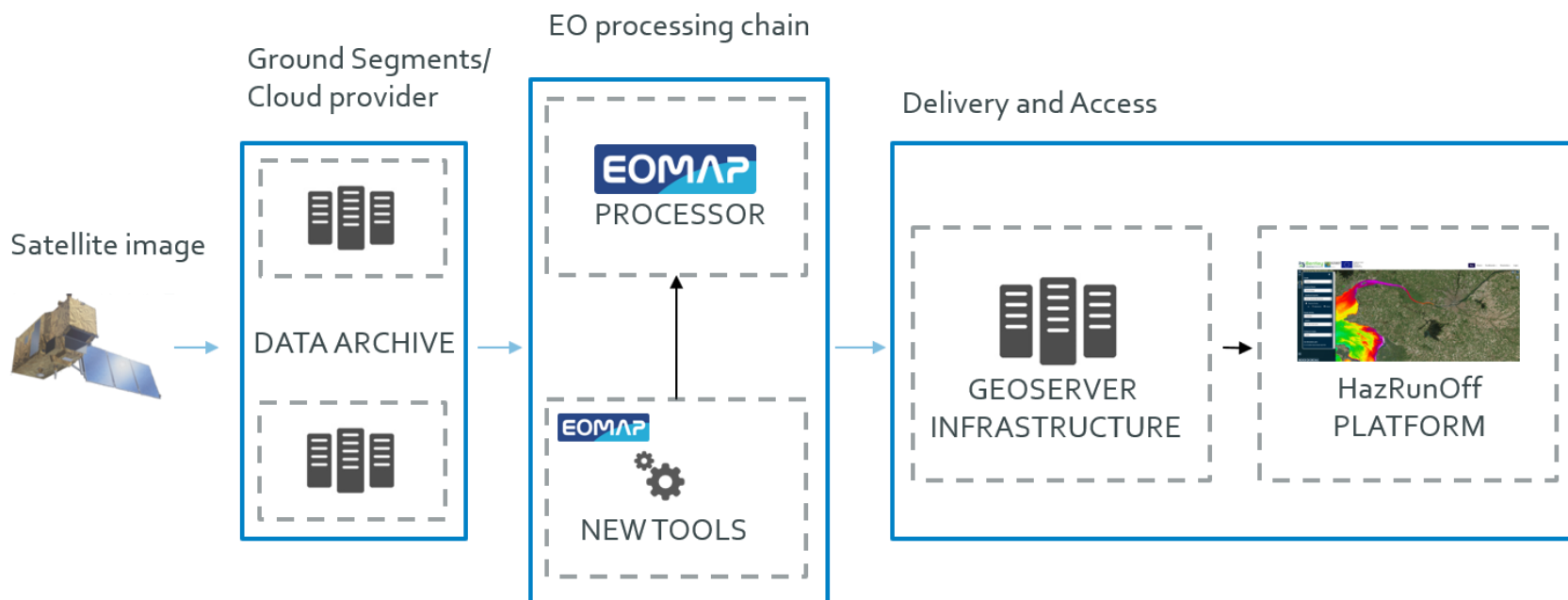


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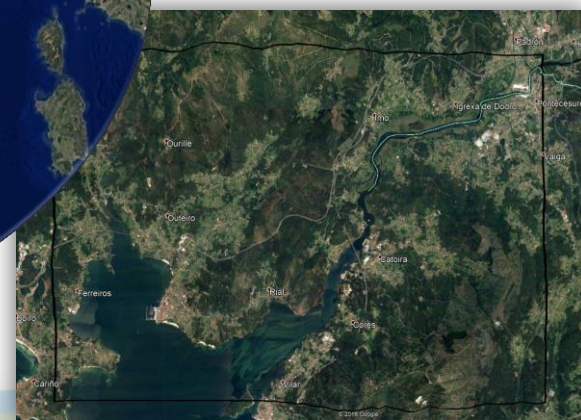
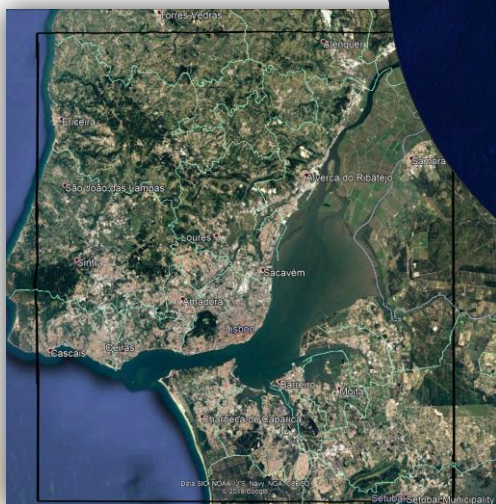
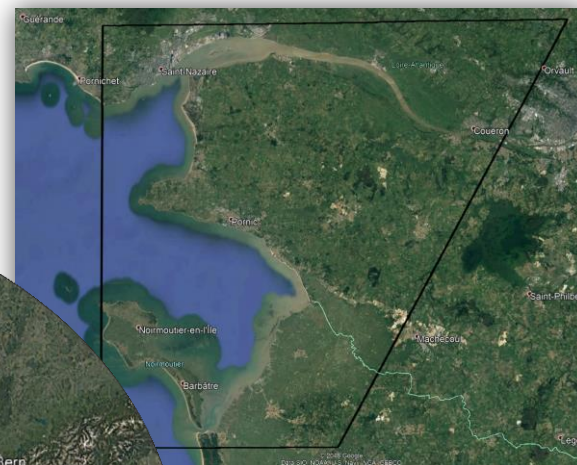
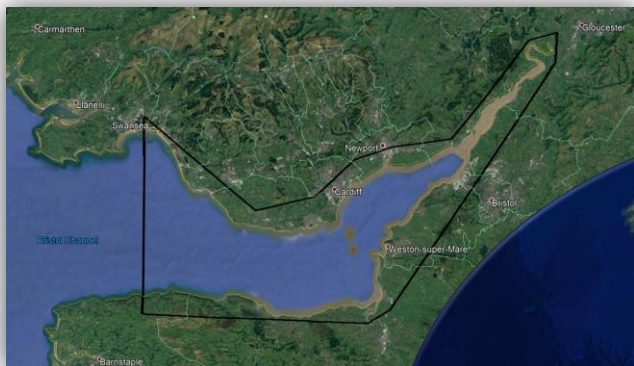
Physics based models for Water Quality assessment



From space to the user



Monitoring for HazRunOff



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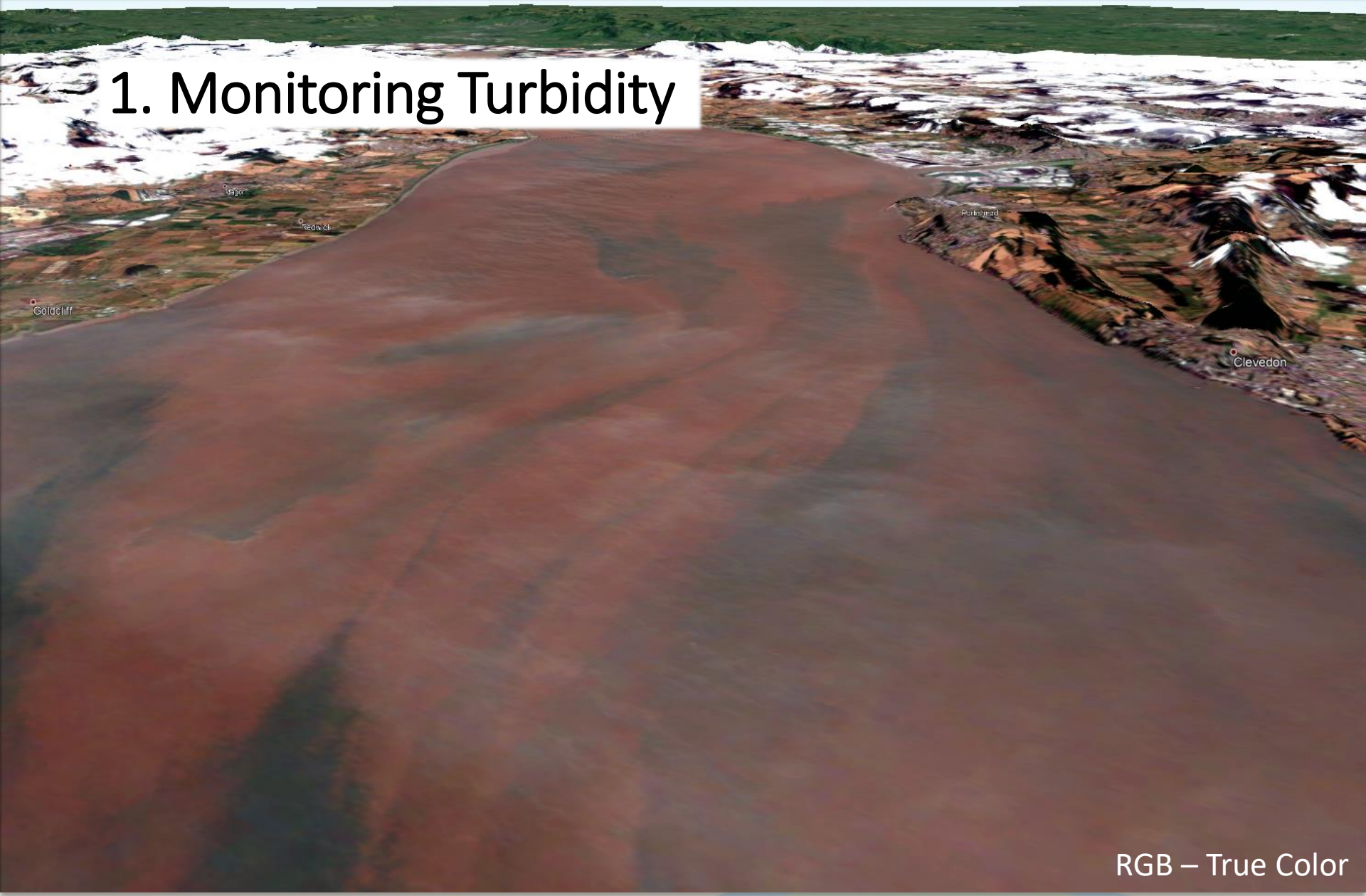


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1. Monitoring Turbidity



RGB – True Color

Severn Estuary – Close to Cardiff

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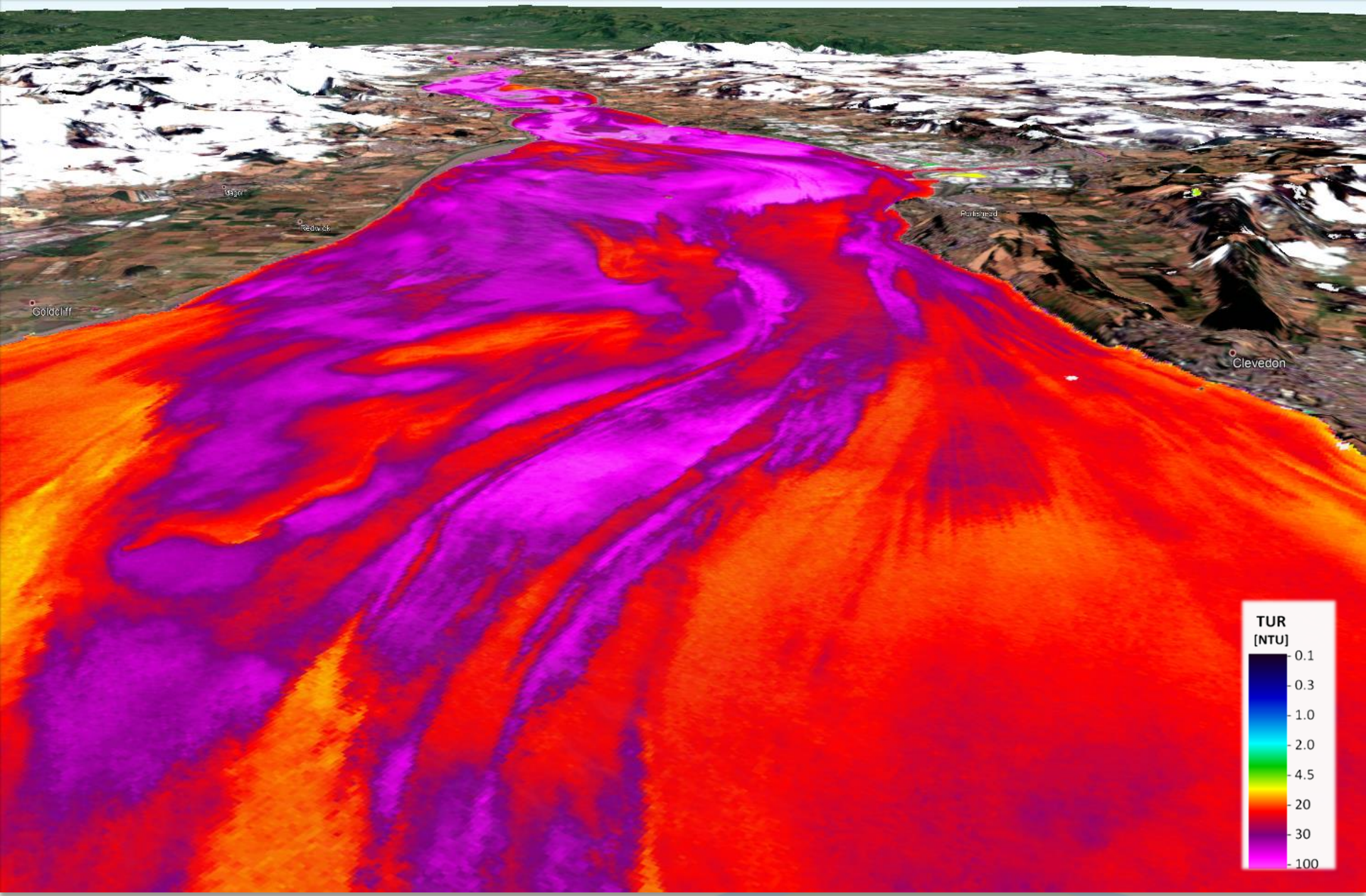
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Severn Estuary – Close to Cardiff

02/06/2020

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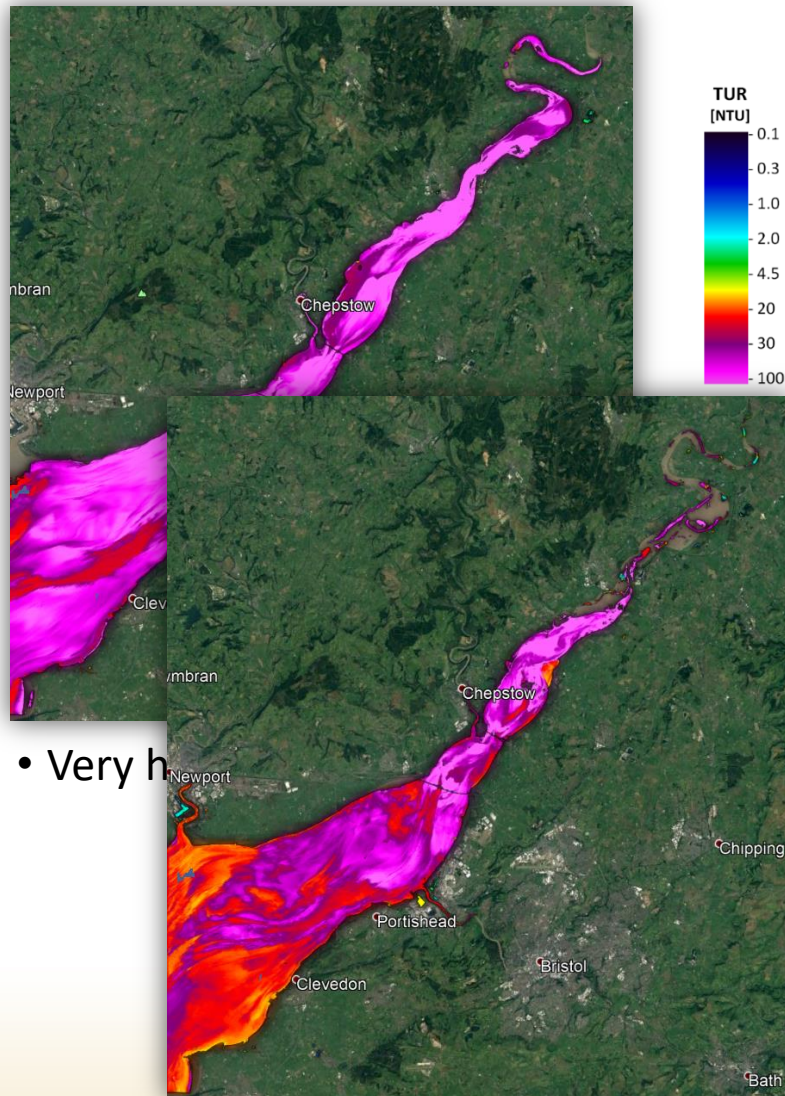


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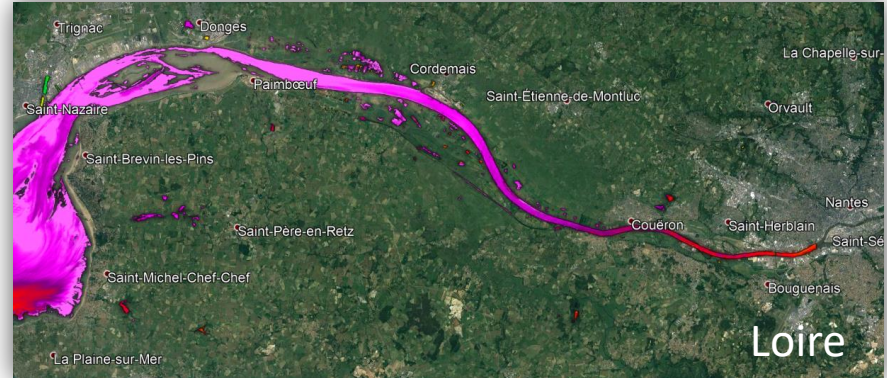


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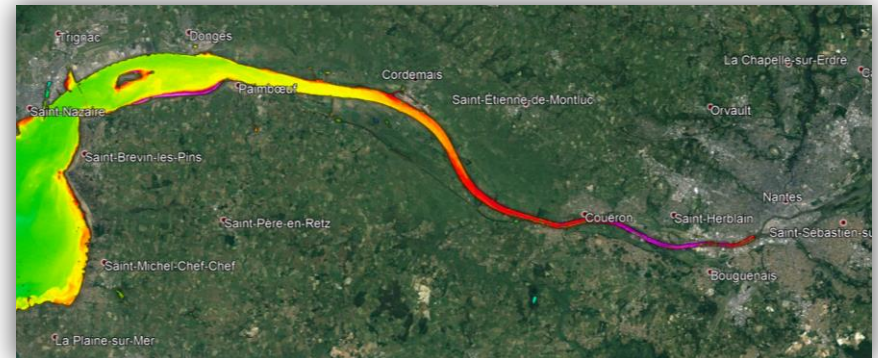
Monitoring over Time and Tide



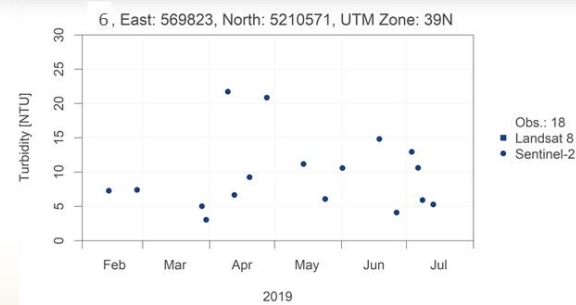
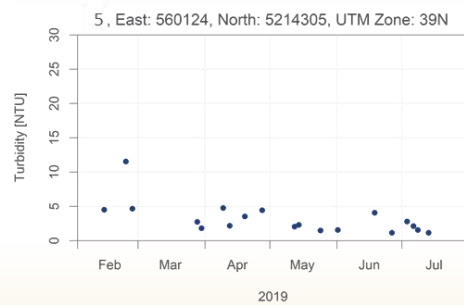
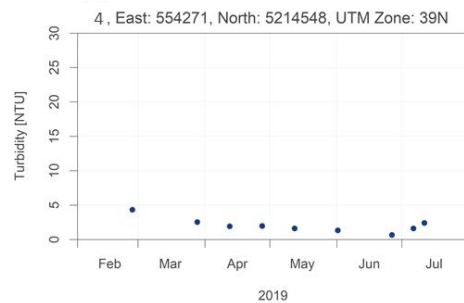
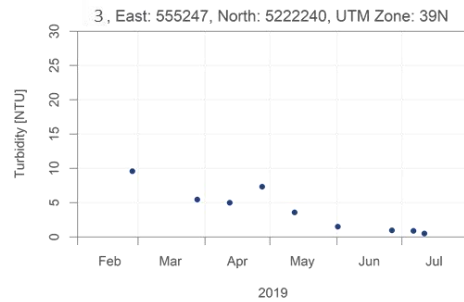
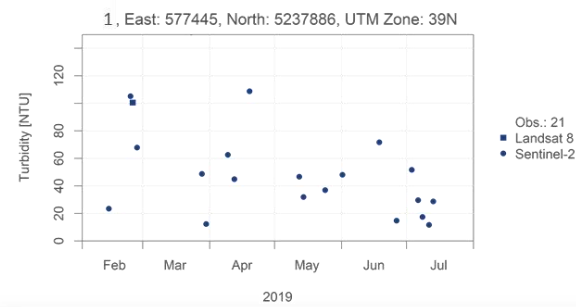
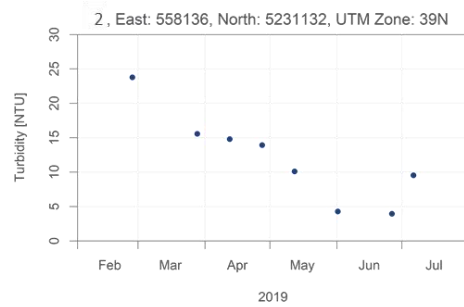
- High tidal range (~6m)



Low tide



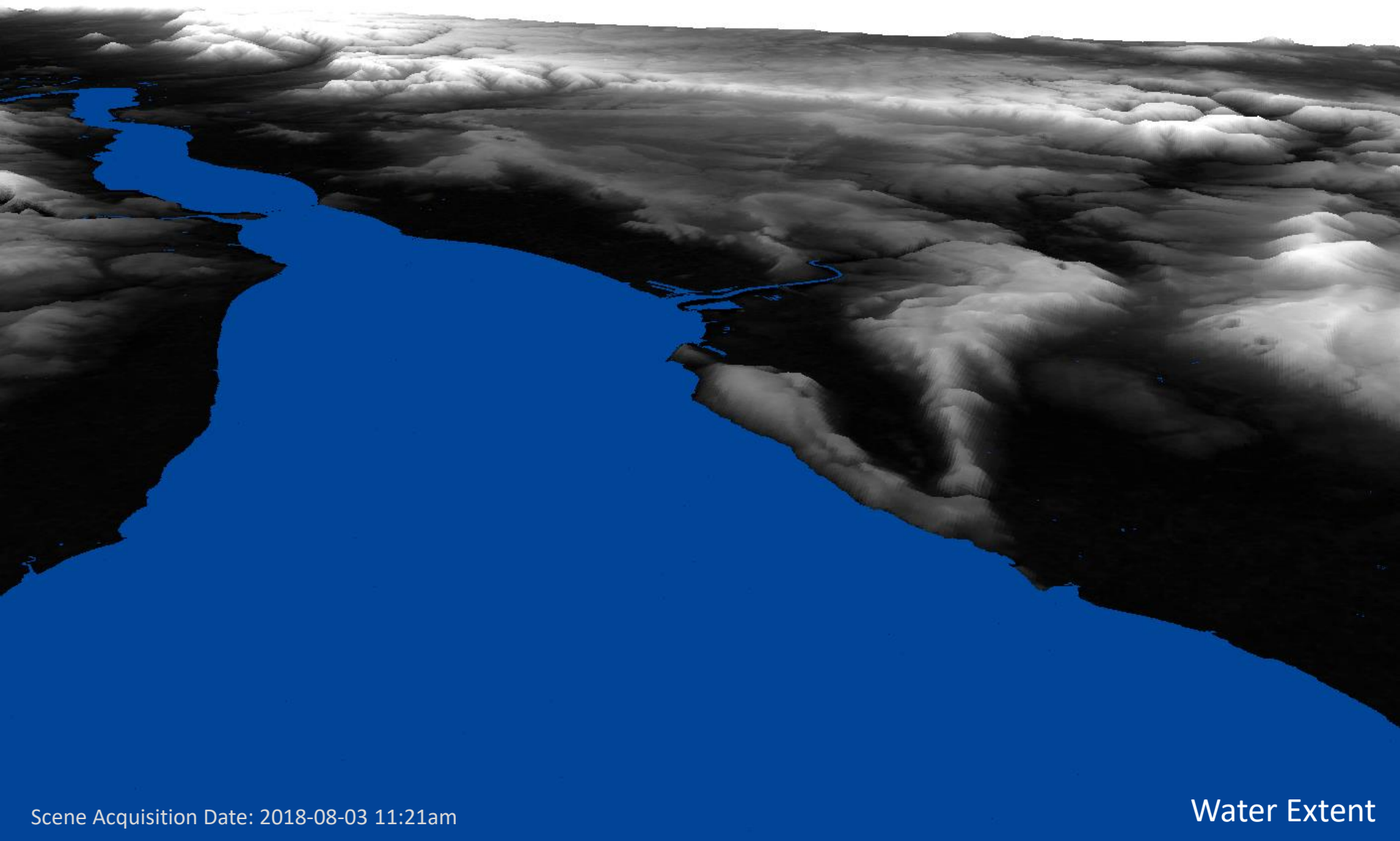
High Tide



Different turbidity regimes in the Loire estuary

2. Monitoring Water Extent

■ Tidal height: 10.2m (Station: Newport)



Scene Acquisition Date: 2018-08-03 11:21am

Water Extent

Severn Estuary – Close to Cardiff

02/06/2020

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2. Monitoring Water Extent

■ Tidal height: 10.2m (Station: Newport)

■ Tidal height: 7.7m (Station: Newport)

Bristol



Scene Acquisition Date: 2018-07-21 11:09

Water Extent

Severn Estuary – Close to Cardiff

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MEETING

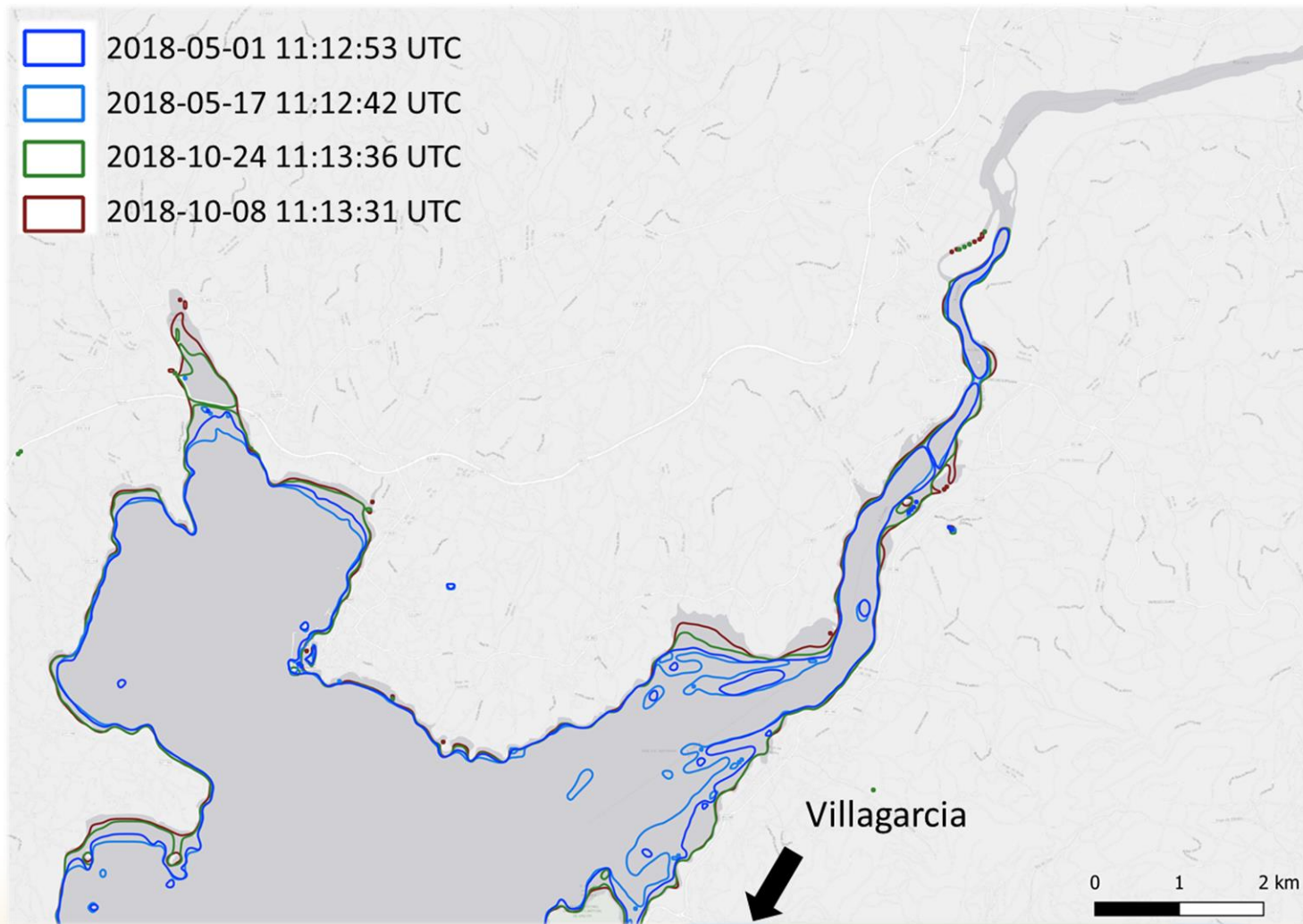


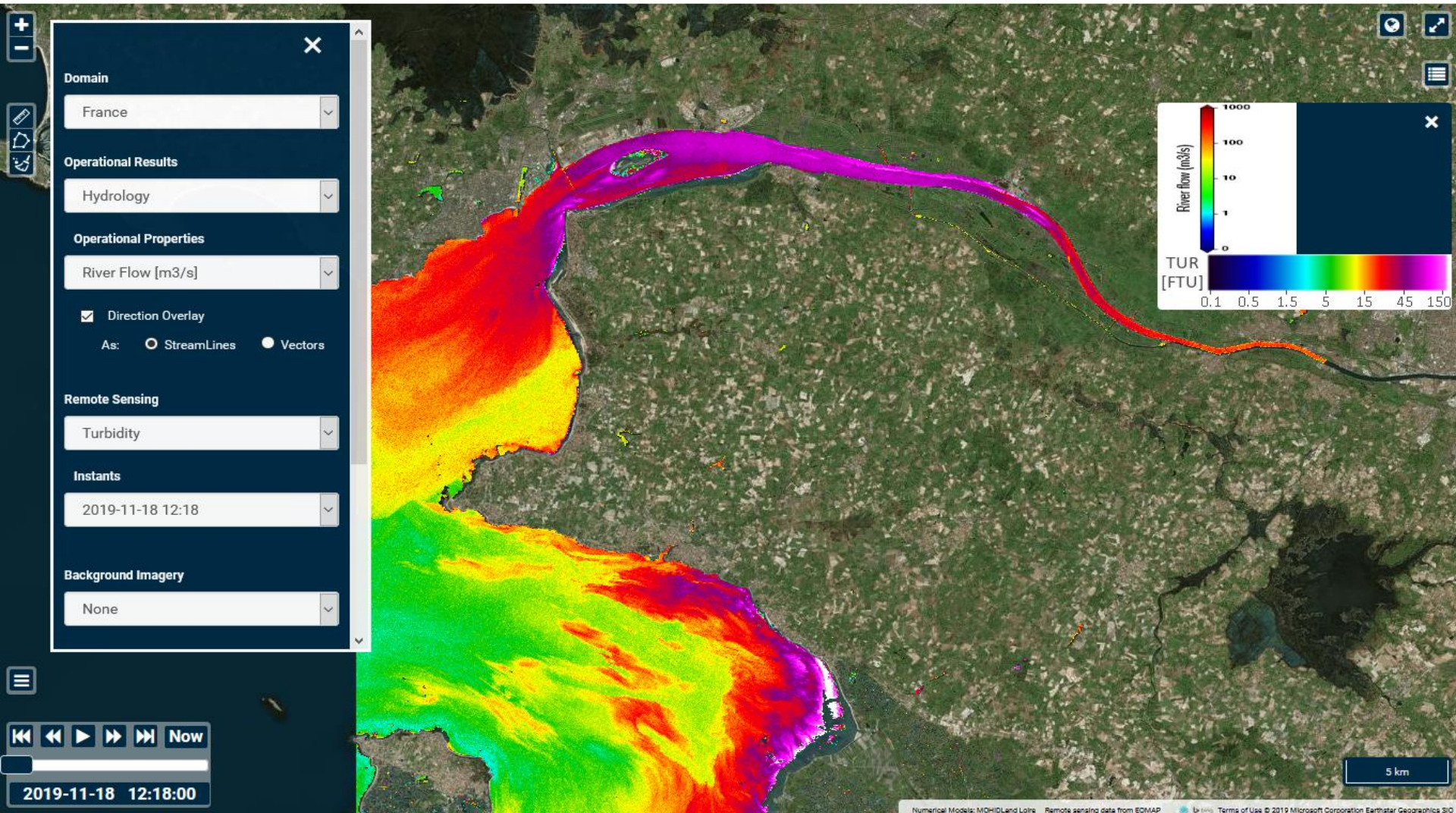
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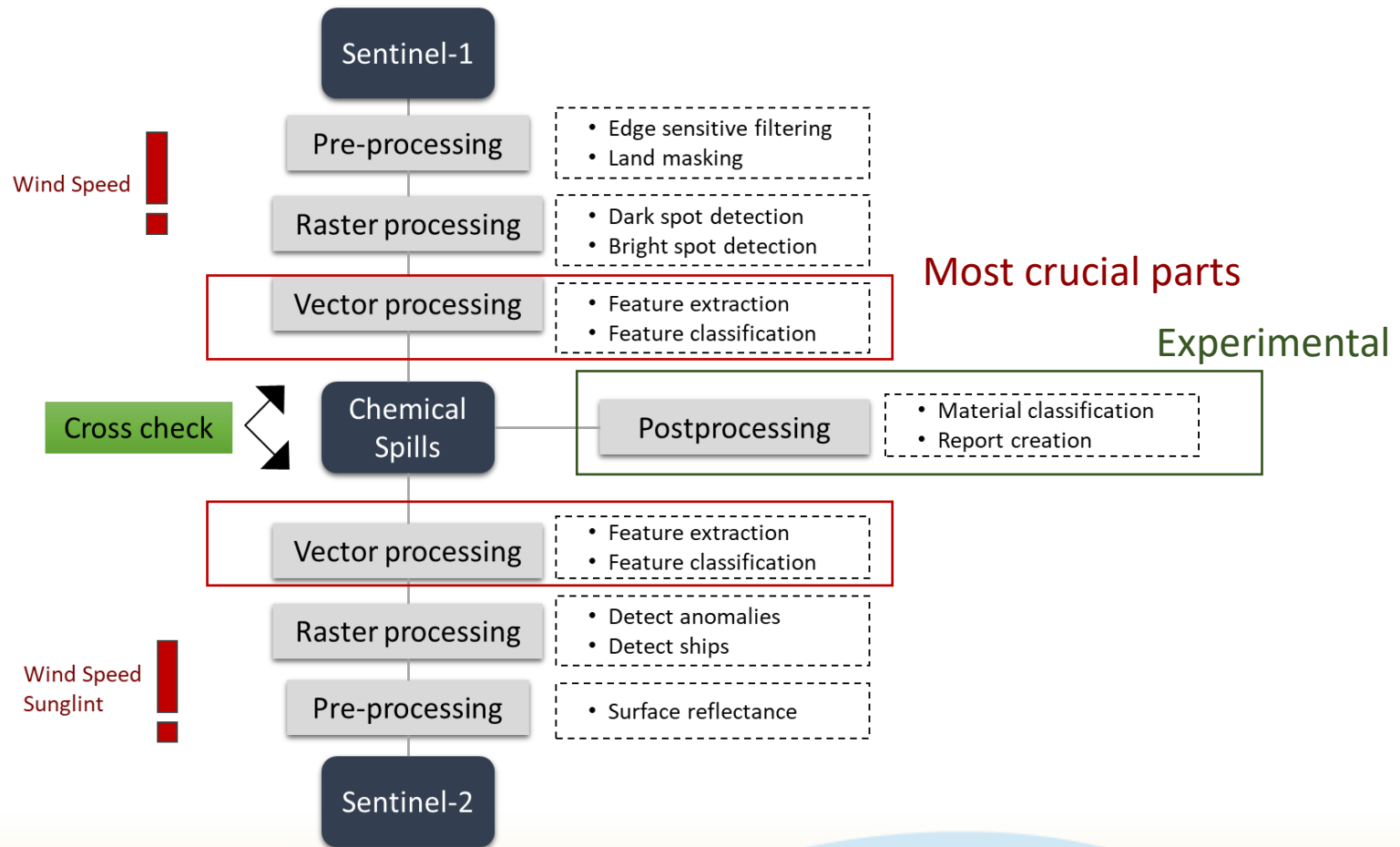
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2. Monitoring Water Extent





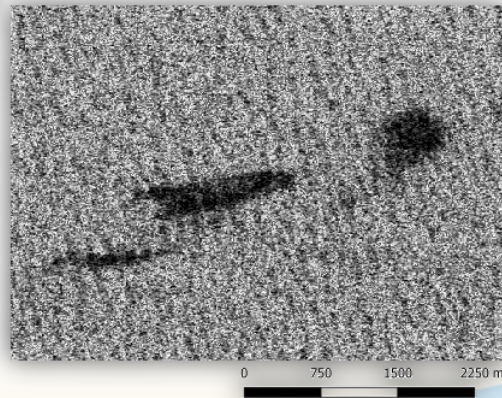
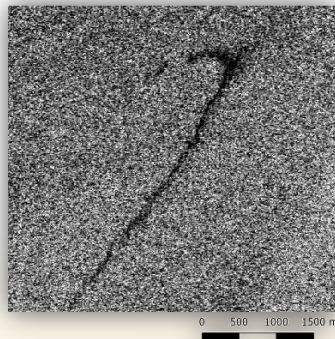
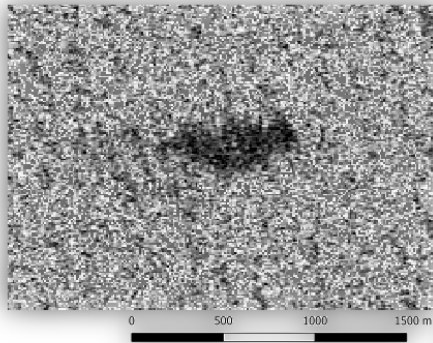
3. Oil Spill Detection – Technical Framework



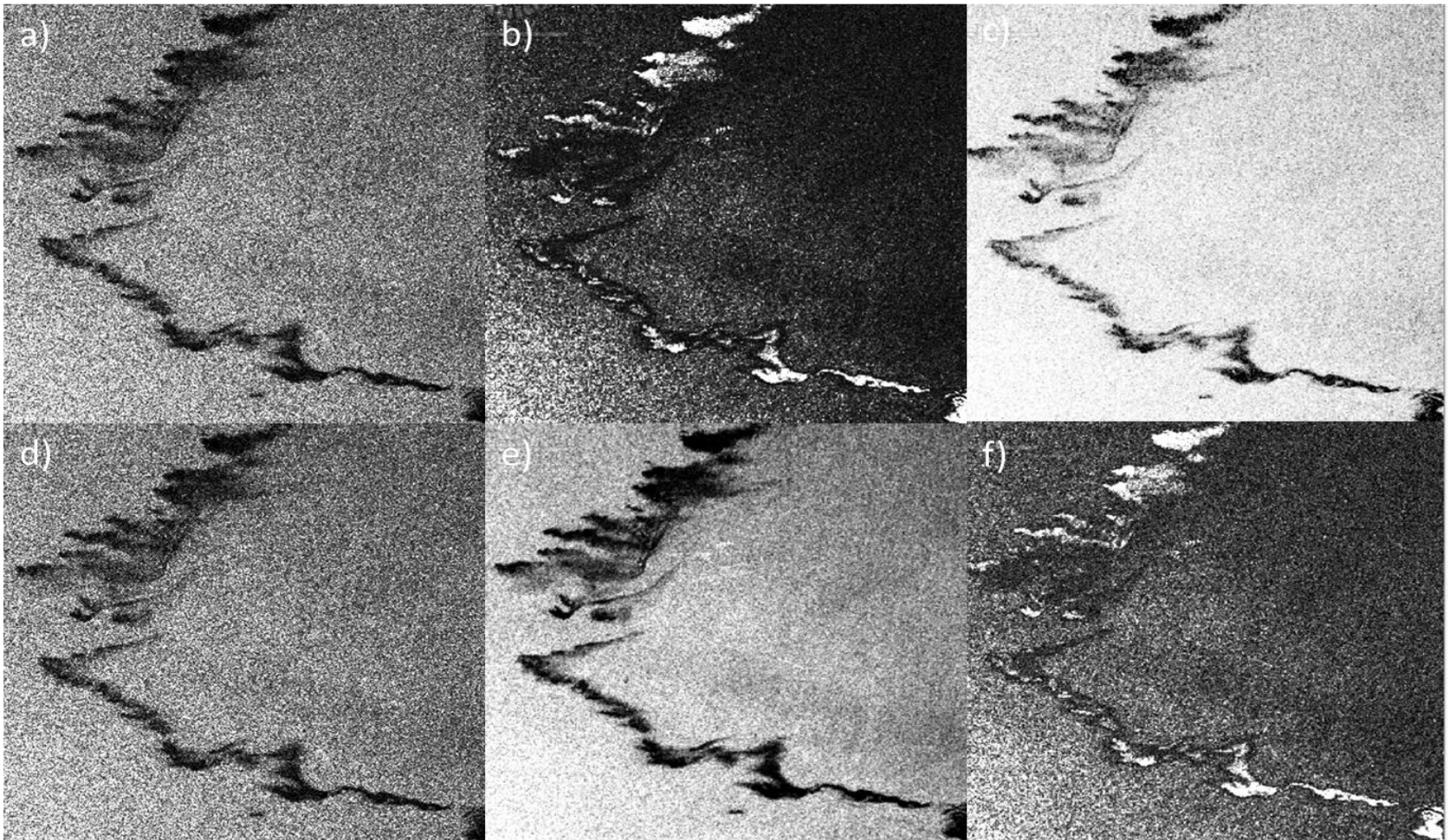
Oil Spill in Radar & Optical

Extensive Database on Oil Spill Properties:

- ❖ Shape, Texture
- ❖ Spectral Signatures > Spectral Library




Radar texture measures



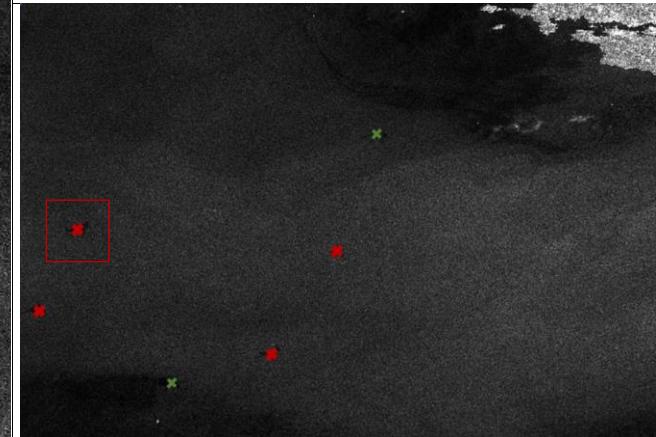
GLCM features calculated from Sentinel-1 SAR imagery (VV polarization). Example from the CLS Virginia collision north of Cape Corse in October 2018. a) sigma nought VV polarization b) GLCM Energy c) GLCM correlation d) GLCM mean e) GLCM variance f) GLCM homogeneity.

Specs:

- ✓ Following EMSA Standards
- ✓ Be Notified
- ✓ Generate Automated Reports
- ✓ Cross-check with other sensors (Sentinel-2 and Landsat 8 optical)

Centre Position		Wind Speed		Area (nm ²)	Length (nm)
Latitude	Longitude	Speed (m/s)	Class		
51° 05' 51" N	006° 16' 02" W	3.00 m/s	Low	0.61	1.80
				Spill Probability	
				High	
				Ships Detected	
				Yes	

Overview



Further Information

Scene Date	2018-10-24 06:31:37
Sensor	Sentinel-1
	Yes
Additional Imagery Available	Sentinel-2 2018-10-23 11:21:11
	No Spill Detected



Using Drones in Pollution Mapping



Source: CEDRE

02.06.2020

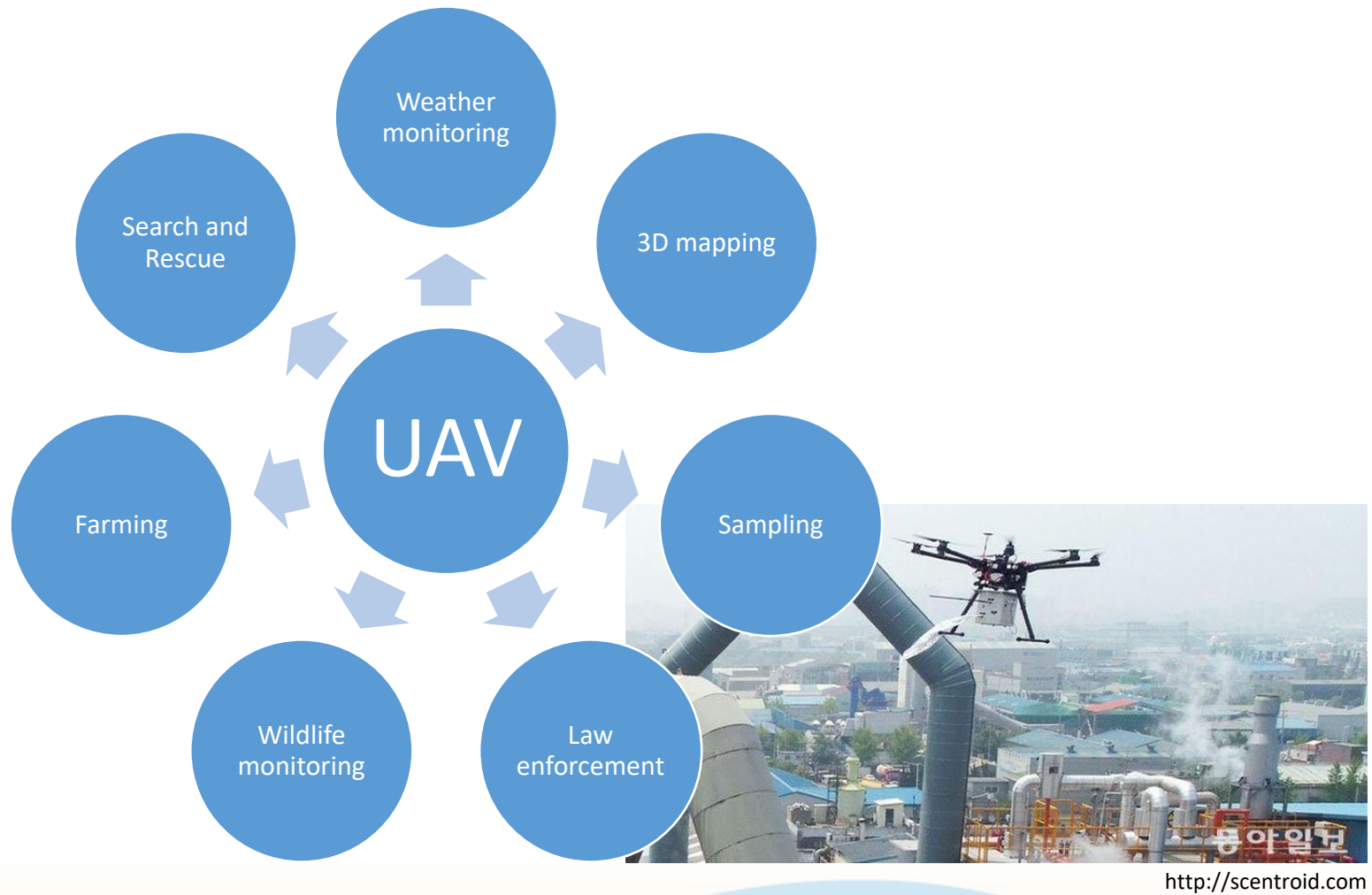


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Drone usage examples



Data fusion of satellite and airborne data (drone) for bathymetric analysis

example shown: Coastal
zone management
project Belize, WorldBank



9cm spatial resolution bathymetry grid



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What to expect from drone pollution mapping?

- Basically no limitation in resolution (mm-scale)
 - However keep in mind:
 - With resolution increases the amount of data
 - Flight height
 - Cost vs. Use
 - Area to cover
- Timeliness
 - Automated or even autonomous operation without close-by operator is possible, but legal issues remain
 - Time to cover a area
- Drone Flight Time
 - from 5min for common consumer drones to 24h with a military drone) → Future development (combustion engines, solar power
 - wind, snow, humid air, or rain reduce the flight time



What to expect from drone pollution mapping?

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- Timeliness

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- Time to cover a area

- Drone Flight Time

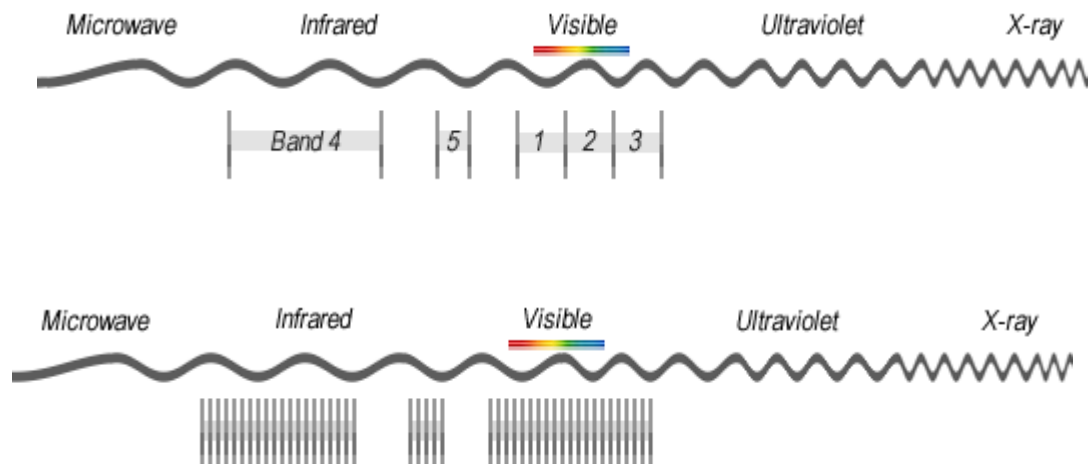
- from 5min for common consumer drones to 24h with a military drone) → Future development (combustion engines, solar power
- wind, snow, humid air, or rain reduce the flight time

- Costs

- Cessna 172 airplane = **\$300 000**, professionally automated drone = **\$25 000**
DJI's Phantom 3 drone = **\$1 000**



Multispectral vs. Hyperspectral



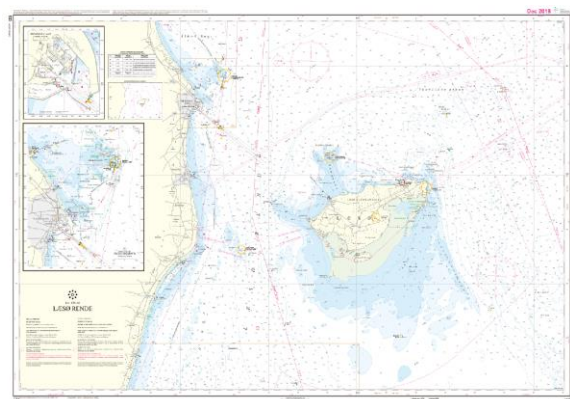
- Multispectral: 3-10 wider bands
- Hyperspectral: Hundreds of narrow bands → Distinguish different chemical materials (~Spectroscopy)

➡ Complexity and Data size (data reduction techniques apply)

gisgeography.com

Working with drone imagery

Geolocated, Geoferenced, Orthorectified, Geocoded, **Georectified**



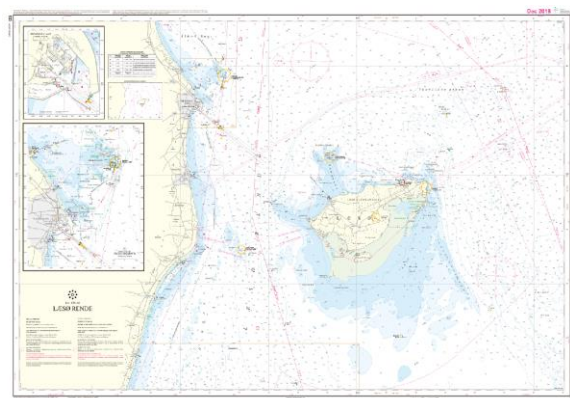
Unreferenced nautical chart

Georeferencing



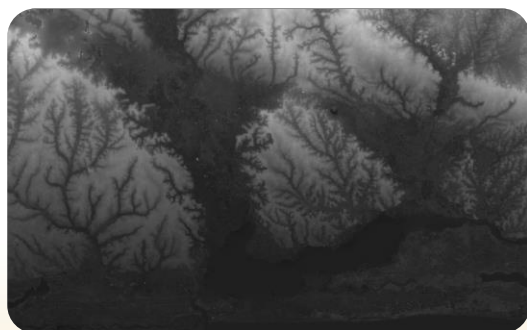
Working with drone imagery

Geolocated, Geoferenced, **Orthorectified**, Geocoded, Georectified

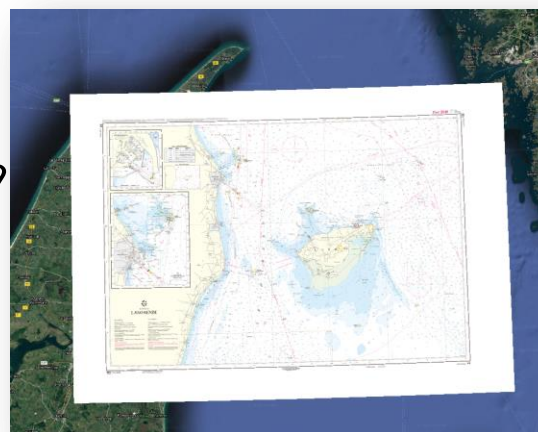


Unreferenced nautical chart

Orthorectification

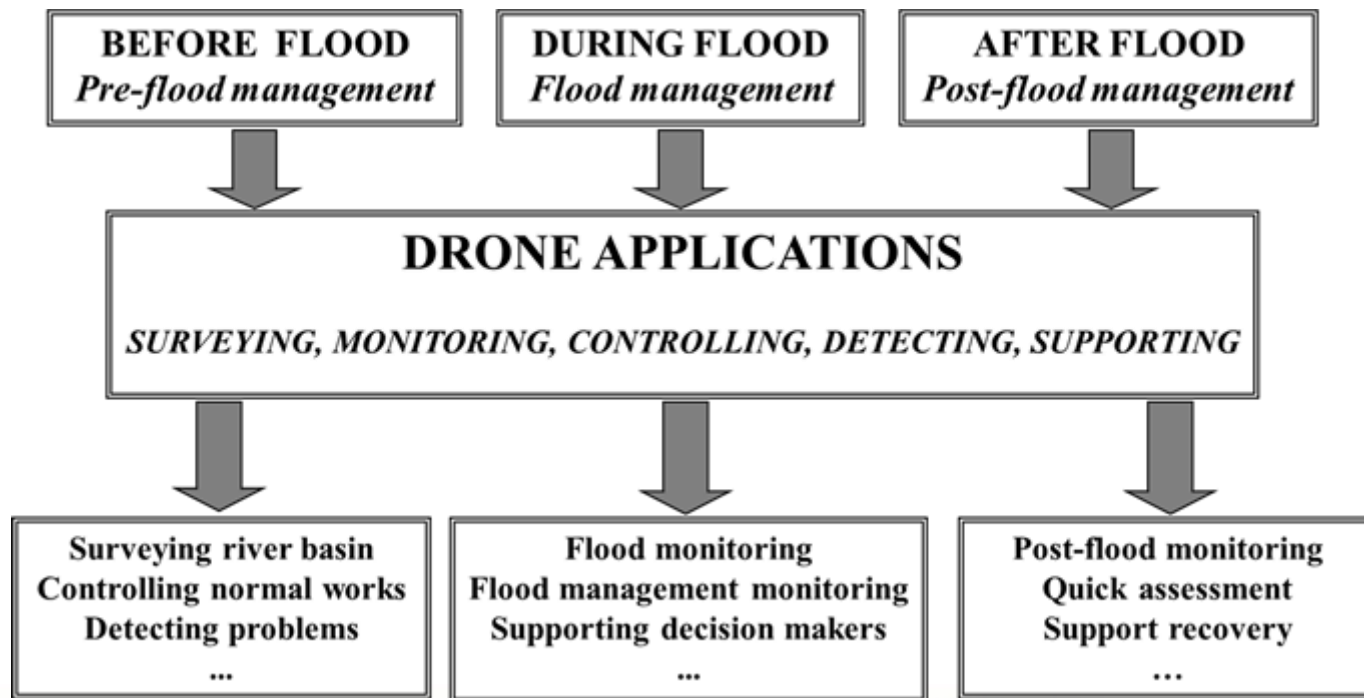


Digital elevation model



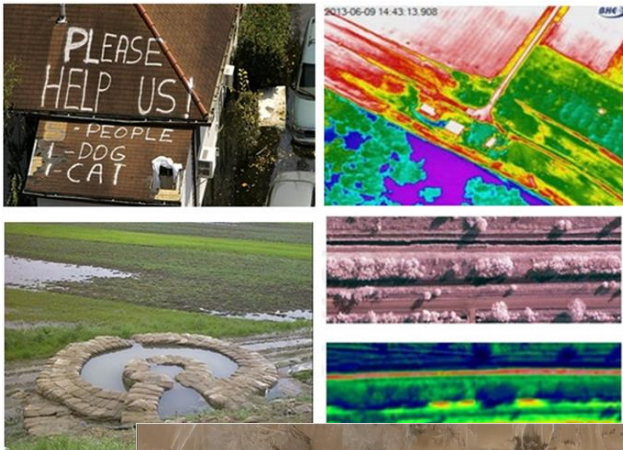
Flood extent monitoring

- Limitation: Extreme environmental conditions during the flood event



Flood extent monitoring

- Limitation: Extreme environmental conditions during the flood event



Terra Drone Europe aids Djibouti in flood damage mitigation and port inspection

© June 20, 2019 | Terra News

Terra Drone Europe has conducted aerial photogrammetric pavement assessment in the Horn of Africa



HOME AFRICA AMERICAS ASIA EUROPE OCEANIA PROTECTION & RECOVERY CLIMATE NEWS

BREAKING NEWS 22 hours ago - Peru - 2 Dead After Rivers Flood in Pasco and Puno Departments

Tanzania – Drones Help Communities Map Flood Risk in Dar Es Salaam Slums

9 JANUARY, 2017 BY TRUST.ORG IN AFRICA FLOOD PROTECTION

f t s+ @ in

With almost 70 percent of its inhabitants living in informal settlements, Dar es Salaam is highly vulnerable to flooding, but **drones** can help communities map the flood risk, reports Kizito Makoye for Thomson Reuters Foundation



terra-drone.net
floodlist.com
html.scrip.org
Addo et al. 2018

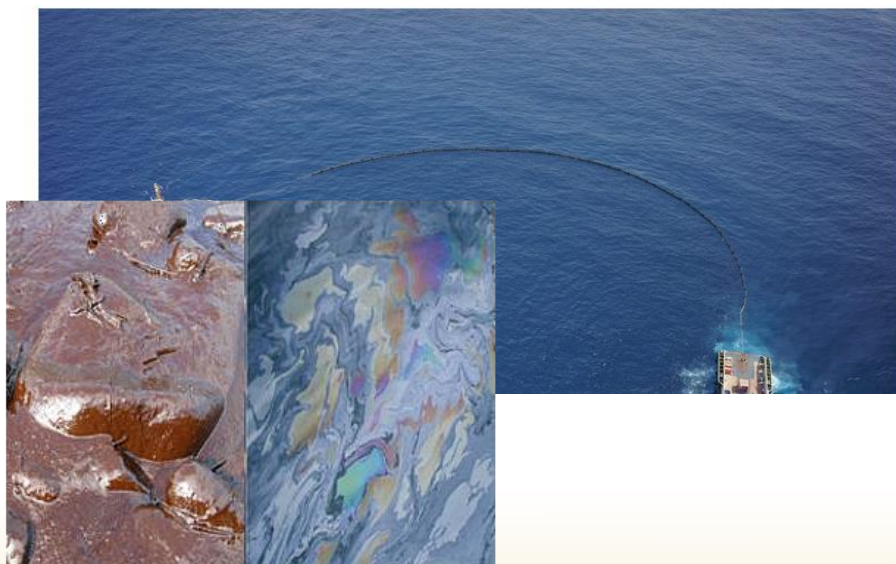
Pollution mapping

Observation, sampling – Thermal infrared to detect chemical reactions

Terra Drone Angola uses UAV in offshore mock oil spill response

September 19, 2019 | Terra News

The Terra Drone group company participated in a mock oil spill response exercise to showcase the benefits of using drones over conventional methods



Persistent oil (left) versus non-persistent oil (right)

Airborne Monitoring Tools for Arctic and Baltic Sea Environment (UAV-ARCTIC)

Basic project information

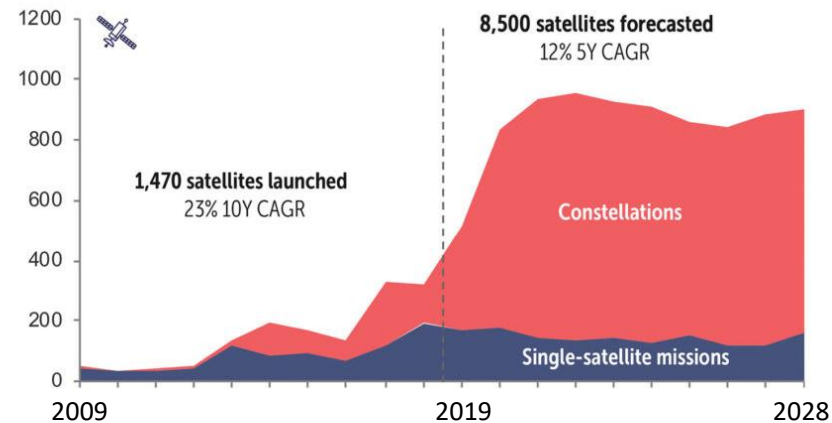
[+ Show information](#)



terra-drone.net
www.syke.fi
www.itopf.org

Conclusions and Outlook

- Quality-controlled outputs accessible via the HazRunOff Webtool
- Processing of about 1350 Sentinel-2 images/a + Sentinel-1 and Landsat 8
- Amount of satellites in space strongly increasing
- Future hyperspectral satellite missions (PRISMA, EnMAP)



spacenews.com

Conclusions and Outlook

- Quality-controlled outputs accessible via the HazRunOff Webtool
- Processing of about 1350 Sentinel-2 images/a + Sentinel-1 and Landsat 8
- Amount of satellites in space strongly increasing
- Future hyperspectral satellite missions (PRISMA, EnMAP)
- Potential of drone use growing with technological progress
- Legal and environmental limitations remain
- Active field of research, e.g. precision and accuracy of data collected via drones
- Cost-benefit analyses are required before drone sampling/monitoring

