



HAZRUNOFF

PROJECT

**“WP4, Planning, Training and exercising
for response”**

**Activity 4.3.: Development of training
activities**

Final Report



Funded by
European Union
Civil Protection
and Humanitarian Aid

WP	4, Task 4.3
Action	Report
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authors	CEDRE
participants	

Disclaimer

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1	CONTEXT	2
2	TRAINING COURSE DEFINITION	3
2.1	A 2-DAY TRAINING COURSE	3
2.2	DETAILED AGENDA	4
2.3	OBJECTIVES AND CONTENTS.....	6
3	REVIEW AND PERSPECTIVE.....	14
4	ANNEXES.....	15

List of figures

Figure 1 :	Final programme of the 2-day training course on Oil and HNS pollution defined in the framework of the HAZRUNOFF project.	4
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1 CONTEXT

This document describes the activity carried out in the framework of Work Package n°4 – **Planning, training, and exercising for response** and, more specifically, it describes the activity 4.3 – **Development of training activities**.

In this activity, CEDRE, with the support of all HAZRUNOFF partners, has prepared training materials and courses to help key staff in charge of emergency response to oil and chemical spills (Civil Protection, Port authorities, stakeholders...). The main objective of these model courses is to provide practical training and guidance in preparing for and response to HNS and oil incidents, taking into consideration the specificities of rivers, estuaries and bays.

2 TRAINING COURSE DEFINITION

2.1 A 2-Day training course

Cedre designed and oversaw development of the content for a 2-day training course to assist in response to accidental pollution in estuary areas during and/or after flood and Hazmat events.

During the third workshop, held in Saint-Nazaire in September 2019, the training programme was validated by all the HAZRUNOFF partners, who also agreed to contribute by preparing presentations detailing the outputs of the project and their application to contingency planning and response.

The agreed training programme comprised 4 blocks proposed to be completed by delegates over 2 days as below (Figure 1):

- **Day 1: HNS & Oil releases.** This session is composed of 3 talks delivering general information on accidental pollution and the fate of pollutants in marine and aqueous environments.
- **Day 1: Preparedness.** A general overview on contingency planning to respond in an emergency context (3 talks + 1 exercise).
- **Day 2: Response.** Options for incident and post-incident environmental monitoring and available actions during response for population protection (2 talks).
- **Day 2: Response.** The application and benefits of modeling tools to aid response (2 talks + 1 exercise).

A 2 days training course on HNS

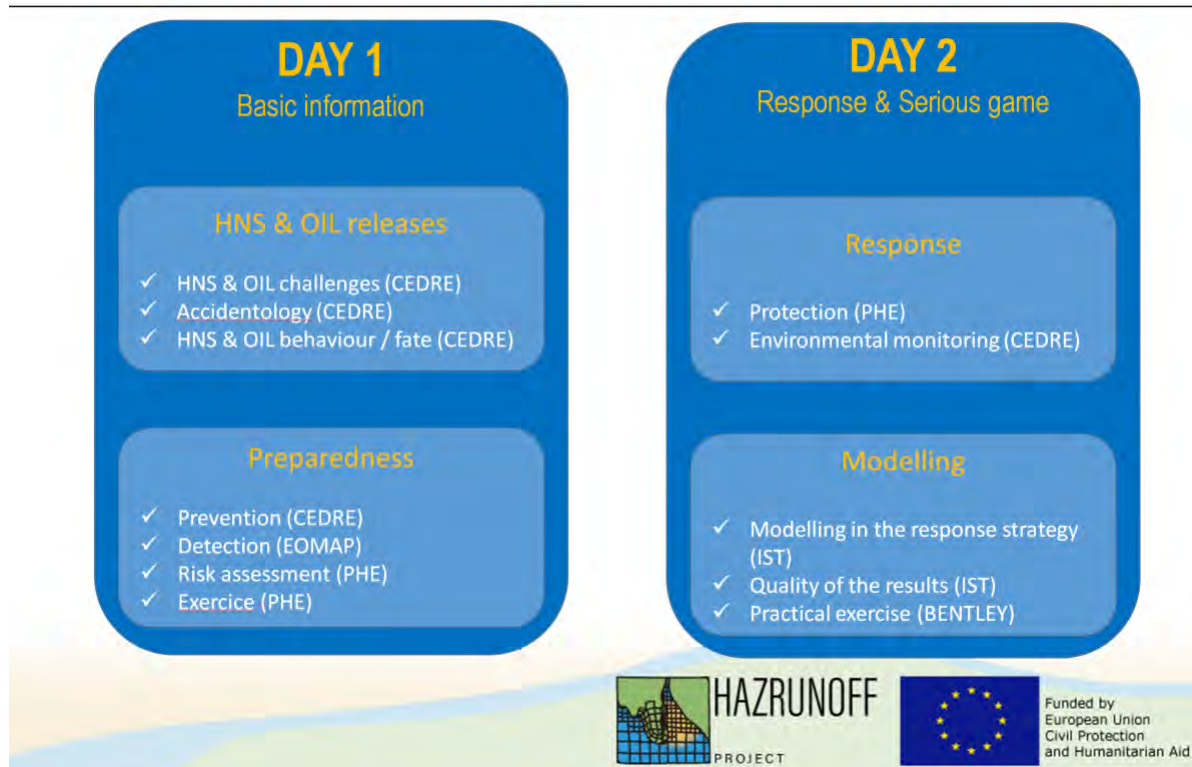


Figure 1 : Final programme of the 2-day training course on Oil and HNS pollution defined in the framework of the HAZRUNOFF project.

2.2 Detailed agenda

The detailed agenda is recommended to be as follows:

Day 1

Welcome from trainers			
08h30		Round table: Presentation of trainees background and expectations	
09h30 - 10h00	1	Introduction and description of the course, its objectives	CEDRE
		Presentation of the HAZRUNOFF project	IST
10h00 – 10h40	2	The stakeholders' point of view	IST
			CEDRE

BLOCK 1: Introduction to HNS and oil spills			
10h40 – 11h20	3	HNS challenges	CEDRE
11h20 - 12h00	4	Lessons learnt from accidents	CEDRE
12h00 - 12h30	5	HNS behaviour and fate in the aquatic environment	CEDRE
12h30 – 13h30	LUNCH		
13h30 – 14h30	6	Practical exercise on HNS behaviour (SEBC understanding)	CEDRE
BLOCK 2: Prevention and preparedness			
14h30 – 15h00	7	Prevention and Preparedness and example of response options	CEDRE
15h00 – 16h00	8	Pollution detection and flood alerting using remote sensing	EOMAP
16h00 - 16h30	Coffee Break		CEDRE
16h30 - 17h00	9	Hazard and Risk, Prioritisation and Assessment	PHE
17h00 - 17h30	10	Hazard Prioritisation and Risk Assessment Exercise	PHE
17h30 – 18h00	11	MARINER project: Enhancing HNS preparedness through training and exercising	CETMAR

Day 2

MODULE 3: Response			
09h00 - 09h30	12	Incident Response – Protecting the Public	PHE
09h30 – 10h00	13	Environmental monitoring programme	CEDRE
10h00 – 10h30	Coffee Break		
10h30 - 11h30	14	Contribution of modelling to the response strategy	IST
11h30 - 12h30	15	Quality of results: data and models	IST
12h30 – 13h30	LUNCH		
13h30 – 16h00	16	Practical exercise: How to use HAZRUNOFF platform	BENTLEY
16h00 – 16h30	Coffee Break		
16h30 – 17h00	Round table Certificate delivery		

2.3 Objectives and contents

The first part of Day 1 will be dedicated to introductions - a welcoming address followed by a round table discussion allowing the trainees to engage and express their expectations.

Topic 1: introduction to course objectives, presentation of the project

Presented by: IST and Cedre

Objectives: Overview of the scope, objectives and contents of the course.

Contents: presentation of the course agenda, presentation of the HAZRUNOFF project.

Format: ppt presentation.

Topic 2: stakeholders' point of view

Presented by: IST (supported by Cedre)

Objectives: understand the constraints and perspectives of various stakeholders.

Contents: Assessment of the interest in tools such as the HAZRUNOFF web platform for use during a flood or Hazmat event. Case study: flooding in the city of Loures and its impact on infrastructure and people.

Format: ppt presentation.

BLOCK 1 - Introduction to HNS and oil spills

Topic 3: HNS challenges

Presented by: Cedre

Objectives: Learn about the specific challenges of response to HNS.

Contents: Review of a number of incidents: causes, sources, consequences, casualties, substances spilled. Statistics and maps

Format: ppt presentation.

Topic 4: Lessons learnt from accidents: ECE incident

Presented by: Cedre

Objectives: Demonstrate the variety of emergency situations that may be encountered through the presentation of the ECE incident.

Contents: A presentation on the ECE incident and the response which was deployed (what was done at sea and experimental work at Cedre's facilities).

Format: ppt presentation.

Topic 5: HNS behaviour and fate in the aquatic environment

Presented by: Cedre

Objectives: Understand the importance of HNS behaviour, and how to assess this behaviour.

Contents: An introduction to main properties (density, solubility, vapour pressure, flash point, pour point...) and immediate behaviour: reactivity. Presentation of the Standard European Behaviour Code. How to assess the behaviour of a substance spilled in marine- or fresh water.

Format: ppt presentation.

Topic 6: Practical exercise on HNS behaviour (SEBC understanding)

Presented by: Cedre

Objectives: Practise using the SEBC approach, and applying the main properties of HNS to predict behaviour.

Contents: trainees will be provided with a set of data on a number of HNS. They will have to assess the short term behaviour of these products when spilled at sea or in freshwater using the criteria set out in the SEBC.

Format: table-top exercise.

BLOCK 2 – Prevention and preparedness

Topic 7: prevention and preparedness

Presented by: Cedre

Objectives: Learn about the main regulations on transport of HNS at sea and prevention of spills; outline planning approaches for emergencies

Contents: Details of the regulations around maritime transport through the presentation of International codes related to the carriage of chemicals at sea (International Gas Carrier Code -IGC Code; International Bulk Chemical Code - IBC Code; International Maritime Solid Bulk Cargoes Code – IMSBC Code; and International Maritime Dangerous Goods Code - IMDG Code). Preparedness will be addressed through a presentation of the Incident Management System concept (IMS concept).

Format: ppt presentation.

Topic 8: Pollution detection and flood alerting using remote sensing

Presented by: EOMAP

Objectives: Learn how satellites and drones can efficiently support the on-scene response.

Contents: Presentation of the performance of satellites and drones. Both assets can be equipped with optical sensors allowing the detection of a pollutant at the water surface, and allowing the monitoring of environmental parameters such as water turbidity and salinity.

Detecting Pollution and Flooding from Space. The following aspects will be described:

- Example projects and entities using satellites for pollution and flood mapping
- State-of-the-art: Methodology and background on technology
- EOMAPs products in HazRunOff and how they can assist in detecting pollution: Water coverage, turbidity and oil spill monitoring products
- Experimental detection of chemical substances: Analysing satellite data, current state and future roadmap

In addition, drones can be used to quickly perform an assessment of inundation in the context of a flood event (mapping of the scene).

- What to expect from drone pollution mapping? (resolution, timeliness, detection capabilities, benefits and economic aspects),
- Research and example projects,
- What to consider when conducting a mapping project (planning, environmental conditions during the flight, geolocation),
- Multispectral vs Hyperspectral sensors,
- Generation of orthophotos and 3D models,
- Drones assisting in flood extent monitoring (environmental and technological limitations under extreme conditions, economic aspects).

Format: ppt presentation.

Topics 9 and 10: Hazard and risk, prioritization and assessment

Presented by: PHE

Objectives: Understand the difference between hazard and risk, be able to assess hazards linked to the situation and prioritize actions

Contents: 1 hour interactive session involving a power-point presentation on hazard and risk in hazmat and flood scenarios, followed by a desk top exercise using tools developed by Hazrunoff to aid the assessment process.

The aims of the session will be to

- Define the concepts of Hazard and Risk
- Describe the risk assessment process - Source-Pathway-Receptor
- Outline risk management and prioritisation
- Present Hazrunoff prioritisation and risk assessment tools
- Complete the exercise using Hazrunoff tools for hazard prioritisation and risk assessment.

A final debrief / question and answer session will conclude the module.

Format: ppt presentation, followed by a table-top exercise

Topic 11: MARINER project: Enhancing preparedness through training and exercises

Presented by: CETMAR

Objectives: Learn about the outputs of the MARINER project, make the most out of them.

Contents: Presentation of the MARINER project and demonstration of its outputs and tools.

Format: demonstration from MARINER platform.

BLOCK 3 - Response

Topic 12: incident response – Protecting the public

Presented by: PHE

Objectives: Understand appropriate measures to protect populations

Contents: A taught power-point session outlining key aspects for protecting the public during an incident (referencing hazard and risk assessment module and using case studies to illustrate key principles).

Aims of the session will be to provide delegates with an understanding and appreciation of

- The key stages of incident response
- Response actions for public protection
 - Zoning, Mass decontamination, Shelter Vs Evacuation
- Risk Communication
 - Warning and informing, Role of Social Media
- Recovery Phase actions

A list of further information sources will be provided at the end of the presentation as well as a short question and answer session.

Format: ppt presentation.

Topic 13: environmental monitoring programme

Presented by: Cedre

Objectives: Develop ability to contribute to the development of a monitoring programme.

Contents: During and after each accident a monitoring programme must be put in place in order to assess the impact on the environment and, also, the efficiency of restoration processes. The main available tools to assess the health status of the environment will be presented in this talk.

Format: ppt presentation.

Topics 14 and 15: contribution of modelling to the response strategy. Quality of results: data and models

Presented by: IST

Objectives: Appreciation of computer modelling and how it can be used.

Contents: Presentations dealing with different notions including the inputs of modelling during the response, the need to have accurate data, and the uncertainties of modelling....

Format: ppt presentation.

Topic 16: practical exercise: how to use the HAZRUNOFF platform

Presented by: Bentley

Objectives: Training to use the tools developed under the HAZRUNOFF project.

Contents: Based on an accident scenario, the different tools of the HAZRUNOFF platform will be presented as well as the modelling options. Emphasis will be placed on the possibility of acquiring environmental data in real time (from sensors positioned in situ and/or satellites and drones) and transmitting them to stakeholders in a timely manner.

Format: demonstration from HAZRUNOFF platform.

The description of the HAZRUNOFF platform will require the entire afternoon session.

Roundtable Discussion

Chaired by: CEDRE

Following completion of the training delegates will have the opportunity to discuss all of the training they have received, make any final comments / observations and complete a feedback form.

All delegates will receive a certificate of completion

3 REVIEW AND PERSPECTIVE

The HAZRUNOFF platform is operational and several tools are available as is this 2-Day training course on oil and HNS pollution in estuaries.

The course is best delivered by HAZRUNOFF partners due to the focus on the operational platform, although it is intended that those delegates completing the course will subsequently be able to deliver it to others. A basic knowledge is needed on the modelling tool to be able to explain how to use it.

Currently, the training material is only available in English but a perspective may be to translate it, into Spanish and French in the future.

4 ANNEXES

All lectures are given in annexes



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*Integration of **sensing** and **modelling** technologies for **early detection** and follow-up of hazmat and flood hazards in transitional and coastal waters*



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HazRunoff at a Glance



Programme: **DG ECHO** - Directorate-General for European Civil Protection and Humanitarian Aid Operations



Start date: January 2018
End date: March 2020



Total budget: 643,770.10 €
EU Grant: 482,827.57 € (75%)



Main Aim:

To increase preparedness and response capacity on floods and pollutant hazards in rivers, transitional and coastal waters, through the development of a situational **awareness and emergency response framework** and associated **tools**, capable of **supporting civil protection units and water pollution authorities**.



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Partners and associated partners



- Instituto Superior Técnico, IST (*Coordinator*)
- Bentley Systems Portugal
- Câmara Municipal de Loures
- Portuguese National Authority for Civil Protection



- Centre de documentation, de recherche et d'expérimentations sur les pollutions accidentelles des eaux, CEDRE
- French Navy



- Centro Tecnológico del Mar - Fundación CETMAR
- Augas de Galicia



- EOMAP GMBH & CO KG
- BfR -German Federal Institute for Risk Assessment



- Public Health England (PHE)
- UK Maritime Coast Guard Agency



<http://www.hazrunoff.eu/>



@hazrunoff

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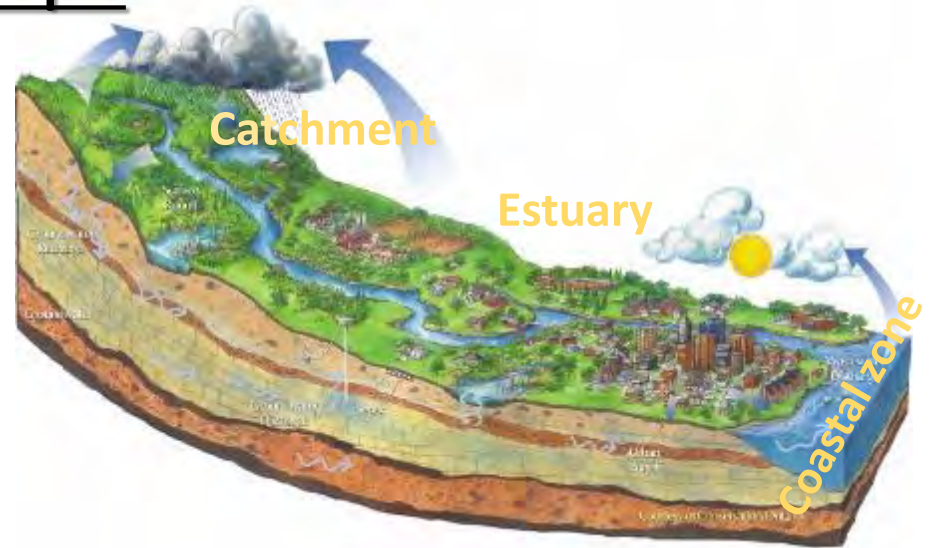
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HazRunoff objectives & scope

- To fill the gaps around knowledge and preparedness involving early warning & detection, follow-up, and response to flooding and hazmat contamination in **inland, transitional and coastal waters**, including urban areas,



- integrating:

- in-situ** sensing technologies
- airborne** (UAV/drones) and **satellite** remote sensing
- holistic high-resolution **modelling**
- operational tools (web platform)** for situational **awareness** and **crisis management**
- improved **contingency planning** and adapted **protocols for response and communication**

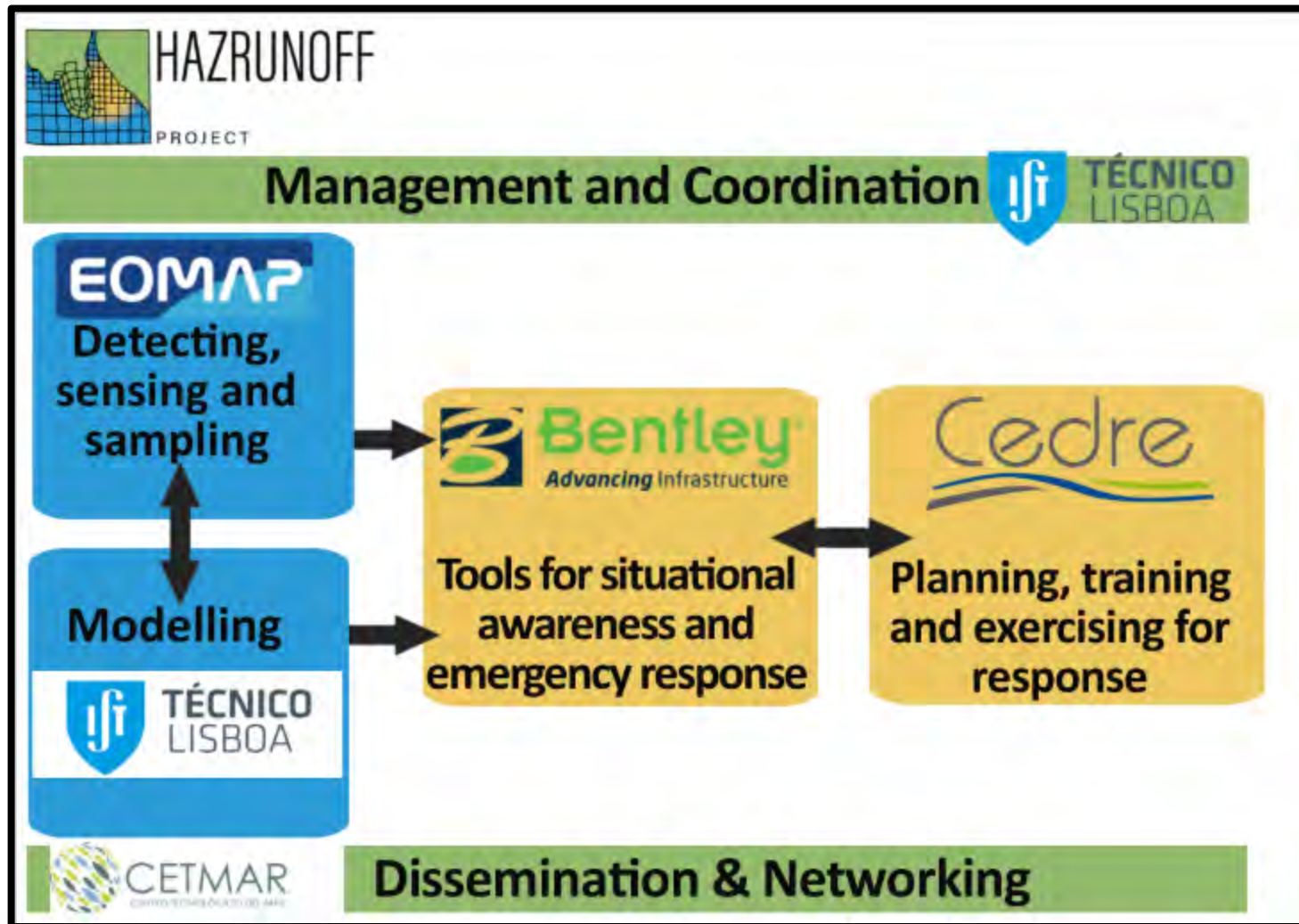


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HazRunoff Work Streams





Natural hazards are usually associated to Extreme meteorological events!

The capacity to forecast meteorology and its implications on storm surge and on river discharge is essential to deliver alerts and to plan crisis management.

The capacity to follow the crisis evolution is based on the capacity to collect actual data: satellites and drones are the most suitable platforms .

Communication of actual data during the crisis using web services is convenient.

Simulation of scenarios and training based on those scenarios is essential to create awareness and for training.

Modelling

To simulate and **integrate the water continuum from the watershed up to the estuary** to reproduce and forecast the processes associated with floods and the dispersion of pollutants

«To be implemented in each pilot area»

Meteorological modelling

To simulate and forecast meteorological variables with the adequate horizontal resolution

Watershed modelling

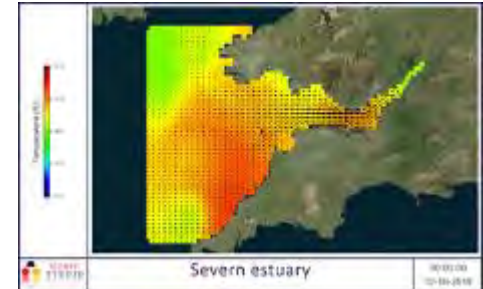
To estimate river flows in regular and extreme conditions

Estuarine modelling

To simulate estuarine circulation including storm surge and floods

Urban storm water modelling

To simulate the water drainage in the main cities associated to the pilot study cases



Integrated flood modelling

To implement a method for full coupling watershed, estuarine and urban drainage models

Pollutants, thrash and debris dispersion modelling

- Radioactivity dispersion in water bodies
- Air dispersion modelling



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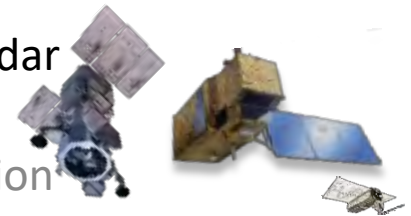
Detecting, sensing and sampling

Data acquisition and measurements regarding **flooding and water contamination**. Early detection and warning and contribution to **model initialization and validation**

APPROACHES:

-Remote sensing: Satellite optical sensors, synthetic aperture radar (SAR) and hyperspectral

Water level, turbidity, oil slick identification and chemical spill detection



-Integration of in-situ environmental data:

Rivers control stations: water quality (pH, dissolved oxygen, temperature, conductivity and turbidity, etc.) and flowrate.

Laboratory measurements of chemicals behaviour and fate



-Unmanned Aerial Vehicles (UAV):



Identification and mapping of floods (environmental parameters characterisation) and water pollution

-Gap analysis and assessment of sentinels and indicators

Review monitoring and detection technologies, key pollutants (and/or proxy indicators) for incident alerting and produce an automated tool to help assess and interpret monitoring data

Tools for situational awareness & emergency response

To support flood and hazmat emergency responders by centralizing and integrating data from observation and prediction, decision making and communication

USER FRIENDLY WEB-BASED TOOLS AND MOBILE INTERFACES

-Multi-hazard early warning system:

Daily reports / Event-triggered early warning notifications

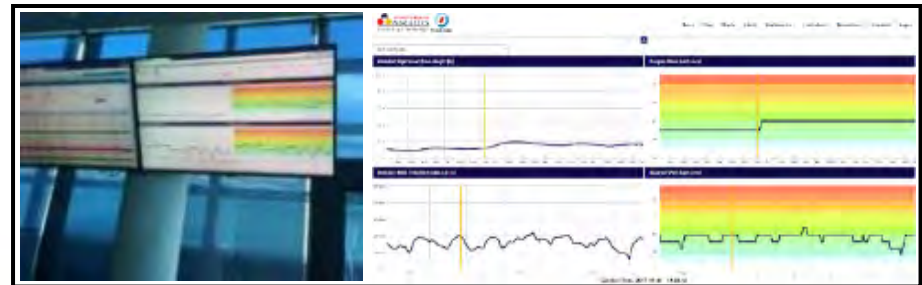
-On-demand pollutant dispersion system:

Web-based multi-platform and mobile-friendly tool for the on-demand simulation of fate and behaviour of objects and substances in transitional waters



-Realtime dashboards for situational awareness:

Online dashboards to present information about hydro-meteorological conditions, pollution indicators and different measured and modelled data coming from other project work streams



Tools for situational awareness & emergency response

-Communication and social media in crisis management:

- **Evaluation of social media and internet systems for early alerting incidents**

Development of search **terms relevant** to Hazmat and Flooding incidents in inland, estuarine and coastal water and bespoke selection of “key words” for social media trial



- Alerting about aquatic incidents
- Increasing public participation

- **Response communication protocols**

Crisis communications – Warning and informing message around priority pollutants. Impact assessment in social networks during incident, exercise or historical incidents (sentiment analysis)

Planning, training and exercising for response

To contribute actively to an efficient preparedness and response to floods and hazmat response in transitional waters.

-Risk management:

To develop maps and tools that help prioritising emergency response actions

- Hazard prioritisation framework to identify key pollutants
- Hazard mapping approach to identify main hotspot and vulnerable areas

-Adapting response protocols in transitional waters:

To **identify past incidents** in transitional waters, highlighting the main difficulties encountered, their specificities and preforming an analysis of equipment available according their characteristics and performance

-Development of training activities:

To help **key staff** in emergency response to HNS and oil incidents, specially adapted to the conditions in transitional waters

-Exercises and demonstration:

To test simultaneously the project techniques, methodologies and operational tools. **Table-top exercises on virtual hazard scenarios**



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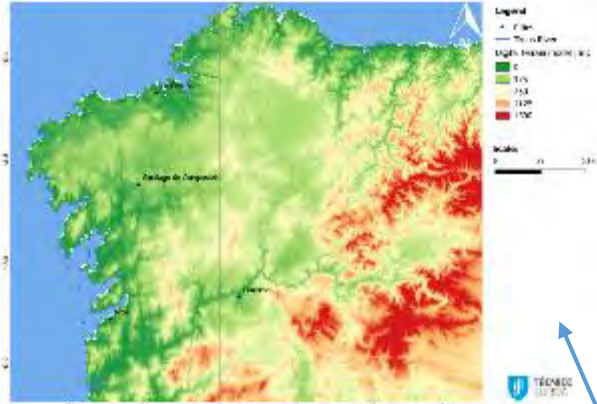


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HazRunoff pilot areas

<http://www.hazrunoff.eu/case-studies/>

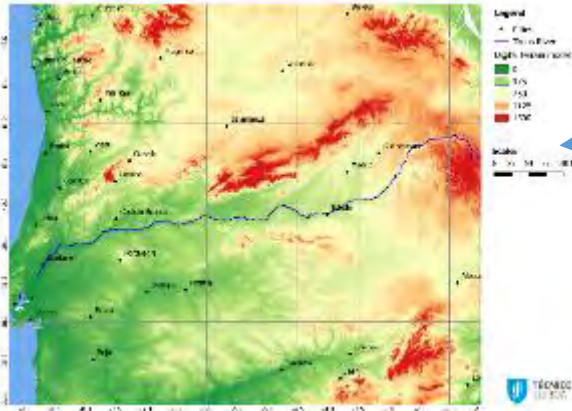
Spain – Ulla and Sar Rivers \ Ría Arousa



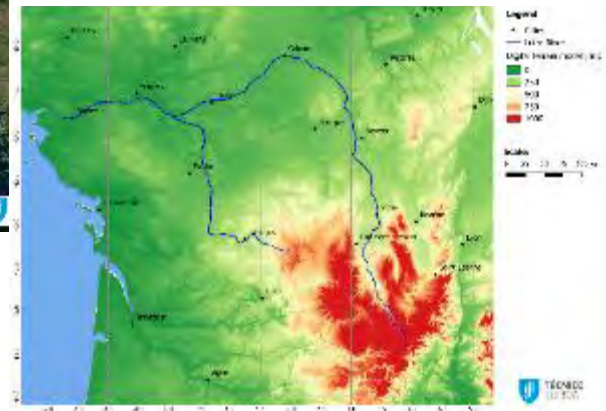
UK - Severn river \ estuary



Portugal - Tagus river \ estuary



France - Loire river \ estuary



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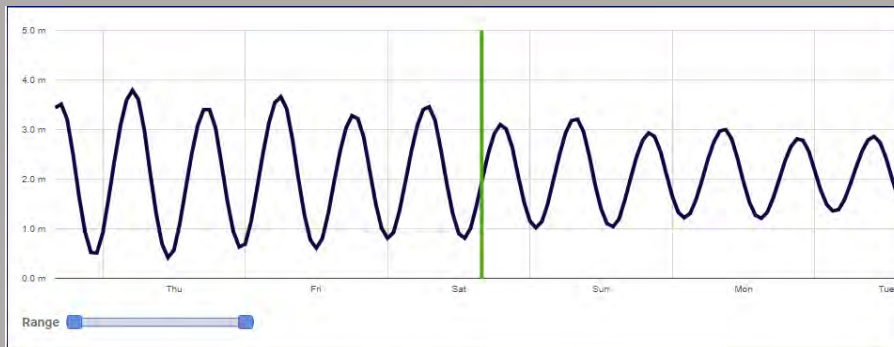
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Products \ Tools

- tools for situational awareness and crisis management
- **Risk management tools** to support contingency planning and decision making
- Response **protocols** adapted **for transitional waters**
- **Training material** and courses to help key staff in emergency response
- **Communication** to social media in crisis management

Water level [m] | Modelled: blue; Measured: green

Villagarcia tidal gauge



Water flow [m/s] & water column

Area 1



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HazRunoff expected impact

To Speed up early warning and detection, follow-up and response to floods and multiple hazmat contamination in transitional waters through:

- **Earlier forecast** of hazmat incidents (oil and chemicals) and a more efficient follow-up of pollution in transitional waters
- **Earlier detection** of hazmat incidents (oil and chemicals) and a more efficient follow-up of pollution in transitional waters
- Increase **preparedness** and knowledge on multiple types of floods

Based on a modelling strategy of simulating flash floods, storm surges, etc.

- Increase **awareness** on marine pollution originated in inland waters or estuarine environments

Based on automatic data analytic on social media



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HazRunoff expected impact

- Stronger and safer capacity for identification and monitoring of contaminated areas

Based on remote techniques avoiding human direct contact with pollution

- Improved contingency planning

Based on hazard mapping for multiple types of hazards

- Improved knowledge on chemical properties and behaviour on transitional waters

Based on lab measurements in 20 chemical substances

- Improved knowledge and awareness on hazards as a consequence of new training material, courses and exercising



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Identification of data gaps, especially in river catchments is a major short term contribution of the project.



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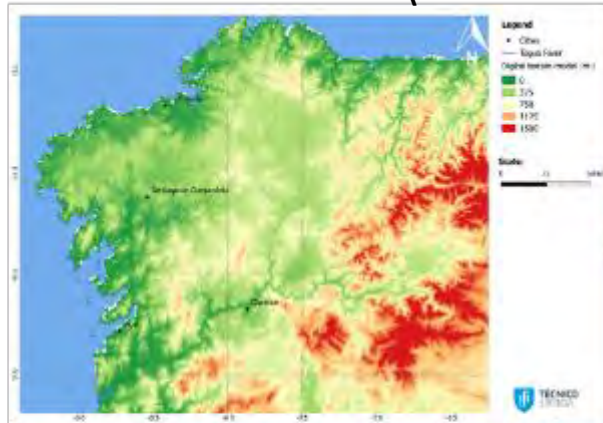
View from stakeholders Loures Municipality



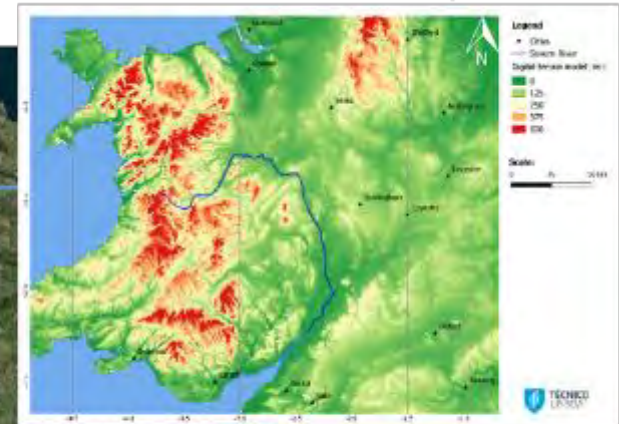
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HazRunoff study areas

Ulla and Sar rivers \ Ria Arosa



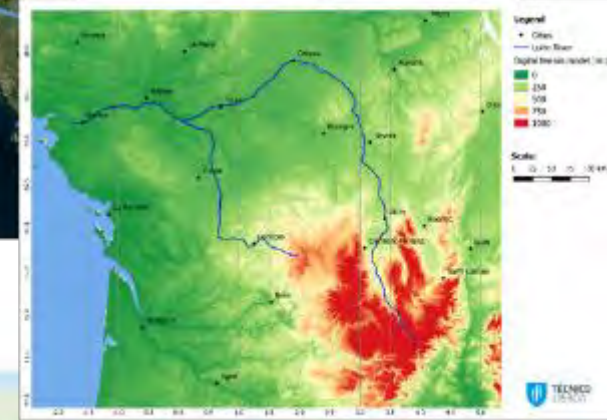
Severn river \ estuary



Tagus river \ estuary



Loire river \ estuary



County of Loures

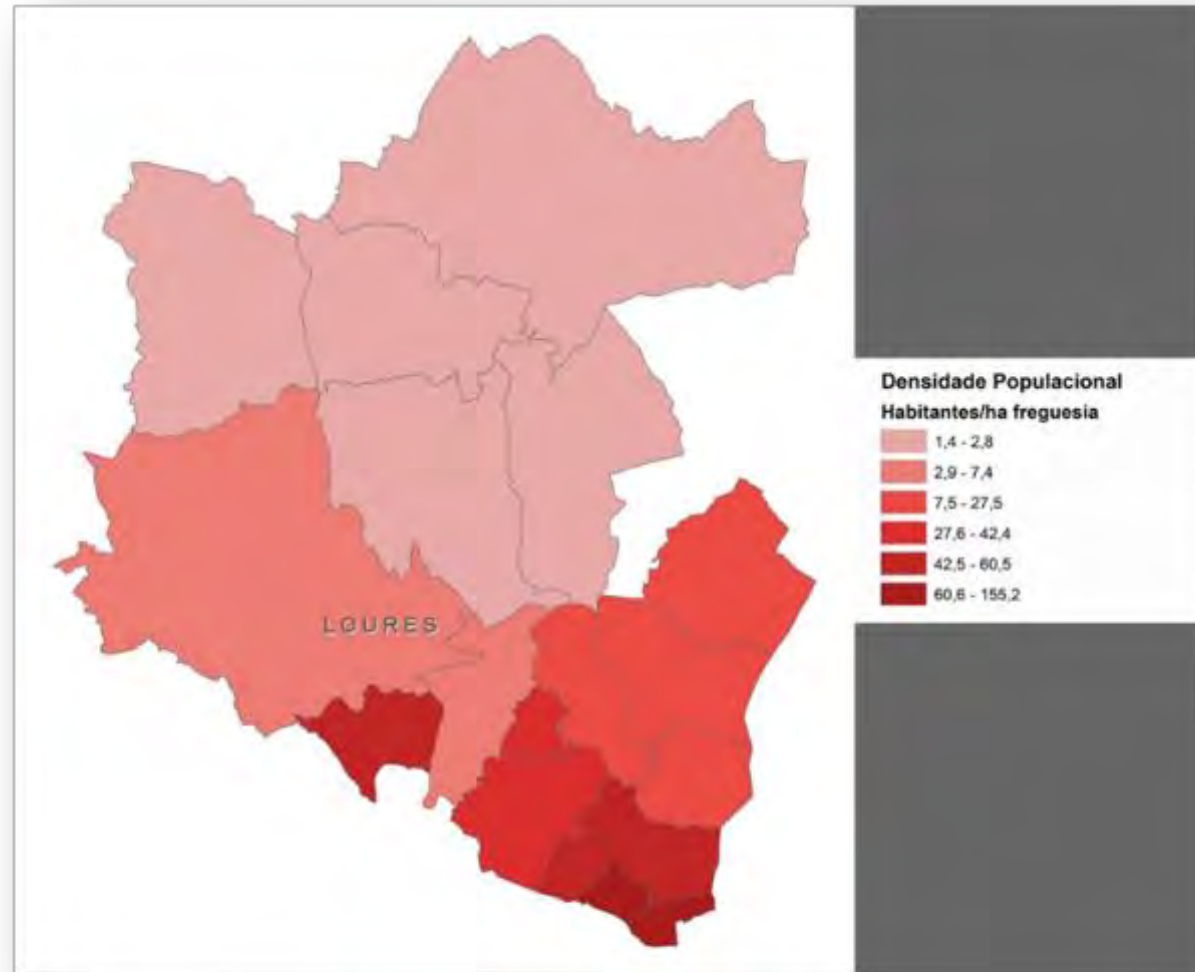
- Created in 1886
- Total extent 167 Km²
- Boundaries confine with six other counties - Lisboa, Odivelas, Sintra, Mafra, Arruda dos Vinhos, Vila Franca de Xira; southeastern limit confines with Tejo river
- Administrative division includes 10 communes
- Cities – Loures and Sacavém
- Villages – Moscavide and Bucelas



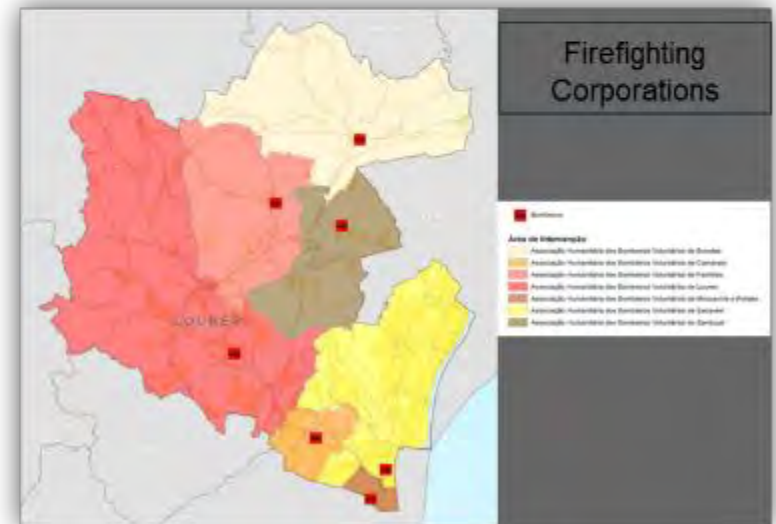
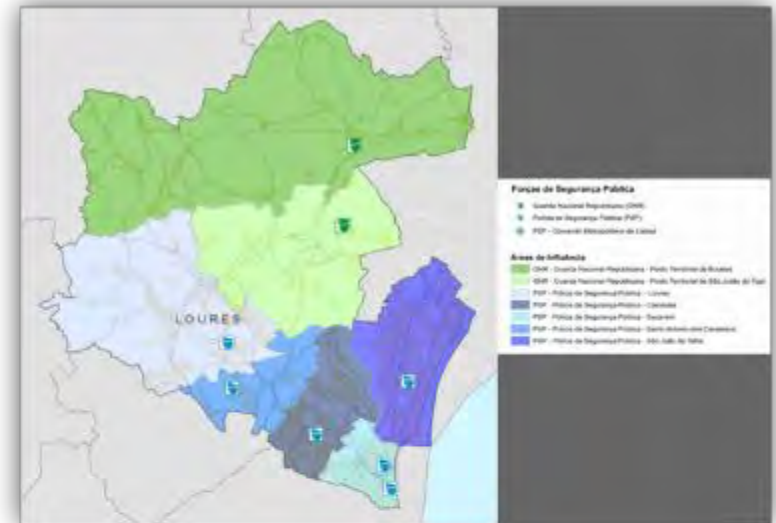
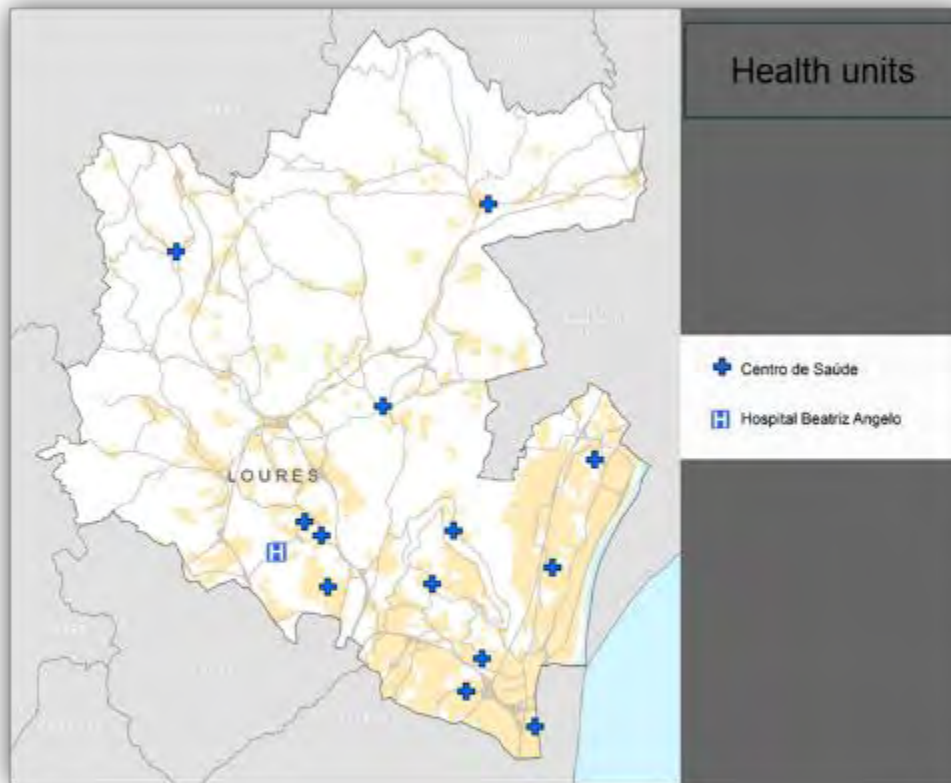
County of Loures

- Demography

- Loures as 200 000 inhabitants
- Higher populational density areas were determined by access to Lisbon and its proximity, as well as local employment availability.
- Urban areas grew along main roads and railway
- Loures northern areas show a rural pattern and a lower density, opposing to the south and southeastern areas, which are densely populated, more urban and industrialized

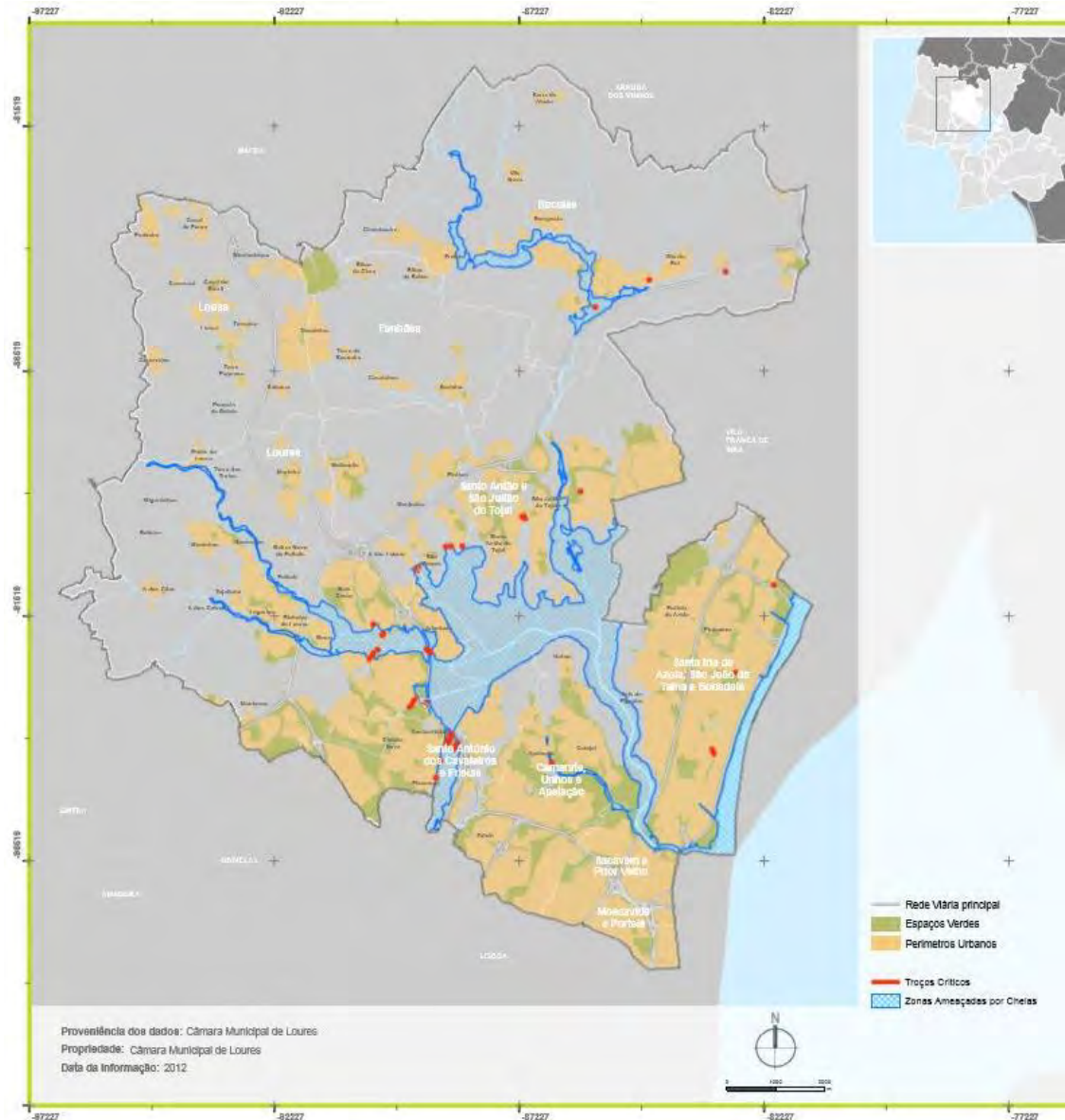


County of Loures - Health, safety and security



County of Loures – flood zones

- Main Rivers: Loures, Trancão, Tagus
- Confluence of Loures and Trancão rivers takes place in the central area of the territory in the meadow of Loures and continues to the Tagus river, with a small flow section;
- Water flow in this area is conditioned by the tide height;
- Hydrographic basin with a reduced time of concentration, potentiating the phenomena of rapid flood.



Sanding-up



Low plains flooded



02/06/2020

Flood events



Water courses maintenance



02/06/2020

Operations and Planning



Loures Hydrographic work group

Constituted by services of the Municipality and central government with responsibility in water resources management



Municipal Civil Protection Service

Civil Protection of Loures Municipality has dealt with floodings over the years. The aim of its action towards flood hazard is to:

- take preventive action through development and updating of specific floods hazard planning;
- mapping hazardous areas and keeping critical flooding sites records;
- promoting and maintaining an effective response system to face events;
- monitoring weather forecasts and river flows;
- triggering flood warnings as early as possible, for specific entities or population in general.

Due to territory specifications, early warning gets special relevance, as flash floods tend to occur.



Obrigada
Thank you

Questions?



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Challenges of the response on chemical incidents

CEDRE

Florence PONCET
Stéphane LE FLOCH



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Comparison with on shore accident

Always difficult to define the response on chemical accident but, on shore, we have

- Industrial sites - plants: knowledge of the product and regular training on emergency response
- Site access and exclusion zones well defined
- Only limited quantities are carried by trucks, trains, river barges and plane
- Many feedback post incidents



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Off shore response specificities

Depending on the exact nature of the product, the location and the environmental conditions of the accident

- Difficulty to have access to the zone (remote access)
- Difficulty to achieve risk assessment
- Limited response crew
- Monitoring heavy to organise
- Adverse environment

For example

Difficulties related to past incidents involving chemical tankers in French waters



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A vessel in trouble



The hazards related to the towing

- Reactivity of the cargoes
- Toxicity of the cargoes
- Weather conditions
-



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YM URANUS (8 October 2010)

Type of ship	Tanker double-hulled (120 meters long, 6 meters draught)
Nature of accident	Collision with a bulk carrier. The collision caused a crack 8 m long by 5 m high in the rear portside but the cargo tanks and bunker tanks remained intact
Localisation	Offshore (30 nautical miles from French Island)
Nature/quantity of the chemicals transported	Pygas (pyrolysis gasoline), 6,500 tons. Pygas evaporates easily and is highly flammable
Quantity spilled	No spill
Strategy of the emergency response	Transshipment of the load
Comment	Determination of spill simulations, determination of mass balance and exclusion zones Transshipment

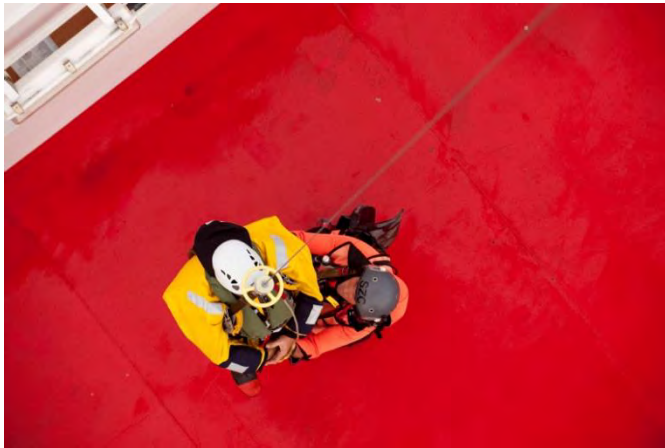


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YM URANUS (8 October 2010)



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Containers & Chemicals

Wide variety of products and scenario that involve

- Large spectrum of reactivities
- Risk of leakage of toxic product
- Different exposure routes
- Different volume / quantities of product (from the drum -200L to the big bag -1000L)
-



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MSC NAPOLI (18 January 2007)

Type of ship	Container ship (276 meters long, 13.5 meters draught)
Nature of accident	Bad weather, crack in the hull
Localisation	Offshore (50 nautical miles from the shore) 70 meters deep
Nature/quantity of the chemicals transported	<ul style="list-style-type: none">• Various goods: 2,200 containers (TEU = twenty-foot equivalent unit), 170 with dangerous goods• Bunker fuel oil
Quantity spilled	103 containers lost (various goods), 3,500 tonnes of Heavy Fuel Oil and around 600 tonnes of marine diesel oil and engine lubes
Strategy of the emergency response	<ul style="list-style-type: none">• Airlifted the 26 crew members• Ship stranded, recovery of containers (1351 on the deck) and then dismantled• Oil recovery (containment + pumping)
Comment	924 days were needed...



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MSC NAPOLI (18 January 2007)



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MSC NAPOLI (18 January 2007)



The vessel posed three main threats to the environment

- **Oil Pollution** – the vessel was carrying 3,500 tonnes of Heavy Fuel Oil and around 600 tonnes of Diesel and engine lubes
- **Inert Pollution** – the vessel was carrying over 2,200 containers with a variety of products onboard. Of the 103 lost, 56 washed ashore and 47 are unaccounted for, presumed sunk
- **Chemical Pollution** – there were a variety of dangerous goods being carried within the containers



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MSC NAPOLI (18 January 2007) – Public disorder issues



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Far from civilisation



Additional difficulties due to the environment

- Difficult to project the rescue team and equipment
- Weather condition and vessel stability
- Sensitivity of the environment
-



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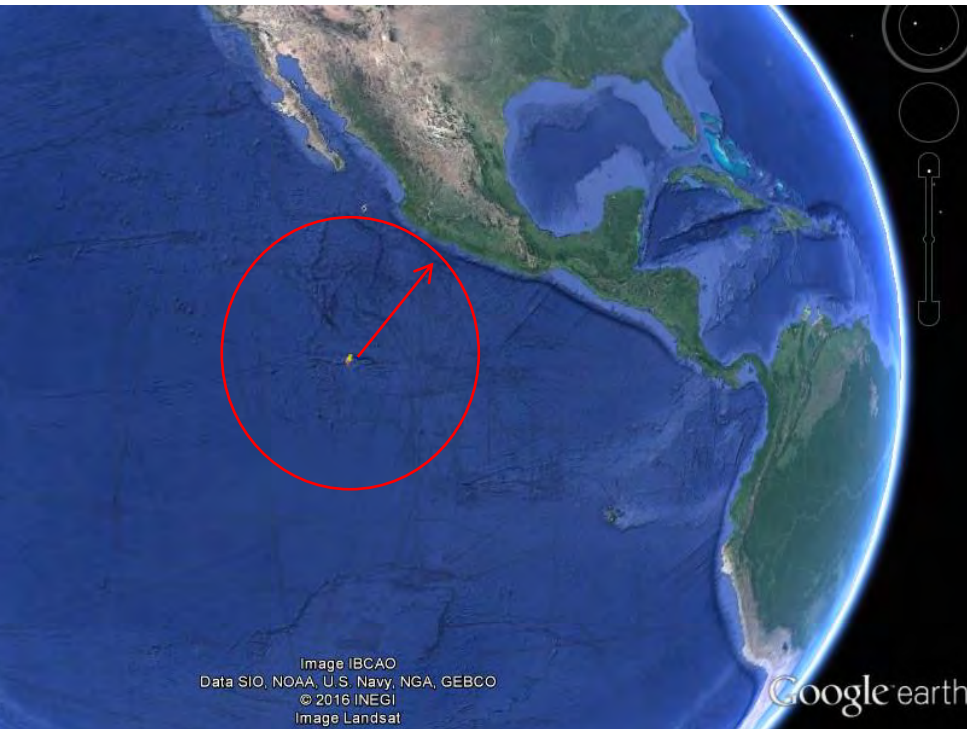


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SICHEM OSPREY (10 February 2010)

Type of ship	Tanker (170 meters long, 10 meters draught)
Nature of accident	Accidental stranding (different factors: natural, material, human and other)
Localisation	Offshore (700 nautical miles from Mexico shore)
Nature/quantity of the chemicals transported	Vegetable 6,000 tons, 6,000 tons animal fats, 10,500 tons xylene
Quantity spilled	No spill
Strategy of the emergency response	Transhipment of the load
Comment	Recommendations: systematically put into practice the assessment-training of the crews on the board vessel they manage.

SICHEM OSPREY (10 February 2010)



Sichem Osprey stranded on Clipperton island.
Photo © Marine nationale



No shore within a radius of 700
nautical miles



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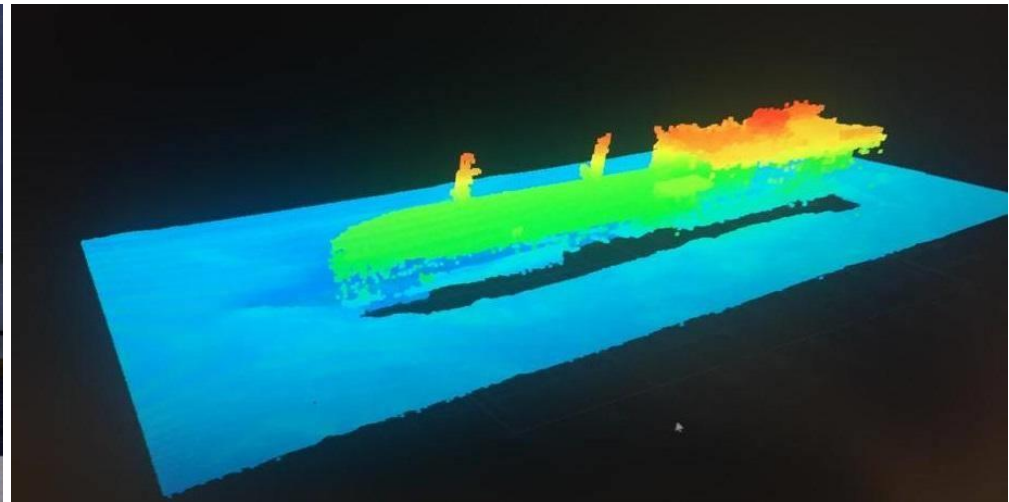


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A wreck on the seafloor with still its cargoes on board



America Grande, 2018



Not possible to do nothing

- Pump the cargo directly from the wreck
- Cargoes released under control in the water column (dissolution)
- Release the cargoes and containment and recovery at the sea surface
-



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IEVOLI SUN (30 October 2000)

Type of ship	Tanker (115 meters long, 6.3 meters draught)
Nature of accident	Leak at the bottom of the ship
Localisation	Offshore (45 nautical miles from the shore) 70 meters deep
Nature/quantity of the chemicals transported	4,000 tons styrene 1'000 tons methylethylcetone 1'000 ton isopropyl alcohol
Quantity spilled	Totality
Strategy of the emergency response	Recovery of styrene, controlled release of the other chemicals
Comment	Ship has sunk during towing (9 nautical miles from shore)



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IEVOLI SUN (30 October 2000)



Several issues have emerged

- Dissolution of the cargo in the water column
- Volume of contaminated water
- Impact on organisms



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ECE (31 January 2006)

Type of ship	Tanker (126 meters long)
Nature of accident	Collision (with General Grot Rowecki , transporting 26'000 tons of phosphates)
Localisation	Offshore (50 nautical miles from the shore) 70 meters deep
Nature/quantity of the chemicals transported	10'000 tons phosphoric acid
Quantity spilled	Totality
Strategy of the emergency response	Recovery of hydrocarbons onboard wreck, controlled release of the phosphoric acid
Comment	Ship has sunk during towing (50 nautical miles from shore)



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And even more...



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Main findings

Large variety of chemicals

- Liquid bulk, Liquid gases (LNG, LPG, CVM,...) but also solid bulk
- Corrosive gases (Ammonia, chloride) and corrosive liquids (Acids and alkalines: may produce corrosive sprays)
- Several reactive chemicals
 - Heat reactives: monomers
 - Fire reactives: ammonium nitrate
 - Water reactive: DRI pellets
 - Air reactive: alkyl aluminium compounds

Main findings

Behaviour and chemical properties

- 5 main behaviour (G, E, F, D, S)
- Liquid evaporators (totally or partially)
 - Toxicity levels in air: CVM, benzene,...
 - Flammability: VOC
 - Explosive: H₂, GPL
 - Toxicity levels for particulates and sprays
- **Care**: some chemicals present an issue even if not identified as evaporators (chloroform is a sinker, dissolver)

Main lessons learnt

- Researching valuable information on cargoes takes time (wide variety of chemicals)
- 5 main behaviours depending on the physical and chemical properties of substances but not only...
- Need to define normal procedures but experts have to work on simple scenarios
- Important to assess the risk for responders and the environment before responding: need of visual observation and measurements before dropping the evaluation crew on board
- **Need training and identifying individual capacities to act in a proper way in a stress situation**



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Challenges of the response on chemical incidents
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Conclusion

- First response actions will face to unexpected situation. In this respect, the training of responders is essential.
- There is no basic response able to face all situations: do not be trapped by contingency planning or by cloudy procedures
- Offshore operations always present risks that are multiplied in case of response to a chemical incident



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Challenges of the response on chemical incidents
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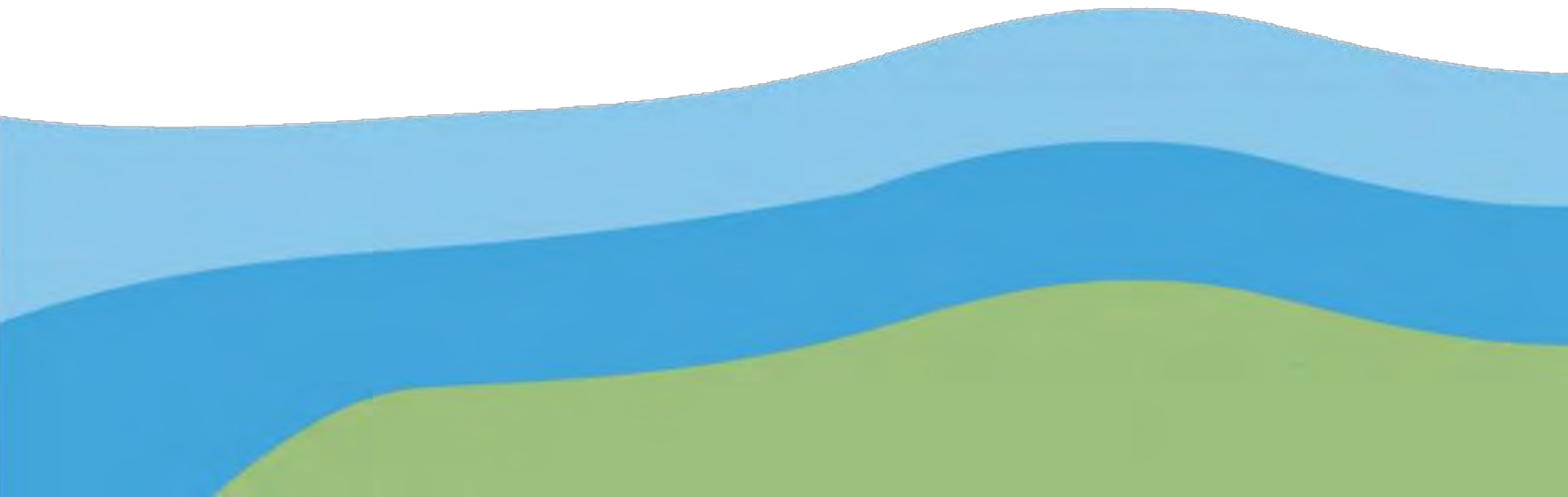
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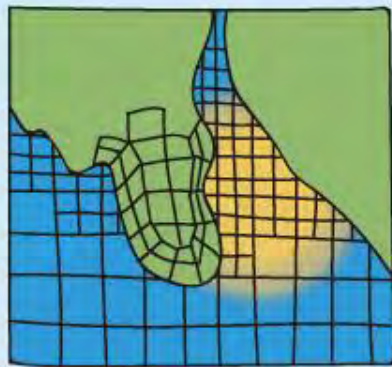


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Lessons learnt from accidents ECE incident

CEDRE

**Florence PONCET
Stéphane LE FLOCH**



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The *ECE* incident (Channel 01-02-06)



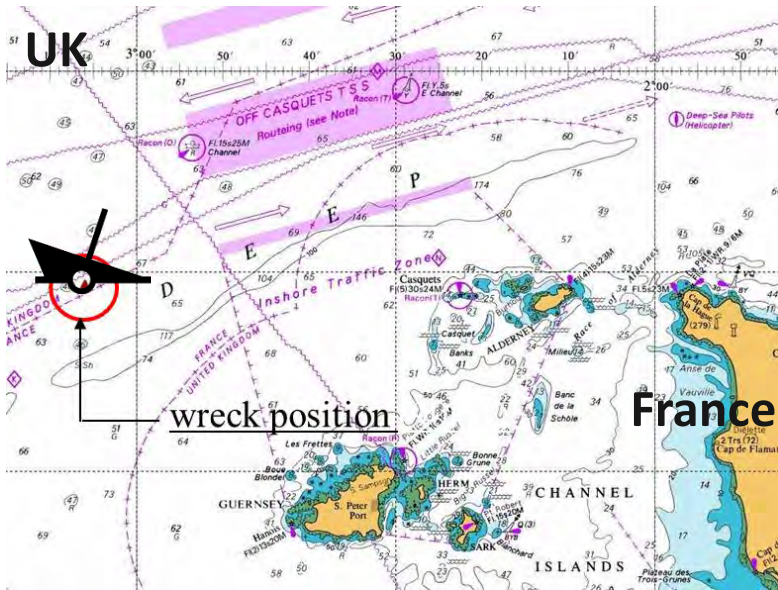
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Incident scenario

Collision



Collision with the General Grot Rowecki
Distress call sent to MRCC Jobourg
=> **Leak** and significant **list**

31st January :

5:00am: arrival of helicopters (British and French)

=> **crew rescue** operation

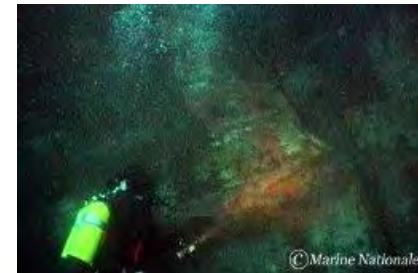
=> **diving inspection**

7:00am: arrival of a tug boat

3:30pm: beginning of **towing**



Source: French Navy



1st February :

3:37am: **sinking**



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Hole in the side of the vessel AND in the tank...



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Scene is Set

- ECE = Double hull (1988).
- Flag : Marshall Island
- 1 chemical (Phosphoric Acid) + Bunker
- Manche Plan activation (UK – France)
- Pollution looking like oilspill observed

For oil (**IFO 180** -70 tons, **Gasoil** -20 tons & **Lubricating oil** -40 tons)
Behaviour with ADIOS (Density < density of seawater, slightly soluble, potential for evaporation and emulsification processes...)

Slick forecast MOTHY



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First line of RESPONSE

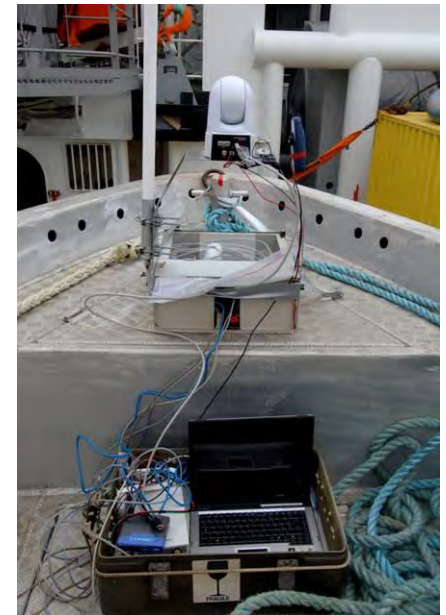
DETECTION / MONITORING OF CHEMICAL



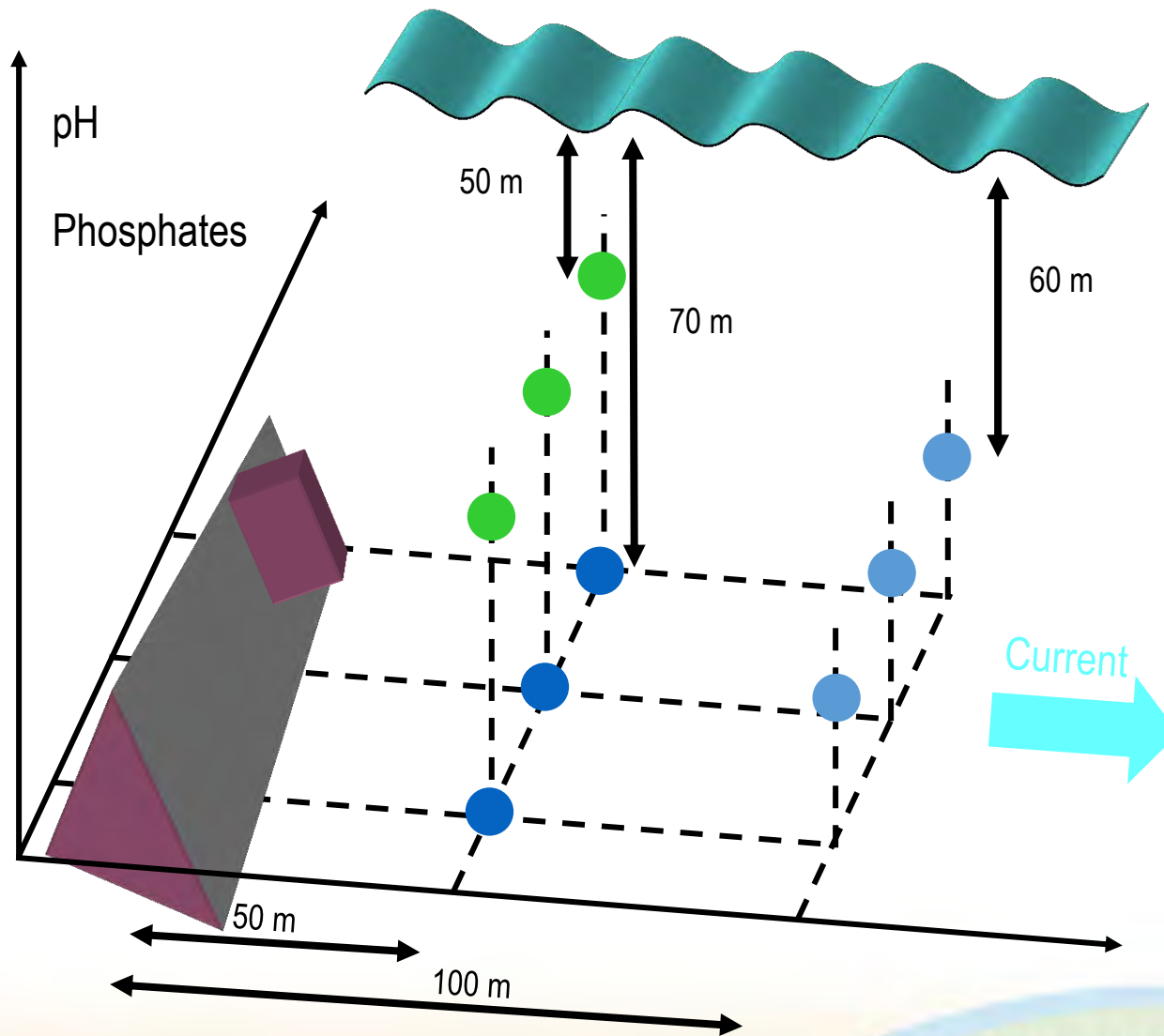
Remote controled
from *Argonaute*



DRONE with multisensor detection device



Monitoring close to the wreck



Several peaks of phosphate at J0 and J+10



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Response organisation

French Navy Headquarter in Cherbourg,
Manche Plan activated (UK and France),
Support by MCA (1 person at Cherbourg)

Meetings with the owner

Group of experts

To propose a response strategy
Water quality monitoring

Examine response options proposed by
the owner
(French Navy, Ceppol, Ifremer, MCA
and Cedre)



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Risk Associated to the CARGO

PHOSPHORIC ACID (10 000 tons)

What is it?

Behaviour in the marine environment ?

Toxicity (heavy metals)? Radioactivity?



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H_3PO_4 : what is it ?

H_3PO_4 FDS

- Concentration : 72% H_3PO_4 = 52% P_2O_5
- Density 1.53
- Totally hydrosoluble
- Acid – corrosive
- Non volatil
- Non toxic, non bioaccumulable
- Heavy metals and impurities linked and radioactivity...

Soluble, Marpol Z



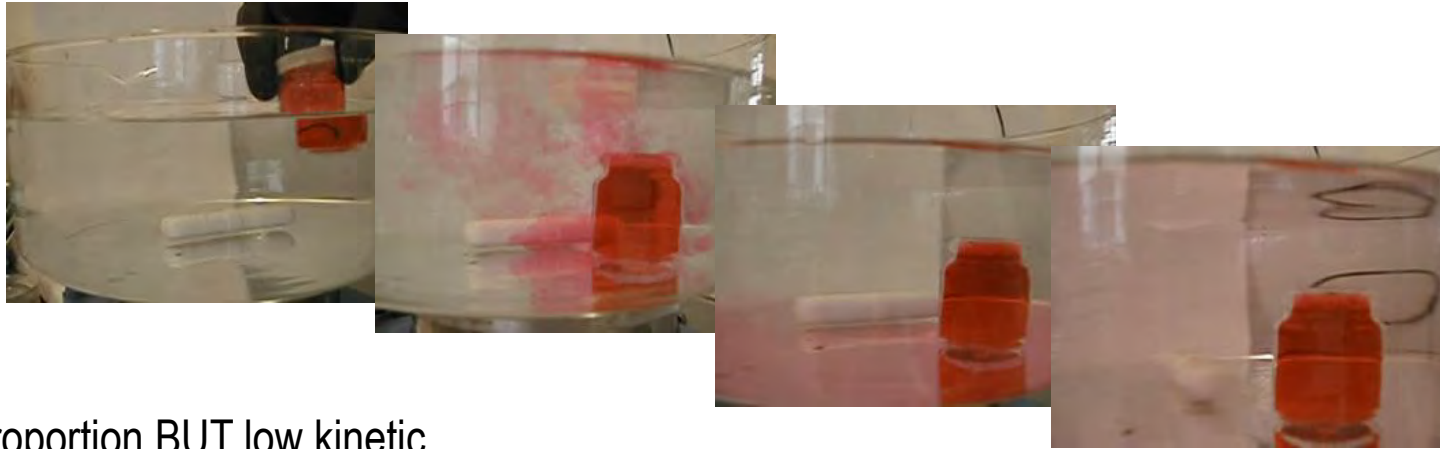
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Experimental work

At lab



Density = 1,53

Soluble in all proportion BUT low kinetic

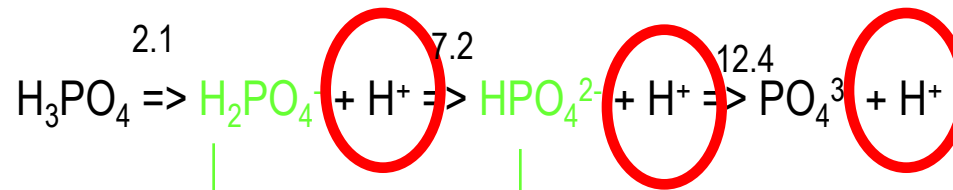


20 days after T0, pH
lower than 3 in the tank



Fate of the cargo

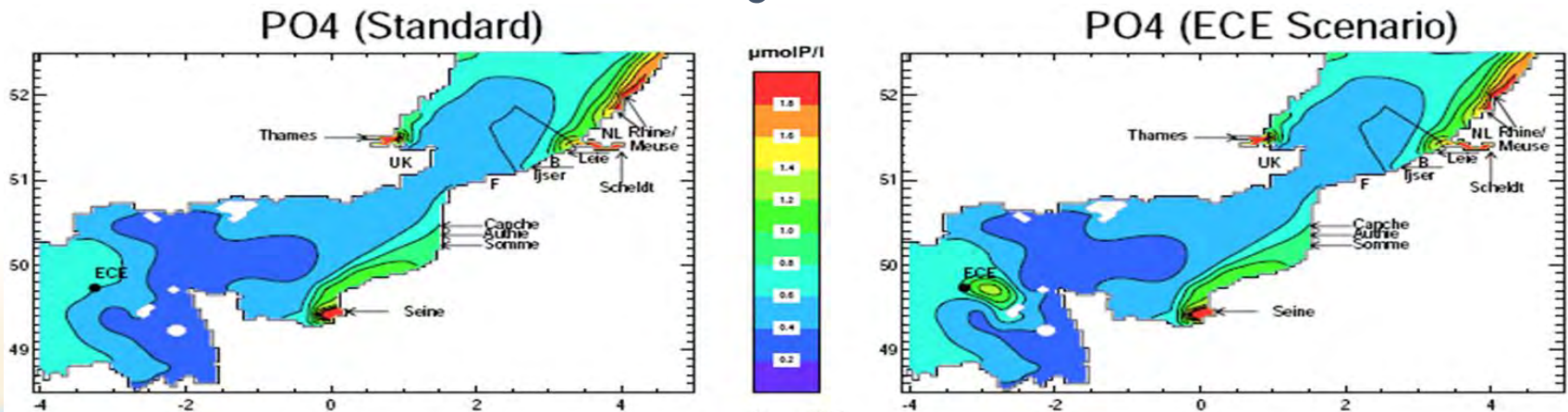
Area with strong currents, fast dilution of phosphoric acid



Can be used by algae

- 4-6 : 100% H_2PO_4^-
- 6-7 : 50% H_2PO_4^- et 50% HPO_4^{2-}
- 8 : 20% H_2PO_4^- et 80% HPO_4^{2-}

Modeling results



Date 07/02 MUMM-RBINS (Model MIRO&CO, AMORE project)

Fate of the cargo

- **Impurities** Hg (5kg), Pb (20kg), As (130kg), Cr (800kg), Cd (400kg), V (1000kg)
 - Heavy metals are a natural constituent of phosphate rock
 - These heavy metals would have been exposed to the environment in any case
- **Methodology applied**
 - following OSPAR, area = zone II = chronic heavy metals inputs
 - Cd, 6 ppm = 60 kg in 10 000 tones (cargo) and OSPAR estimations give 50 to 79 tones per year

↳ Less than 1%



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Fate of the cargo

- Bioavailability, bioaccumulation and biomagnification
 - In seawater, heavy metals will form complexes with organic and inorganic materials.
 - Biomagnification appears not to occur with inorganic metals.



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Fate of the wreck

- Minimum depth 44.5 m
- No appurtenances likely to be released
- TBT-free antifouling Jan 2005
- Small quantities of paints and cleaners
- Potential impairment of activities of trawlers and potters
- 57 wrecks in box $1 \times 1/2^\circ$ & 483 between $2^\circ - 4^\circ W$
- Insignificant loss of fishing opportunity but longer term niche fishing
- Conclude wreck itself doesn't pose threat to environment or significant impairment to commercial fishing activities



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Conclusion

- Low release of the cargo
- IFO and lubricating oil recovered
- 21 days for the response on the wreck



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Take-home message

- All answers are **not in the literature...**
- Important to be able to conduct **experiments in emergency** conditions in order to provide authorities / responders with **right data**
- In some conditions, **slow release** of chemicals can be the best option
- Do not forget **“secondary” pollution**
- HNS incidents involve also **OIL**

No perfect solution, do not precipitate, calculate the risk and consider all options



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Lessons learnt from accidents ECE incident

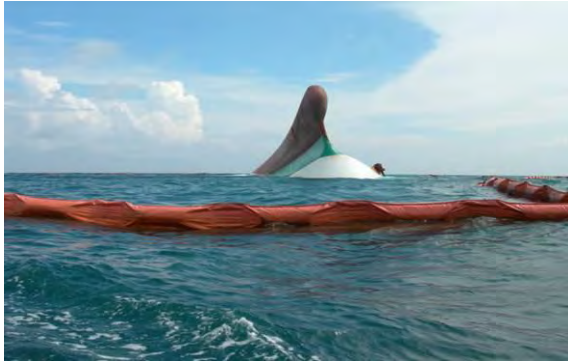
CEDRE

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Crash, leakage, accident



Where is the product?

Atmosphere
Sea surface
Water column



What is the risk?



What could be the impact?

Humans
Environment



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Plan

I. Parameters

II. Short-term

III. Long-term



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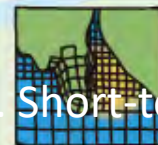
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Chapter 1

Parameters



I. Parameters



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II. Short-term



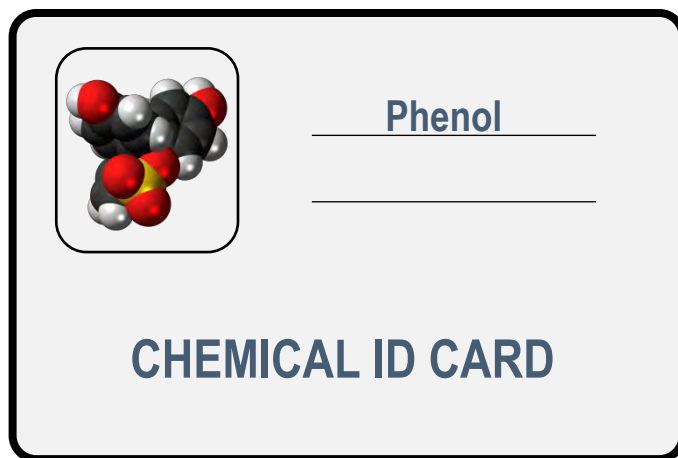
III. Long

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What can be found on a MSDS ?

physicochemical data

- Molecular weight
- Boiling point
- Fusion point
- Flash point
- Density
- Vapor pressure
- Solubility
- Viscosity



Laboratory

Ecotoxicity data

- LC50 (fish, rats...)
- Threshold Limit Value (TLV)

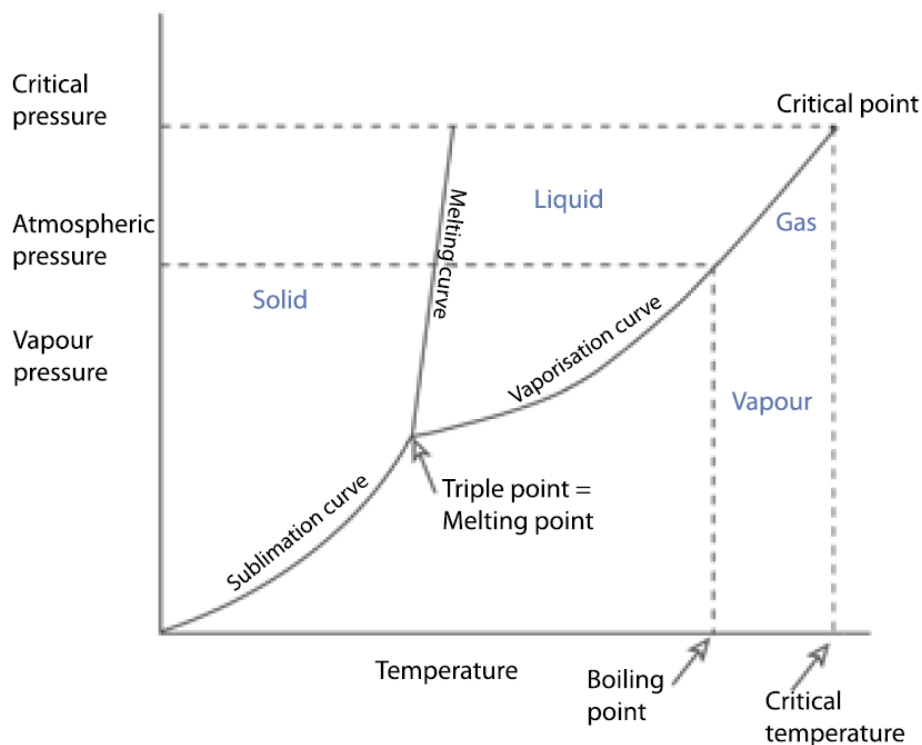


Chemicals states

6

3 states possible

- Gas
- Liquid
- Solid



HNS behavior will depend on



Transport condition

The environment



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Physico-chemical properties

Density

Mass per unit volume

Floating or sinking

Solubility

Ability to dissolve in the water column

Dissolve or not

Viscosity

Flowing resistance

The spreading of the slick

Vapor pressure

Thermodynamic equilibrium between condensed phase/vapor

Evaporate or not

Source Cedre



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Predicting a behavior



Marine Nationale

Accident

Immediately

- **REACTIVITY**

State changes
Reaction with :

- Air
- Light
- Water
- Product

First hours,
days

- **SHORT-TERM**

**SEBC
Code**

- Physico-chemistry

After a week...

- **LONG-TERM**

Physico-chemistry
and
Toxicity and
Environment



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HNS reactivity

Fast transformation of
the product



4 main reactions

With O₂ from
air

With water

With light

Polymerization
reaction



HNS reactivity

- With O₂ from air



Fire/Explosion

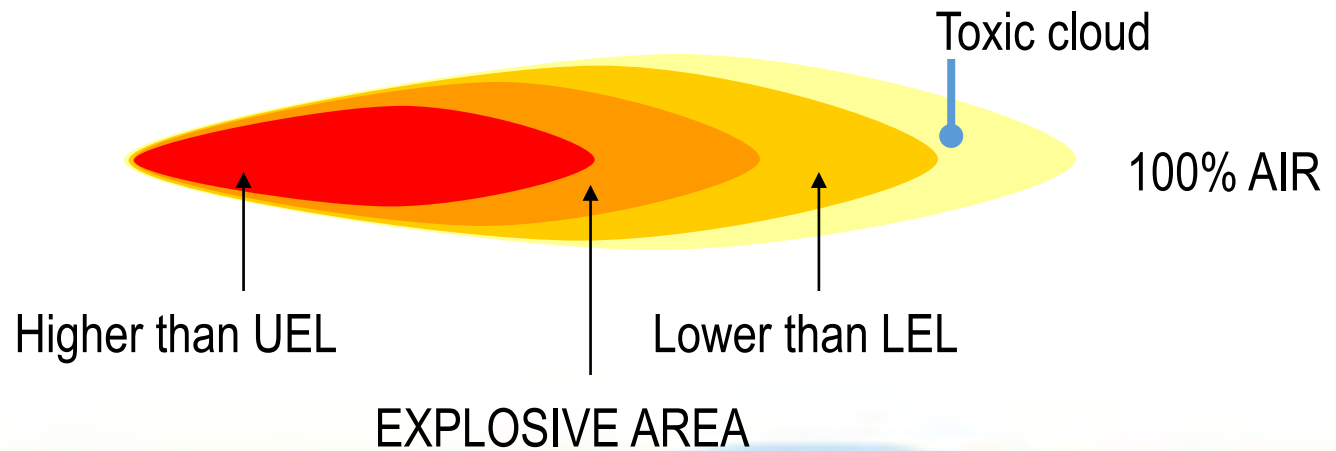
- With water

- With light

- Polymerization reaction

Flammability limits :

- Lower explosive limit – LEL
- Upper explosive limit - UEL

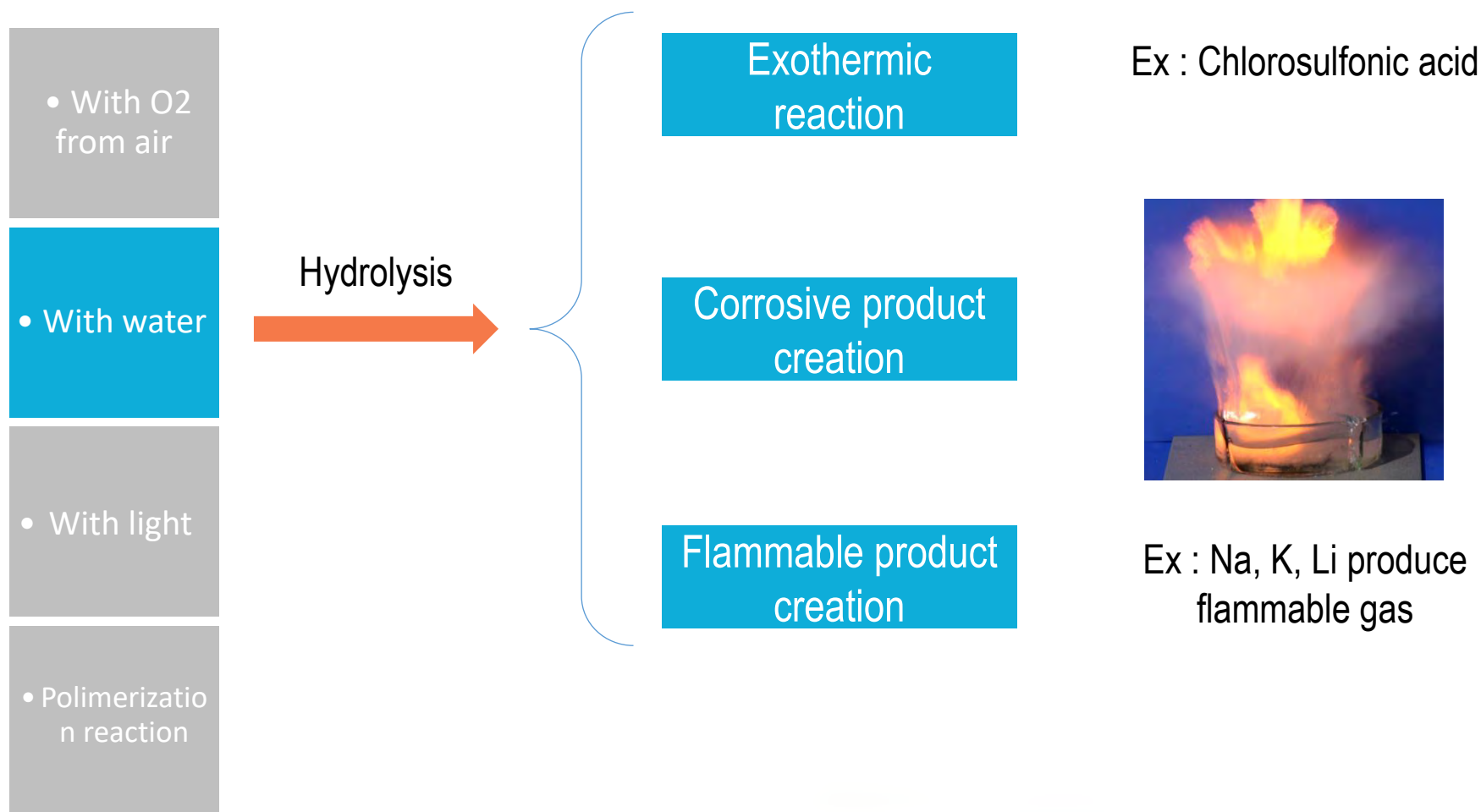


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HNS reactivity



HNS reactivity

- With O₂ from air

- With water

- With light

- Polymerization reaction

Chemical decomposition caused by light

T = several minutes to several months

Ex : N-nitrosoatrazine, Anthracene ...



Creation of toxic and/or explosive compound



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HNS reactivity

- With O₂ from air

- With water

- With light

- Polymerization reaction

Addition of inhibitors but polymerization can happen

- Contamination
- Contact with rust
- High temperature long exposure
- Static electricity
- Heat source

Monomer becomes unstable



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Influence of parameters - keypoints

Global
behavior



Depends on physico-chemical properties and environment



Depends on time scale



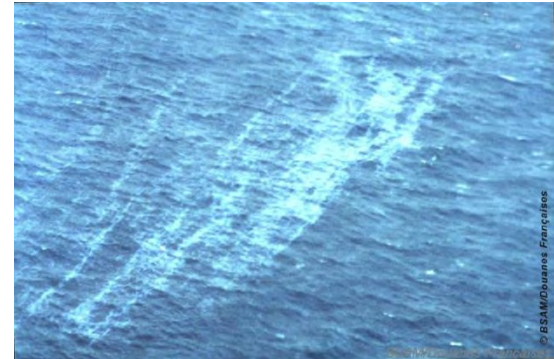
Immediate
behavior



States changes



Reactivity : Air – Water
– Light – Polymerization



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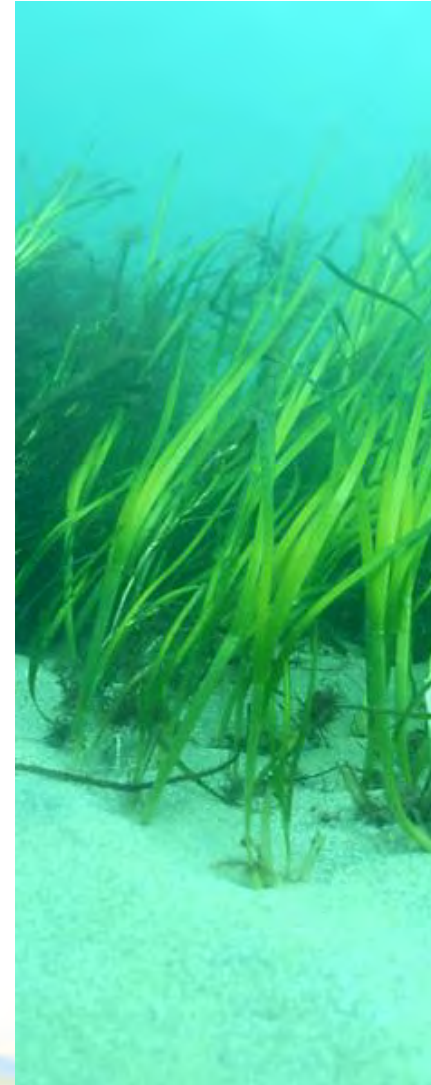


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Chapter 2



Short-term behavior

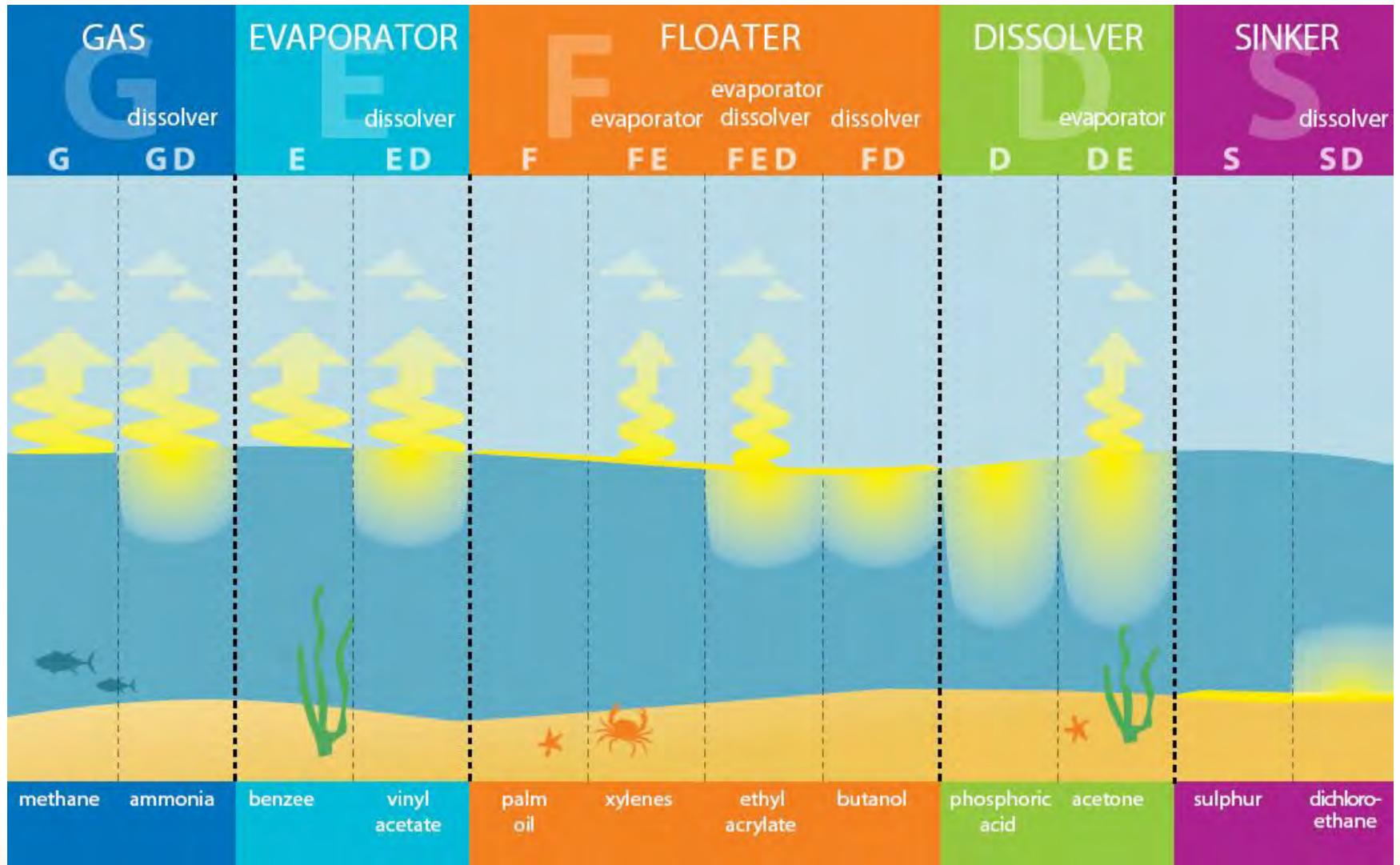


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Behaviors classification



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Short term behavior - Thresholds



Vapor pressure

0,3 kPa

100 kPa

Negligible

Fast evaporation

Gas

Density
(/seawater)

1,03



Floater

Sinker

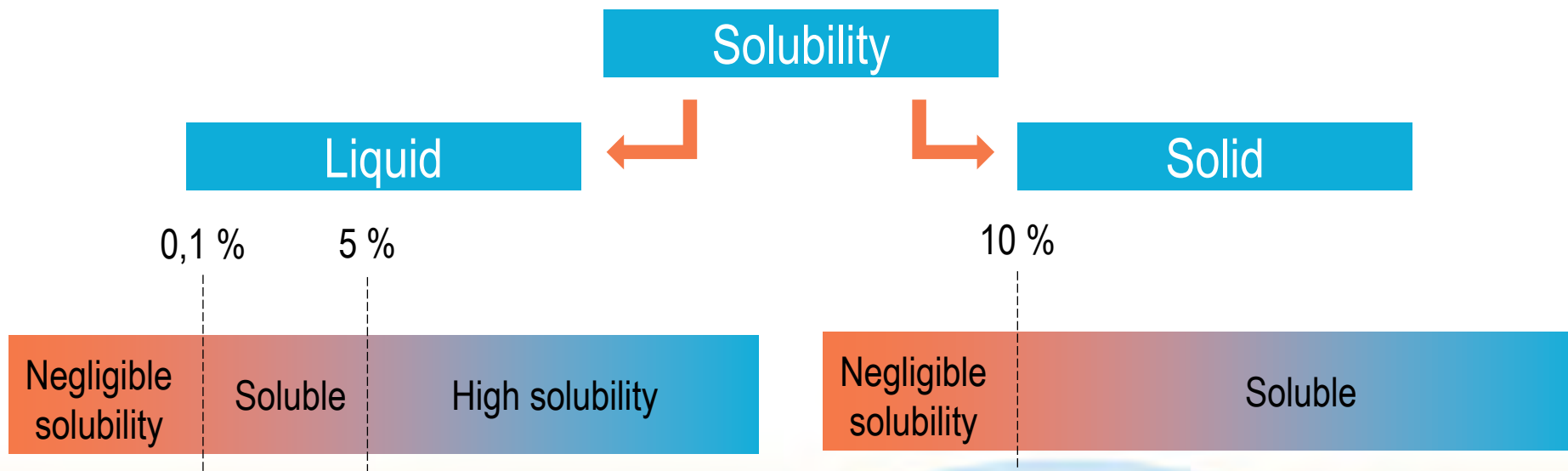


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Short term behavior - Thresholds

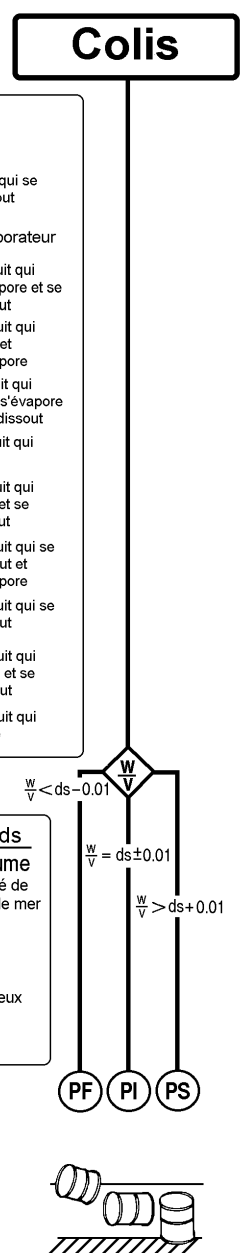
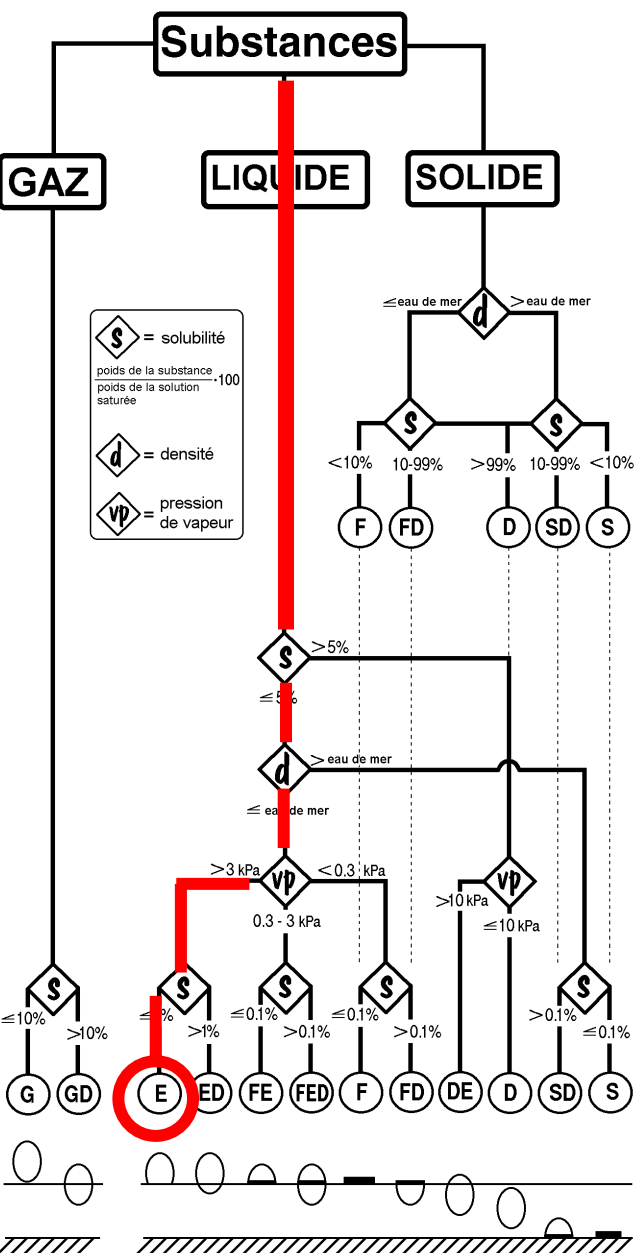


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Legal representation : SEBC Code



HNS classification

Example : Benzene

Physical state and appearance: Liquid.

Solubility in freshwater: 1,780 mg/litre at 20° C
1,830 mg/litre at 25° C

Specific Gravity: 0.8787 @ 15 C (Water = 1)

Vapor Pressure: 10 kPa (@ 20°C)

Evaporator

Limitation :

- Pure product
- In fresh water
- At 20°C

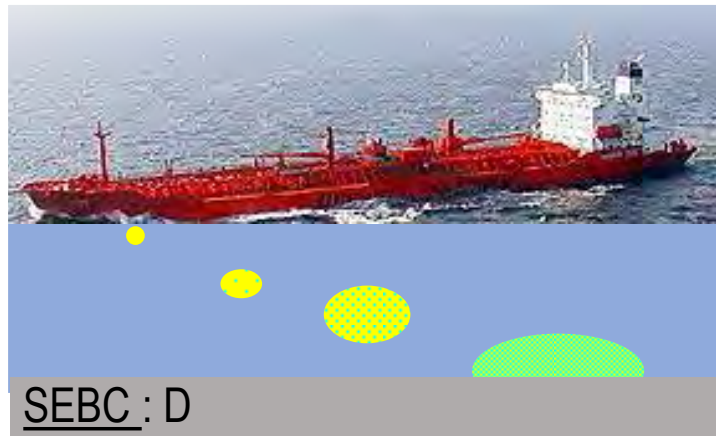


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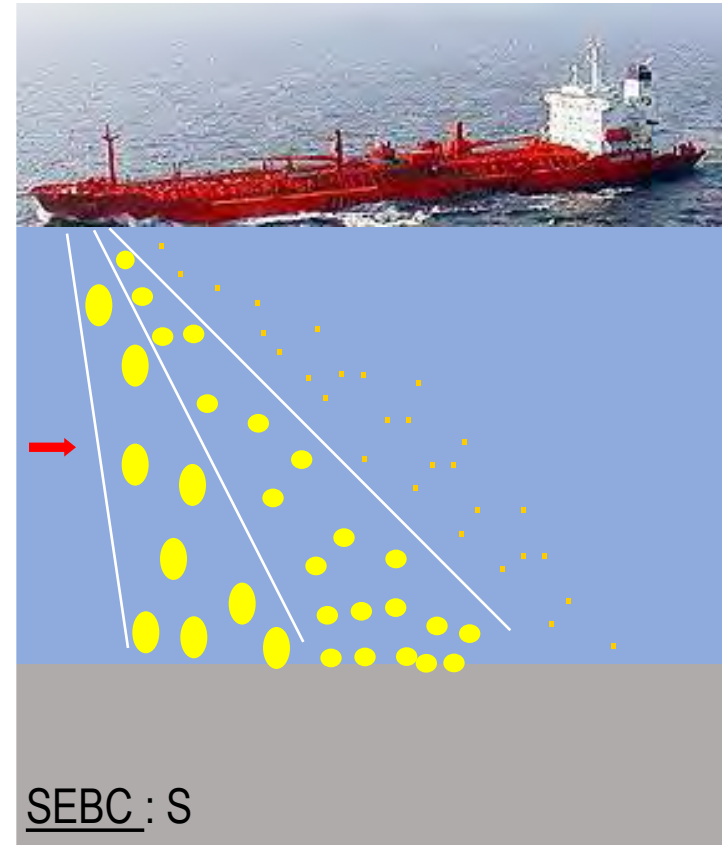
Limit of the SEBC Code



Methanol
solubility = 100%
density = 0.8



Sulfuric acid
solubility = 100%
density = 1.84



Dimethyldisulfure
Solubility: not soluble
Density: 1.063



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Short-term behavior - Keypoints

Behavior ?



5 main behaviors
(G – E – F – D – S)

SEBC Code?



Based on : State -
Vapor pressure –
Solubility - Density

Limitation



Efficient tool,
differences with reality



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Chapter 3

Long-term behavior

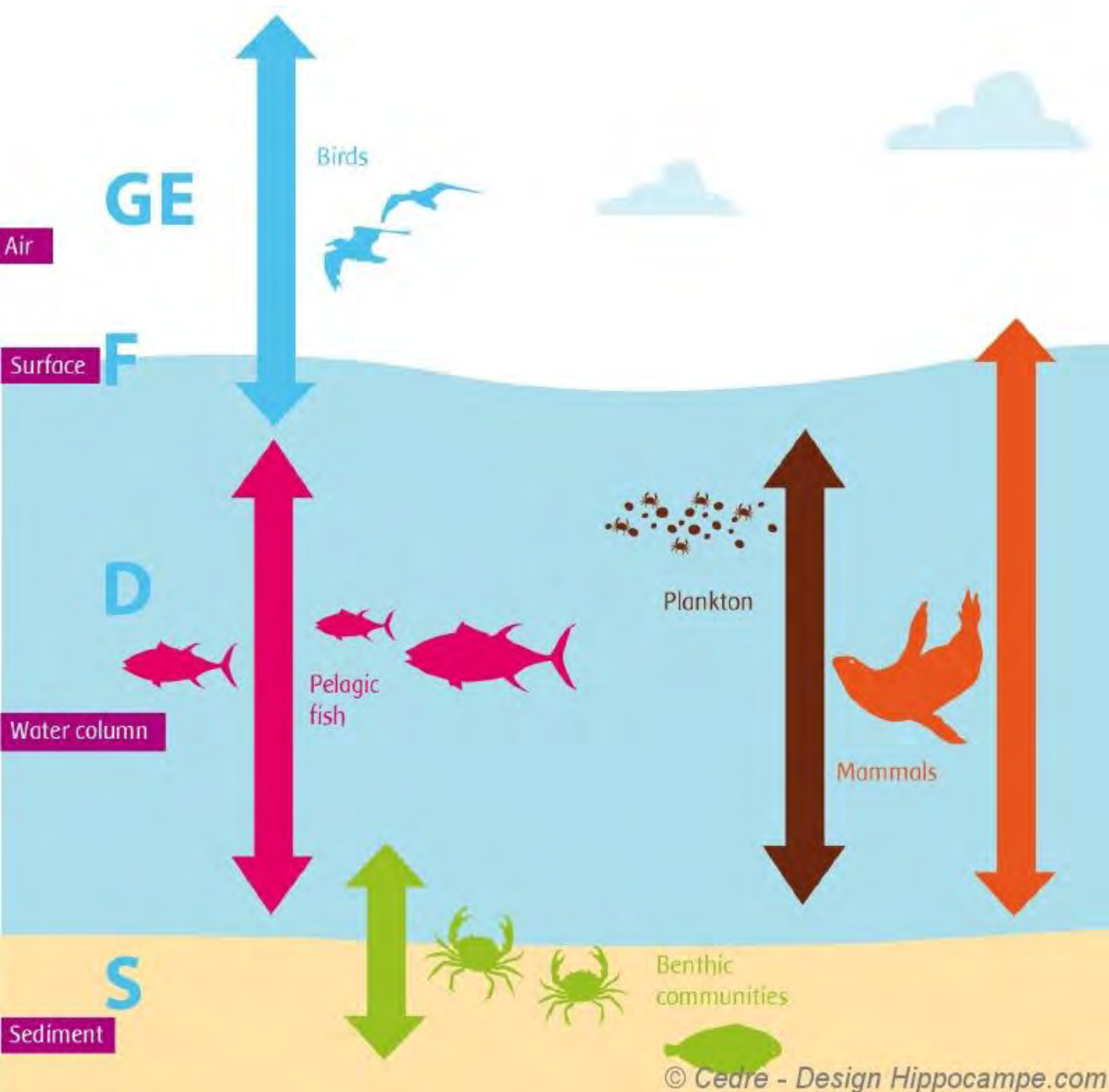


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Long term behavior



Environmental
effects monitoring



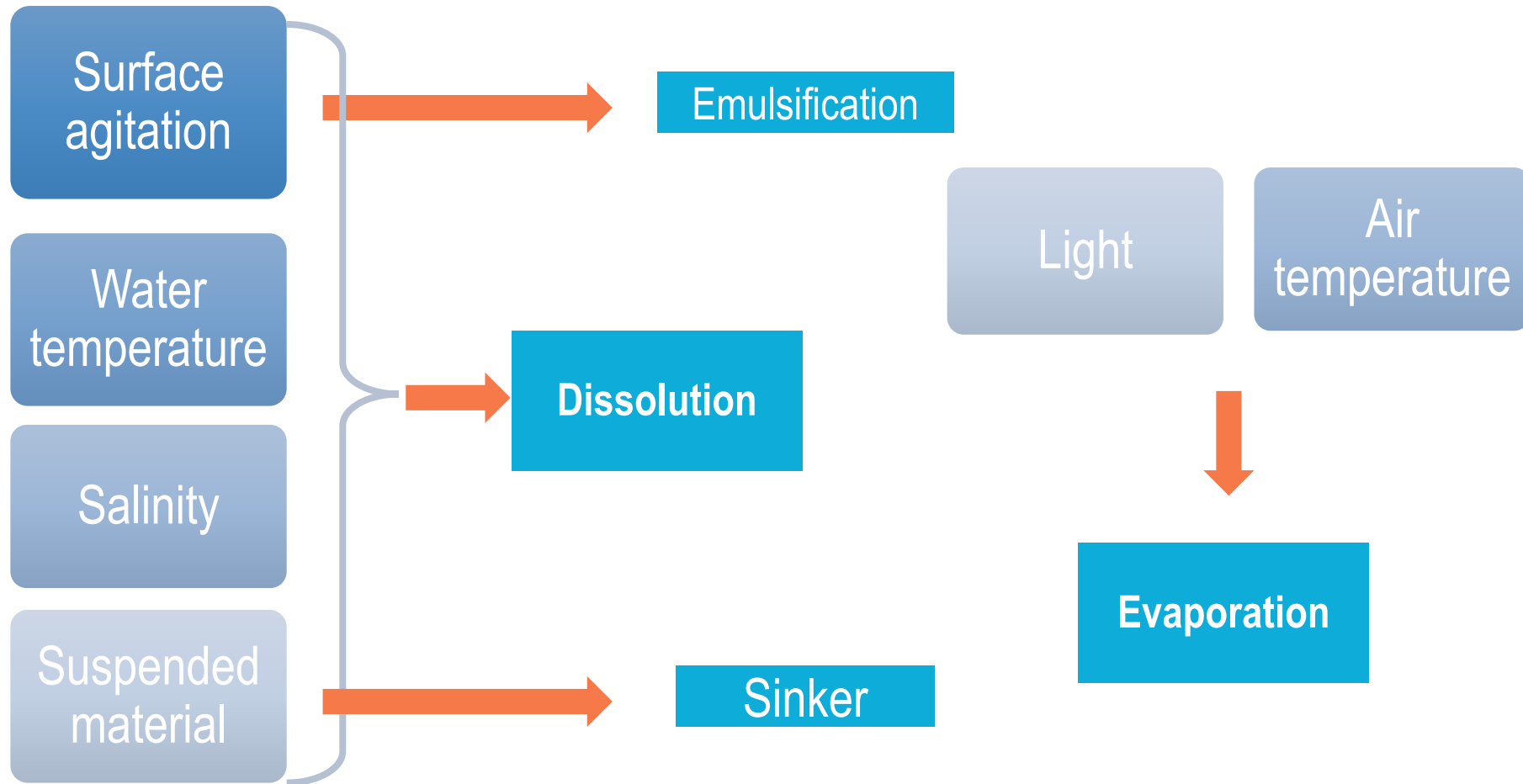
Trophic chain

INOFF



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Influence of environmental parameters

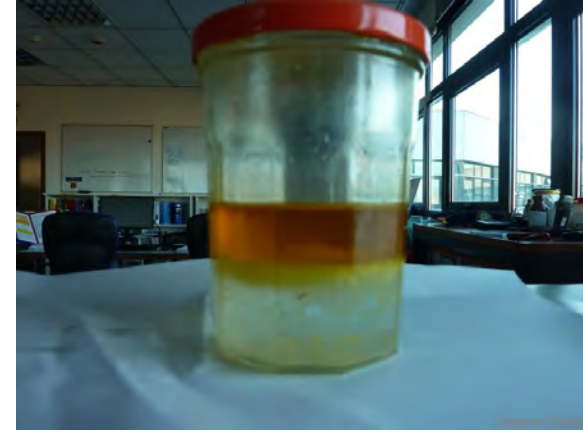


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Influence of environmental parameters



Ex : Soybean oil



Response technique may evolve
through time



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Long-term behavior - Keypoints

Environment



Monitoring impact



Behavior?

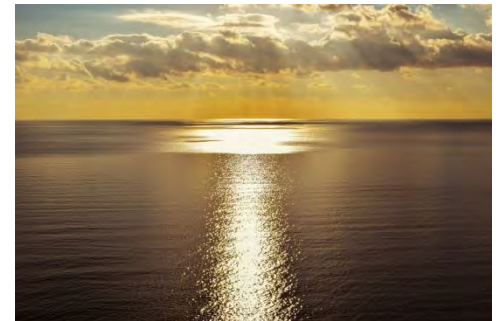


Can evolve with various parameters

Responses techniques



Needs to adapt to the change of behavior



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Keypoints

Not only one behavior per compound

Emergency context → quick answer

Short-term → SEBC code

Long-term → Monitoring the environment

Perform research to assess precisely the behavior



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Humanitarian Aid**



<http://www.hazrunoff.eu/>



@hazrunoff





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Practical exercise on HNS behaviour SEBC understanding

CEDRE

Florence PONCET
Stéphane LE FLOCH



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The Material Safety Data Sheet

- MSDS (Material Safety Data Sheet) produced / drafted by manufacturer (legal obligation)
- 16 compulsory sections



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1. Identification of the substance / mixture and of the company / undertaking

2. Hazards identification

3. Composition / information on ingredients

4. First-aid measures

5. Fire - fighting measures

6. Accidental release measures

7. Handling and storage

8. Exposure controls / personal protection

9. Physical and chemical properties

10. Stability and reactivity

11. Toxicological information

12. Ecological information

13. Disposal considerations

14. Transport information

15. Regulatory information

16. Other information

Contribution of MSDS to the chemical behavior understanding



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Practical exercise: Which behaviour ?

- MSDS

- Benzene
- Linear Alkyl Benzene
- Sulphur, Solid
- Toluene
- p-Xylene

- Physical and Chemical properties

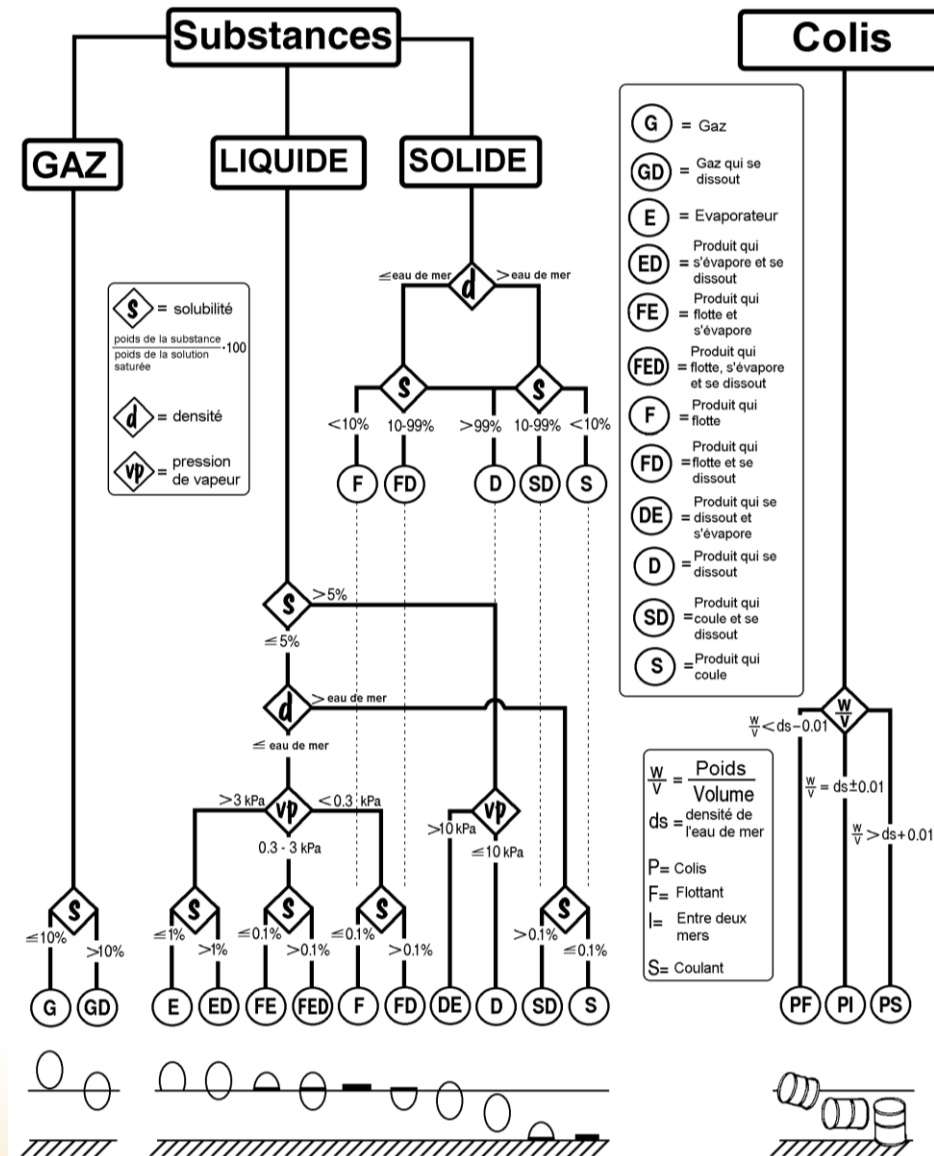


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How to use the Standard European Behaviour Code



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- **But keep in mind**

- **MSDS designed for land/factory based worker**
- With more or less information
- More or less reliable
- Physical and chemical properties from the lab
- The impact of weather condition is not considered



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Additional information

- Interest in looking at other databases
 - <http://www.ericards.net/>
 - <http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/ergmenu.aspx>
 - ...
- be ready to use conversion tools
 - <https://converticious.com/>
 - kg/m³ to ppm, mg/L to %...
- Commercial names
 - <http://ccinfoweb.ccohs.ca/cheminfo/search.html>
- Lack of ecotoxicology data
 - [HNS-MS project](#)



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- “Easy” to predict the short term behaviour
- BUT, keep in mind that the environment will have an impact on the fate of the product...
- Need to get advice from expert



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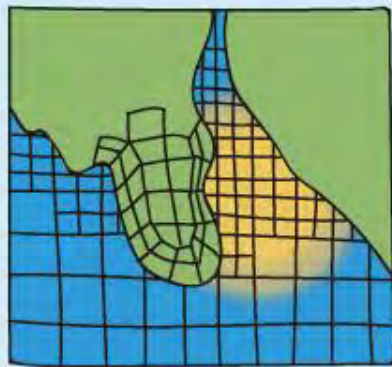


<http://www.hazrunoff.eu/>



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Prevention, Preparedness and example of response options

CEDRE

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Methodological approach



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Preparedness & Response

- Preparedness is based on 3 pillars

- Organisation
- Human resources
- Materiel resources

- Response is based on the chemical behaviour

- Floater
- Evaporator
- Dissolver
- Sinker

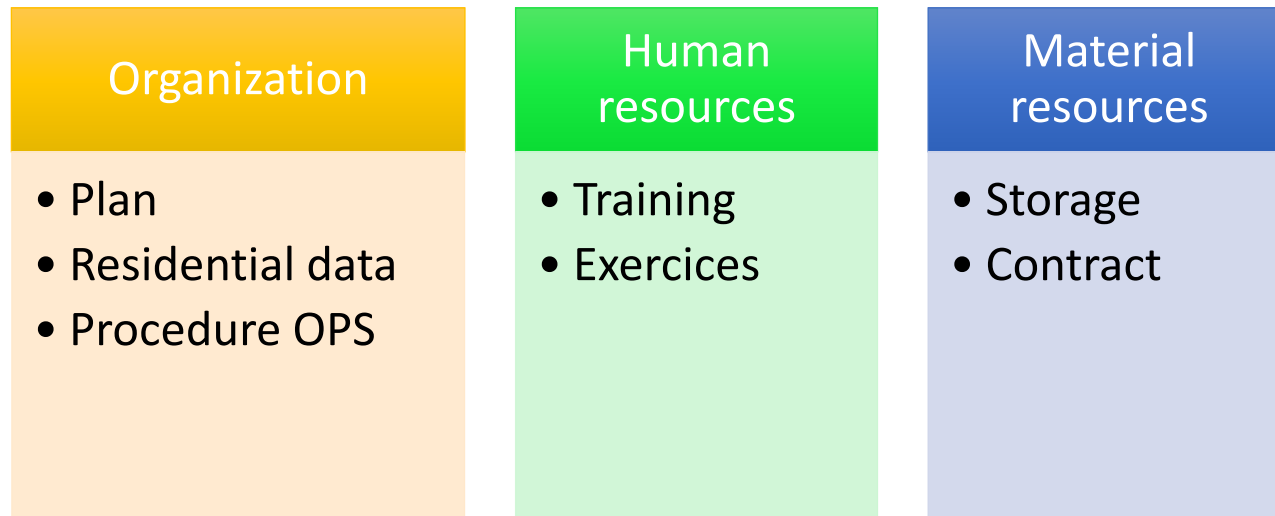


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Preparedness



Preparedness represents 90% of the response efficiency



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Organisation

Plan
Residential data
Procedure OPS



Objectives of a Contingency plan



Protect potential targets

People

Environment

Goods



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Expectations



Real efficiency

Operational

- Concise & complete
- Realistic
- Easy to use

Universality

- Known, understood and agreed by all users

Adaptability

- Tested
- Reviewed
- Upgraded regularly

Contingency plan annexes



Every operational info useful
for response



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Contingency plan : key points

Operational : concise & complete, realistic, easy to use ...

Known, understood & agreed by all users

Tested, reviewed and upgraded regularly



Human resources

Training
Exercises
Communication



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Training

- Employer is responsible for the safety of employees,
- Responders must be trained on the materials they will wear or deploy,
- Stakeholders must aware of field reality.



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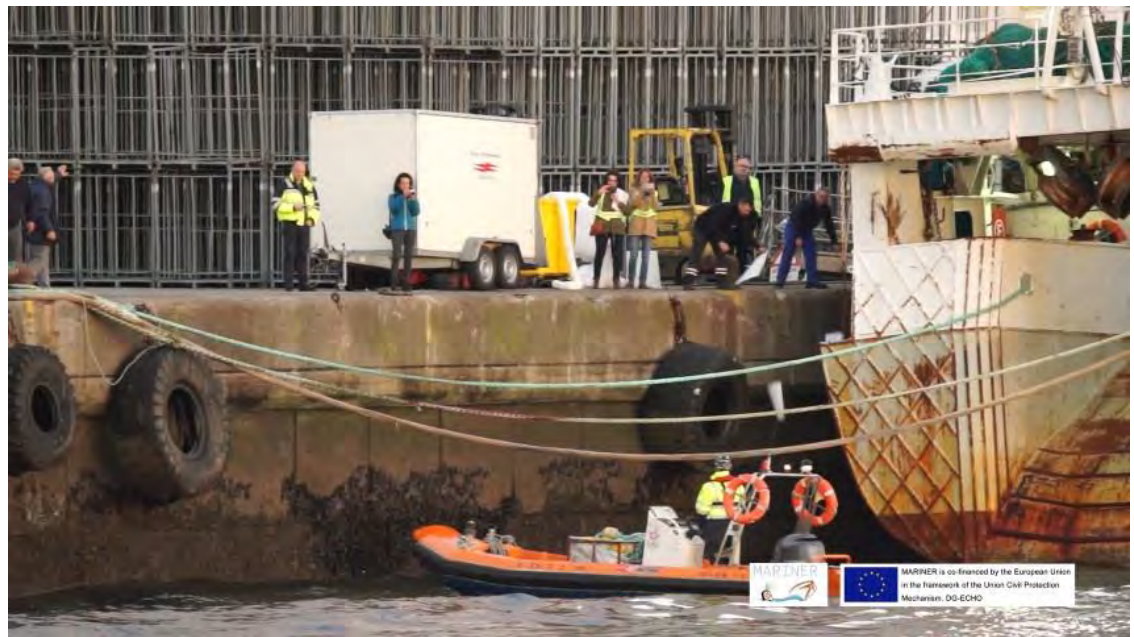
Exercises

3 Phases

Preparation

Exercise

Assessment



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Communication & media relation plan



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Human resources: key points

Training

Organize exercises

Communication is essential
(Internal & External)



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Material and Resources

Storage Contract



I. Contingency plan

II. Human resources

III. Material resources



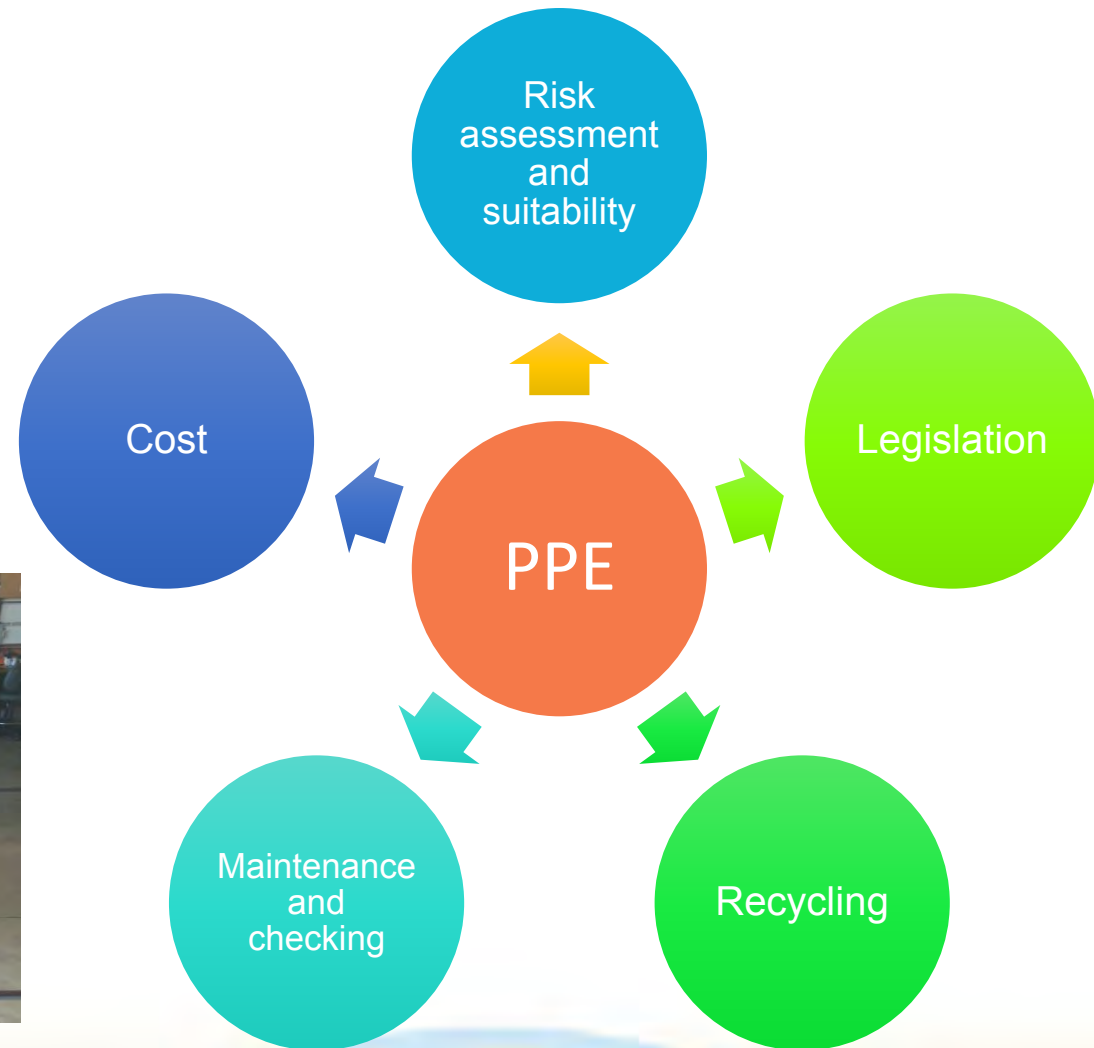
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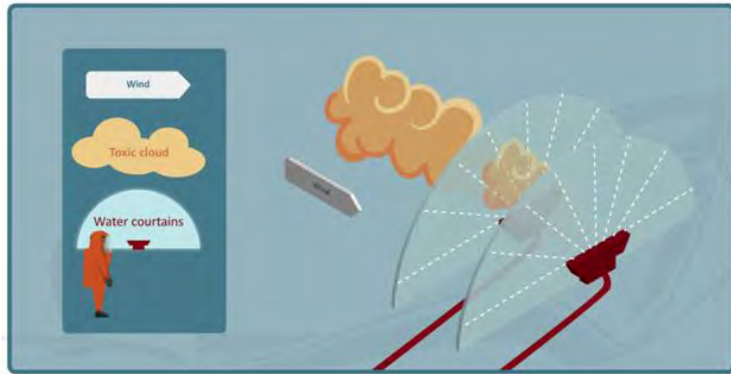
Which material to acquire ?

Personal
Protective
Equipment



Which material to acquire ?

Response
material



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Material resources: key points

Acquisition of PPE must be considered with care

Specific hazard require specific material

Be prepared for every cases, know the limit of each material

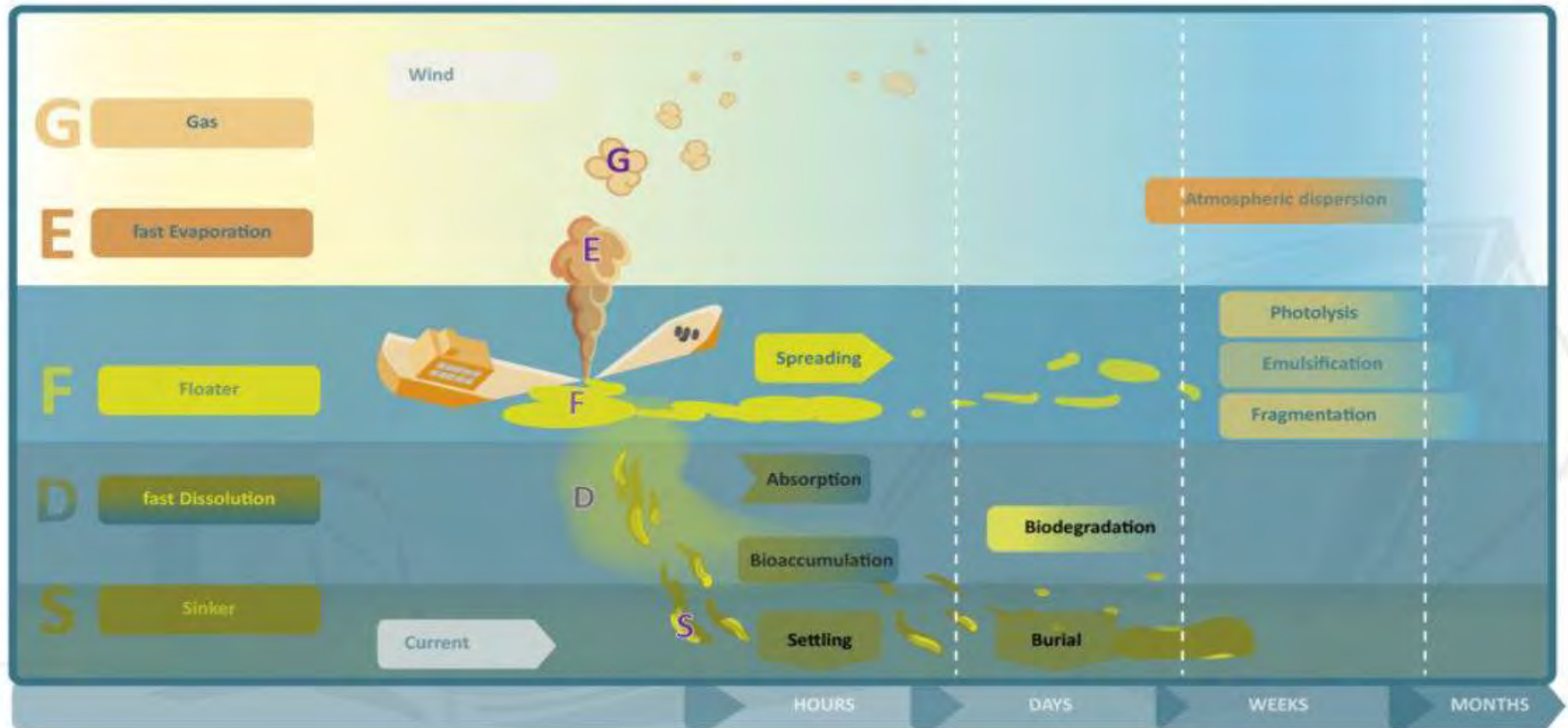


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Response



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Response: Evaporators

Measuring



Vapour cloud

Use :

- Sensors
- Gas detector
- Thermal Imaging Camera



- Can be :
 - Corrosive
 - Flammable
 - Toxic



Neutralizing



Protect and limit evaporation

Use :

- Water curtain
- Mist
- Foam

Gaps....

Detection

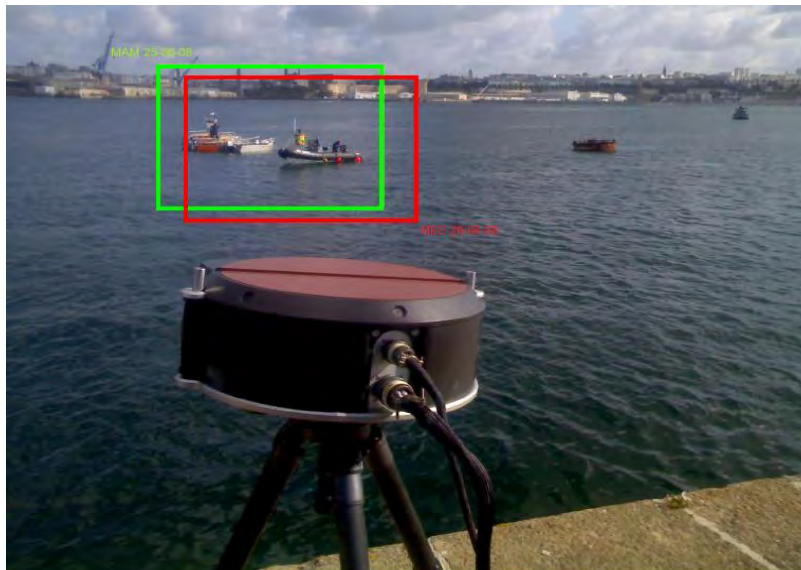
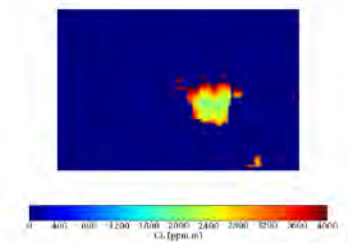
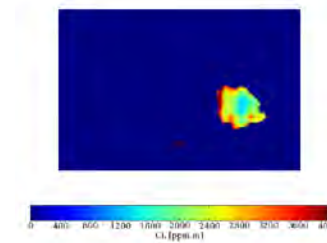


Figure 5 Champs surveillés avec le SPIM pour le MAM le 25/06/2008 (en vert) et pour le MEC le 26/06/2008 (en rouge)



Modelling validation

Response: Floaters

Measuring



Sampling the slick

By :

- Ship or helicopter
- Airborn sensors
- Measuring UV or IR

Neutralizing



Recovery

Only on pesisting and low toxicity product (animal and vegetable oils)



Marking by drifting buoy



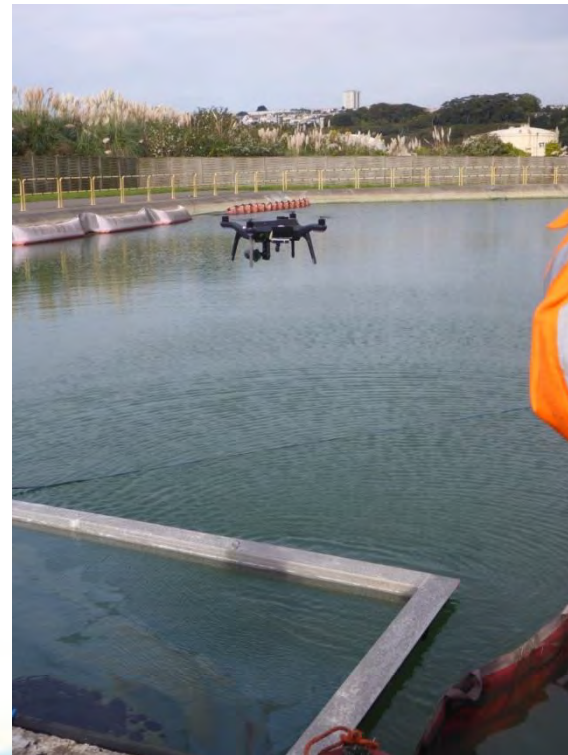
Gaps....

Teledetection of chemical pollution at sea

Detectors



Vehicles (satellite, plane, drone)



Response: Dissolvers

Measuring



The water column

By :

- Classic sampling
- ROV or AUV
- In situ sensors

Neutralizing



Seldom possible

- Impossible recovery of the dissolved part
- Displacement of the spill



Marking by drugged buoy



Long-lasting monitoring of the pollution



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Dosing Units – Water Based

Water-Based Mills



Earth Systems' water-based mixing and dosing units are suitable for many water treatment applications. Why pump water to a centralised plant when it is more cost effective to treat at the site of your issue or directly in your water body? These units avoid pumping and piping costs, and despite their size, have large reagent throughputs. If you are seeking cost effective, flexible, dependable and robust mixing and dosing units, then consider a water-based system employing our patented Neutra-Mill technology.



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Response: Sinkers

Measuring



On the sea floor

- Sampling by protected divers
- By ROV or AUV
- Acoustic imaging

Neutralizing

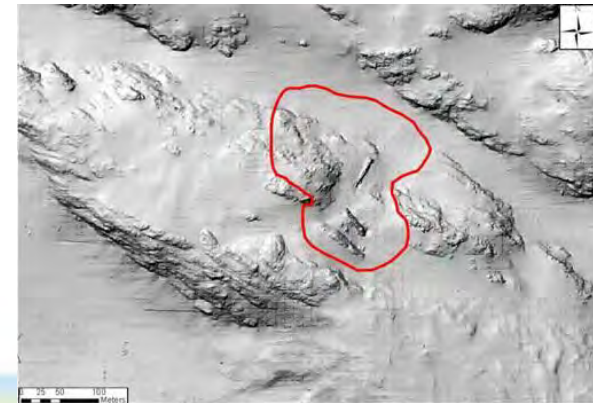


Recovery

- In low depth area



Can be hard to detect



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Neutralization option

Sinking the ship

- Only with good reasons
- Used about 20 times in 35 years
- Adamandas (2003); Turtle (1983); Stade (1972); Ammersee (1974); Circe (1967); Cavo Cambanos (1981)...



Insurances !



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Keypoints

Identify the exact nature of the chemical(s)

No rush, get information by sampling

Response depends on HNS behaviour and reactivity

Mark the spill to monitor it

Sinking must be the last response available





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HAZRUNOFF

PROJECT

Pollution detection and flood alerting using remote sensing

EOMAP

Christian BÖDINGER
Karin SCHENK



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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



EMODnet

Data
Provider



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The Ocean...



www.eomap.com

02/06/2020

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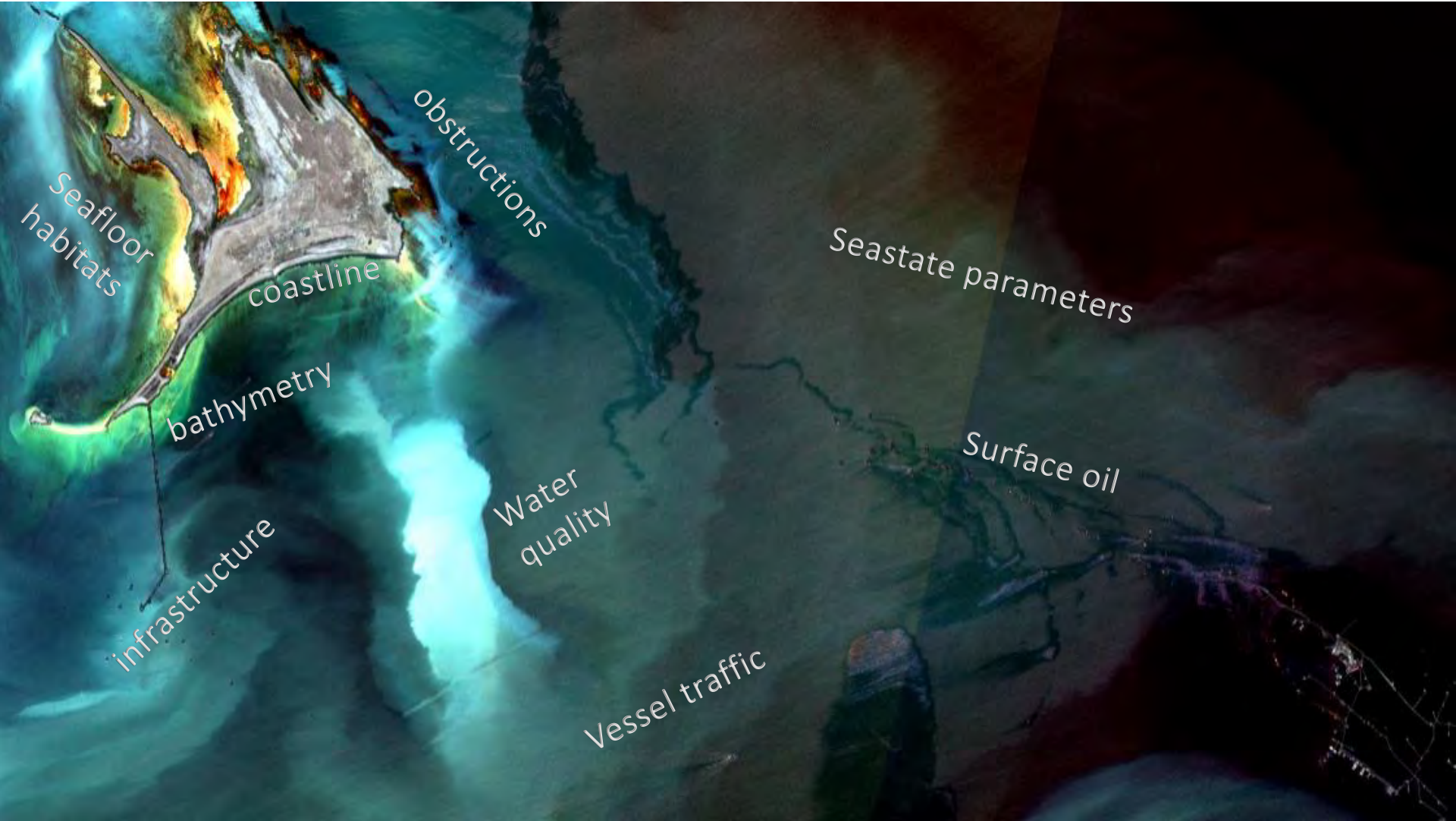


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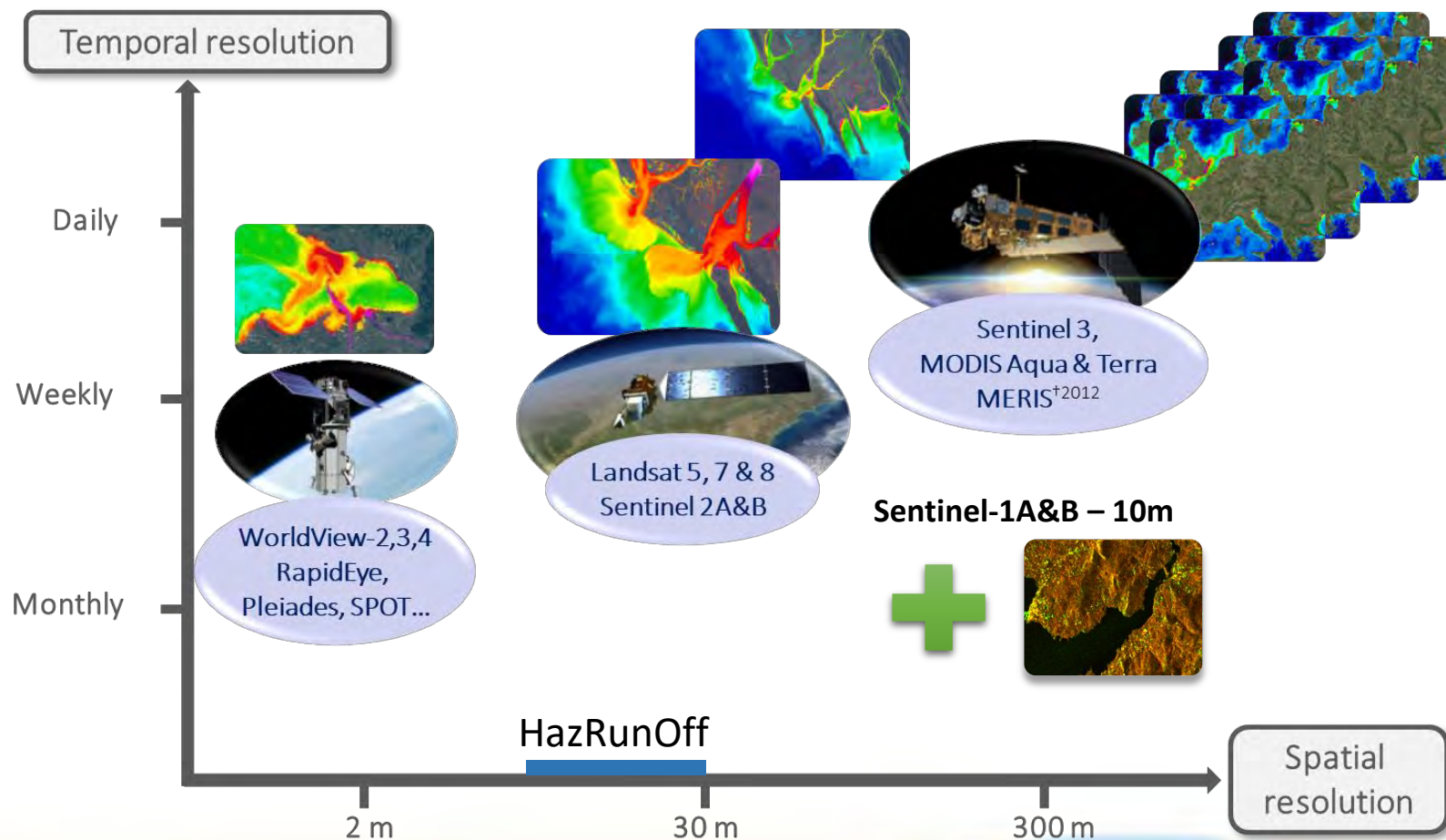


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... a sea of possibilities for remote sensing



Satellite missions frequently used

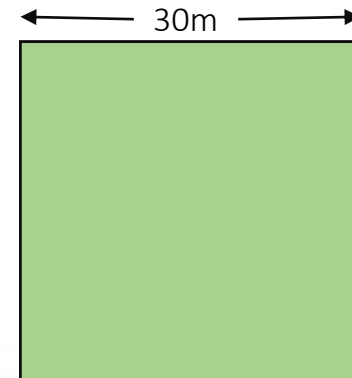


Landsat 8

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



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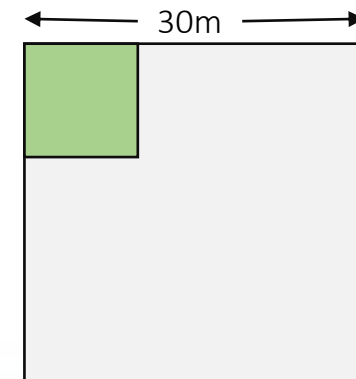
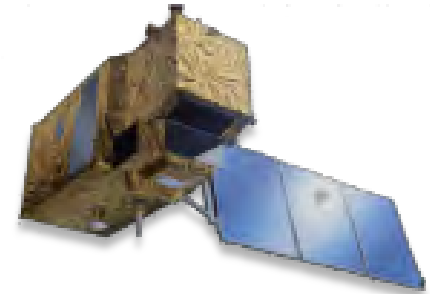
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Sentinel 2a and 2b

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



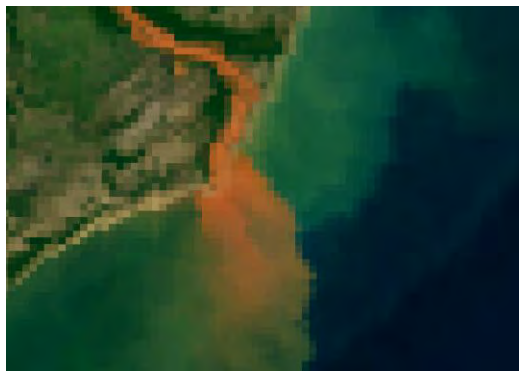
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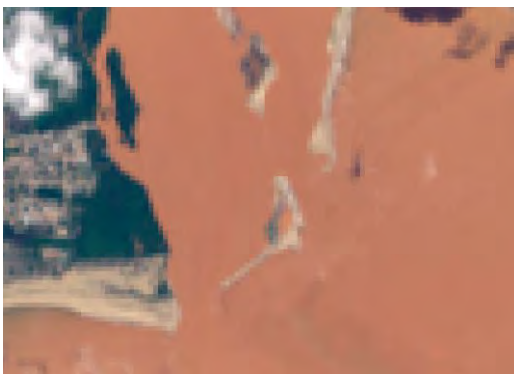
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Spatial resolution matters

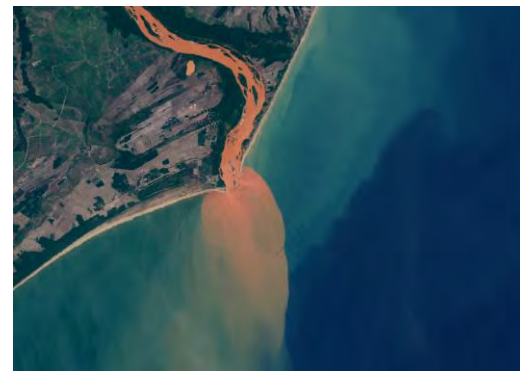
MODIS (500m)



Landsat 8 (30m)



Sentinel-2 (10m)





Optical:

- Sentinel-2 – 10m
- Landsat 8 – 30m



Some Pros:

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

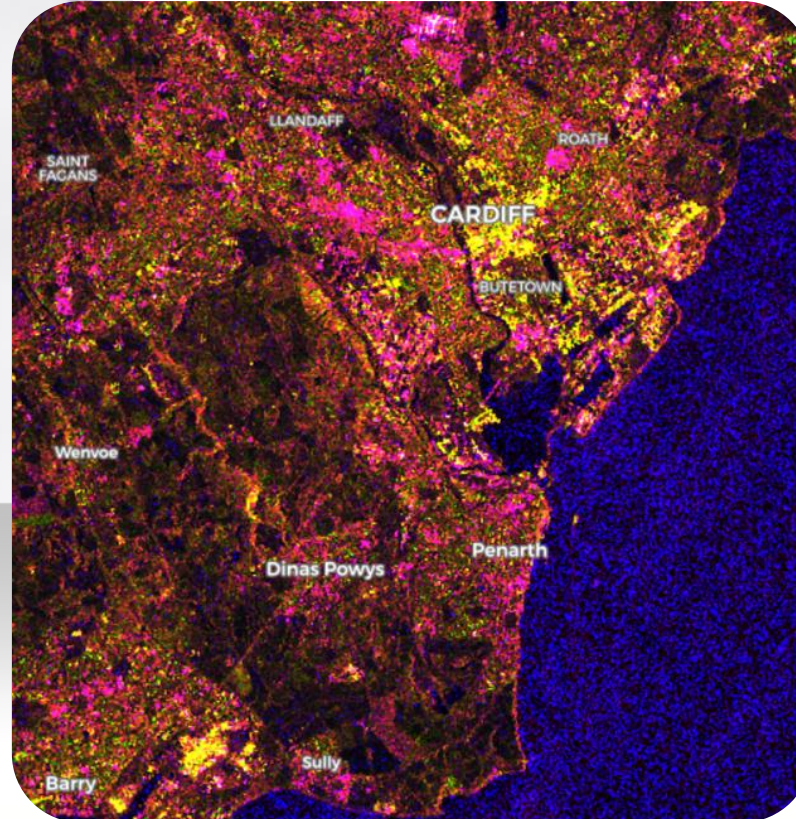
The Con:

- *Cloudiness*



... simply use Radar!

Sentinel-1 C-Band Radar



Images every
1-2 days!

Sentinel-2 Optical



Images every
2-3 days!

02.06.2020

MEETING



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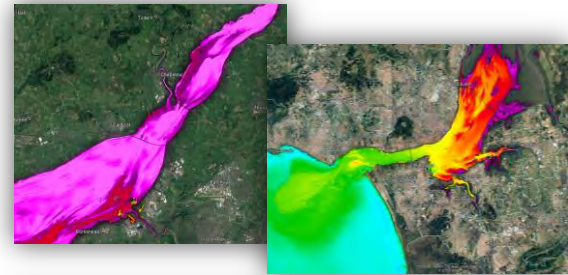


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Our tasks in HazRunOff

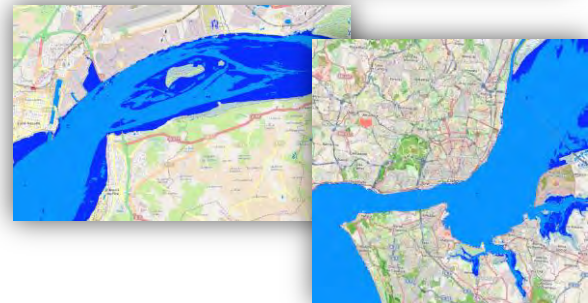
1. Turbidity

Monitoring Turbidity in river estuaries



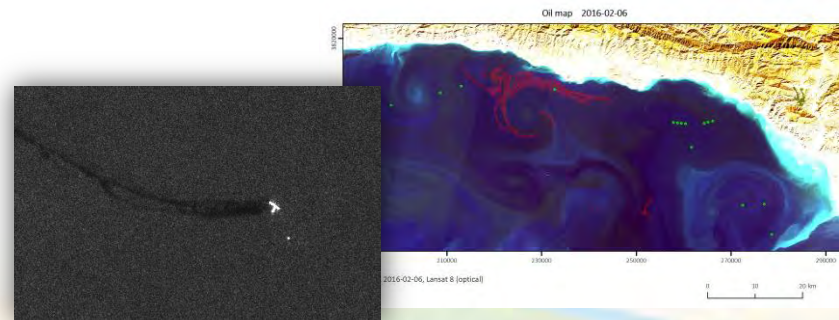
2. Water Level and Extent

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



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II. Detecting Pollution and Flooding from Space

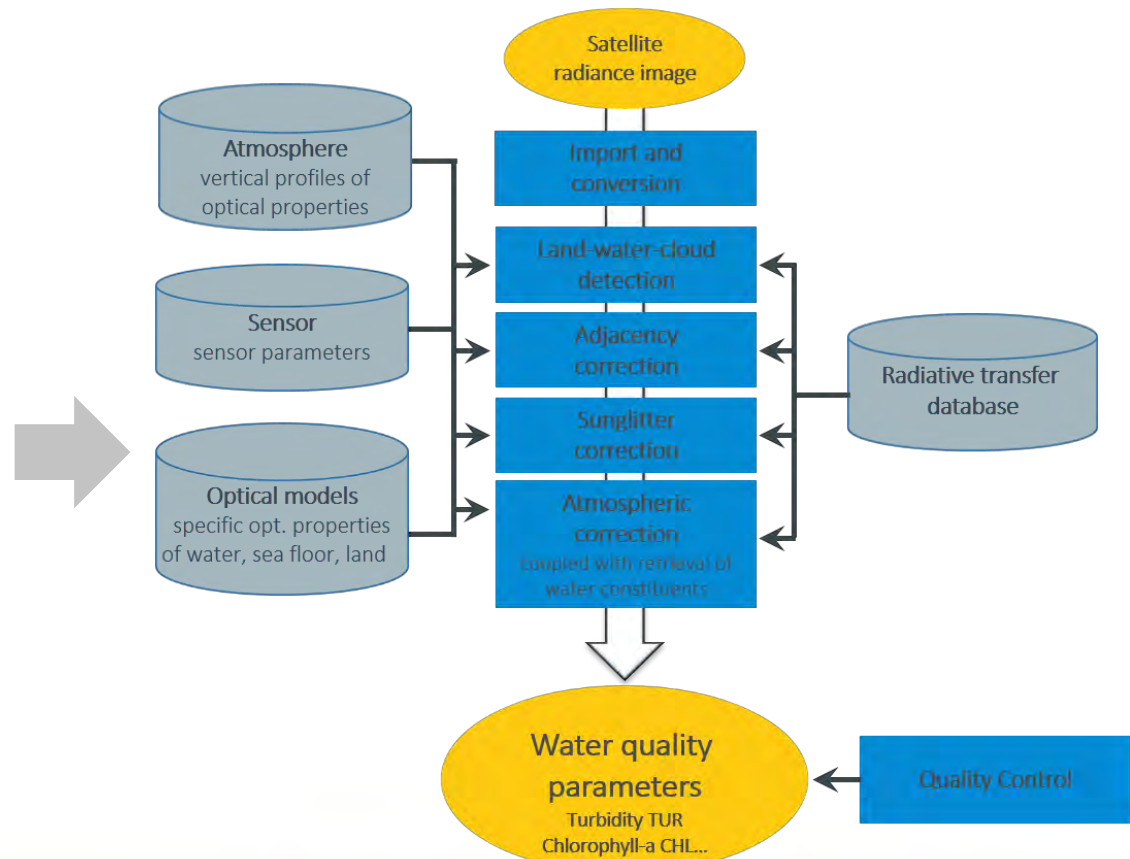
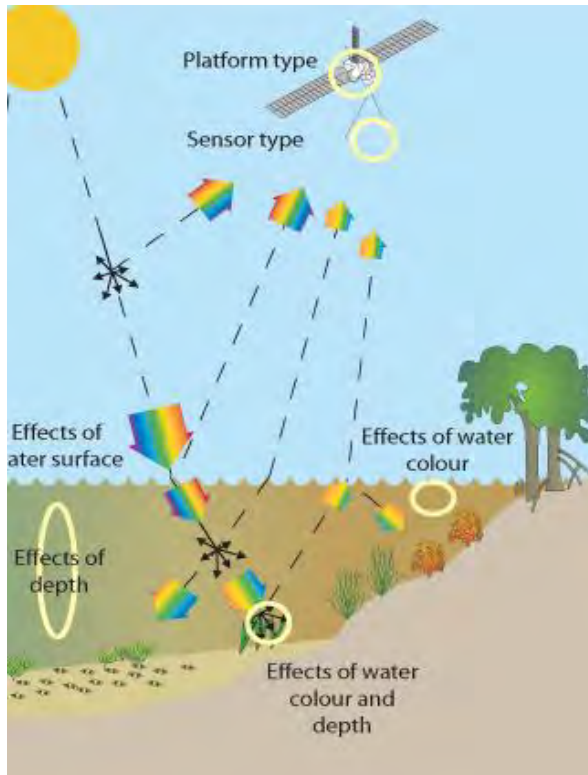


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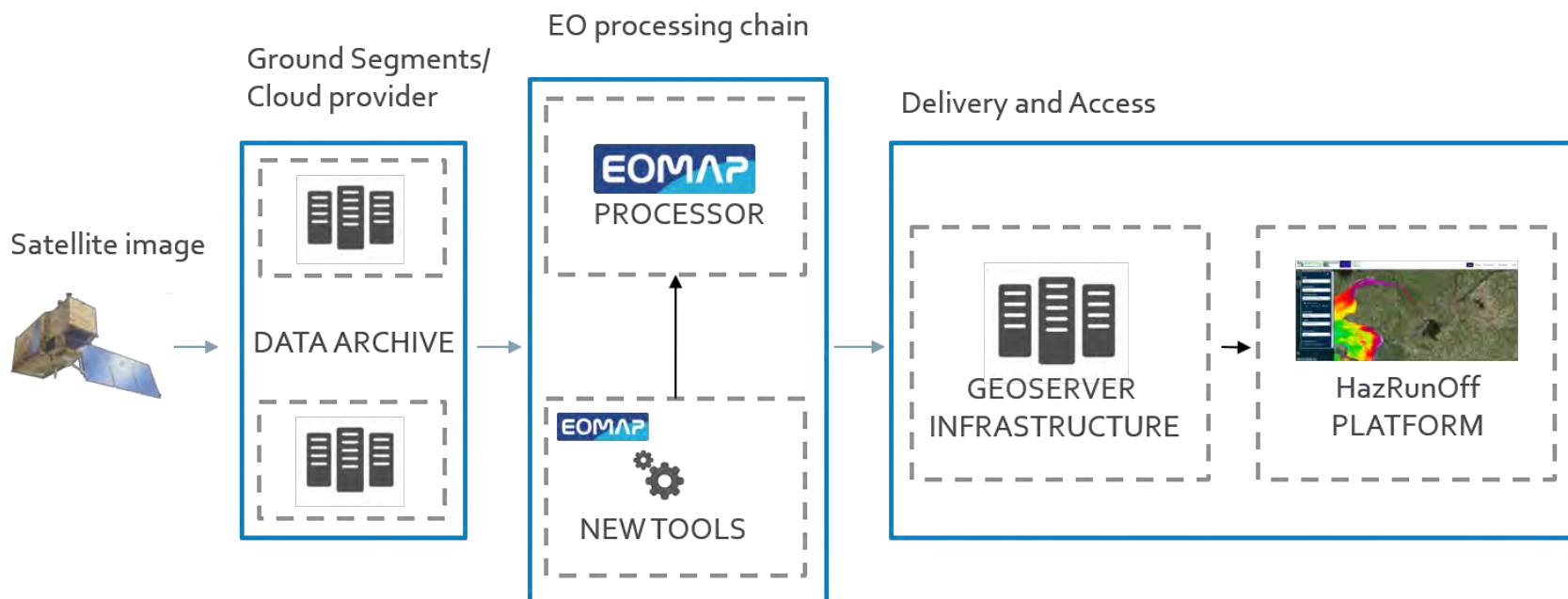


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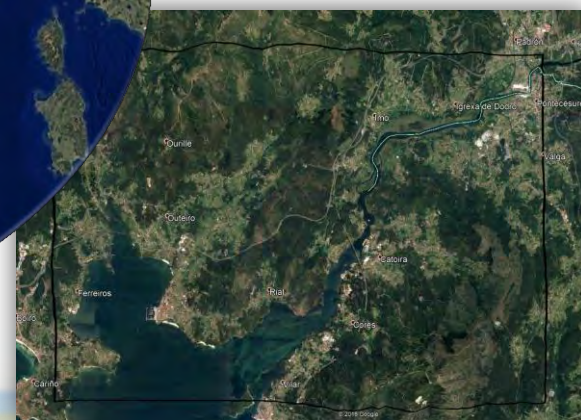
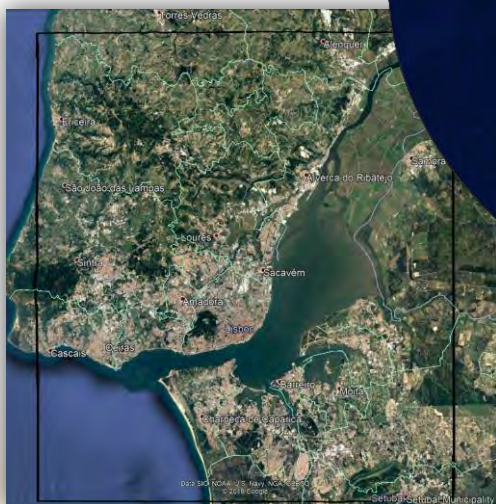
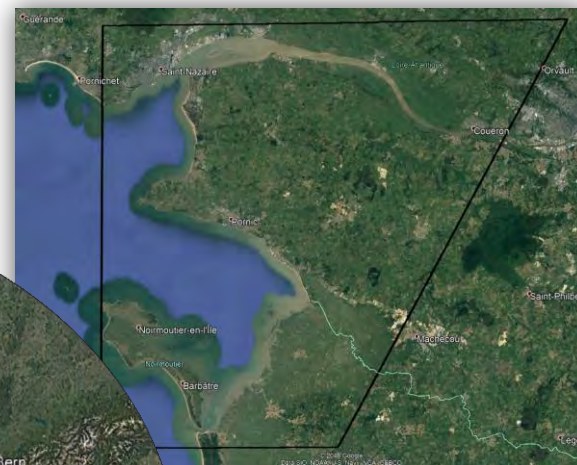
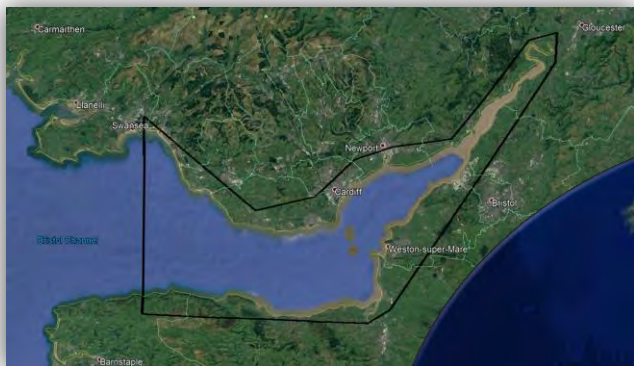
Physics based models for Water Quality assessment



From space to the user



Monitoring for HazRunOff



02/06/2020

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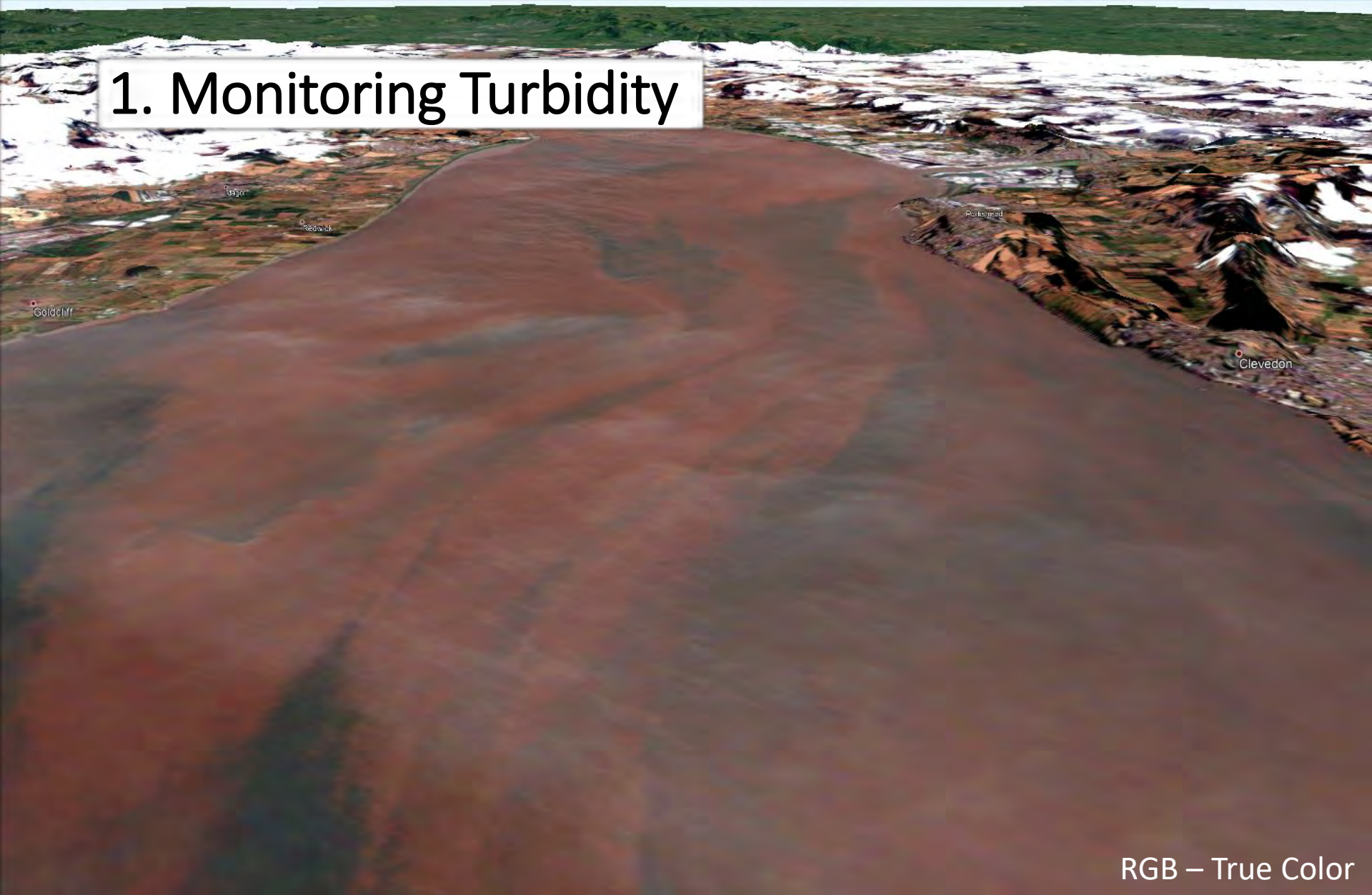


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1. Monitoring Turbidity



RGB – True Color

Severn Estuary – Close to Cardiff

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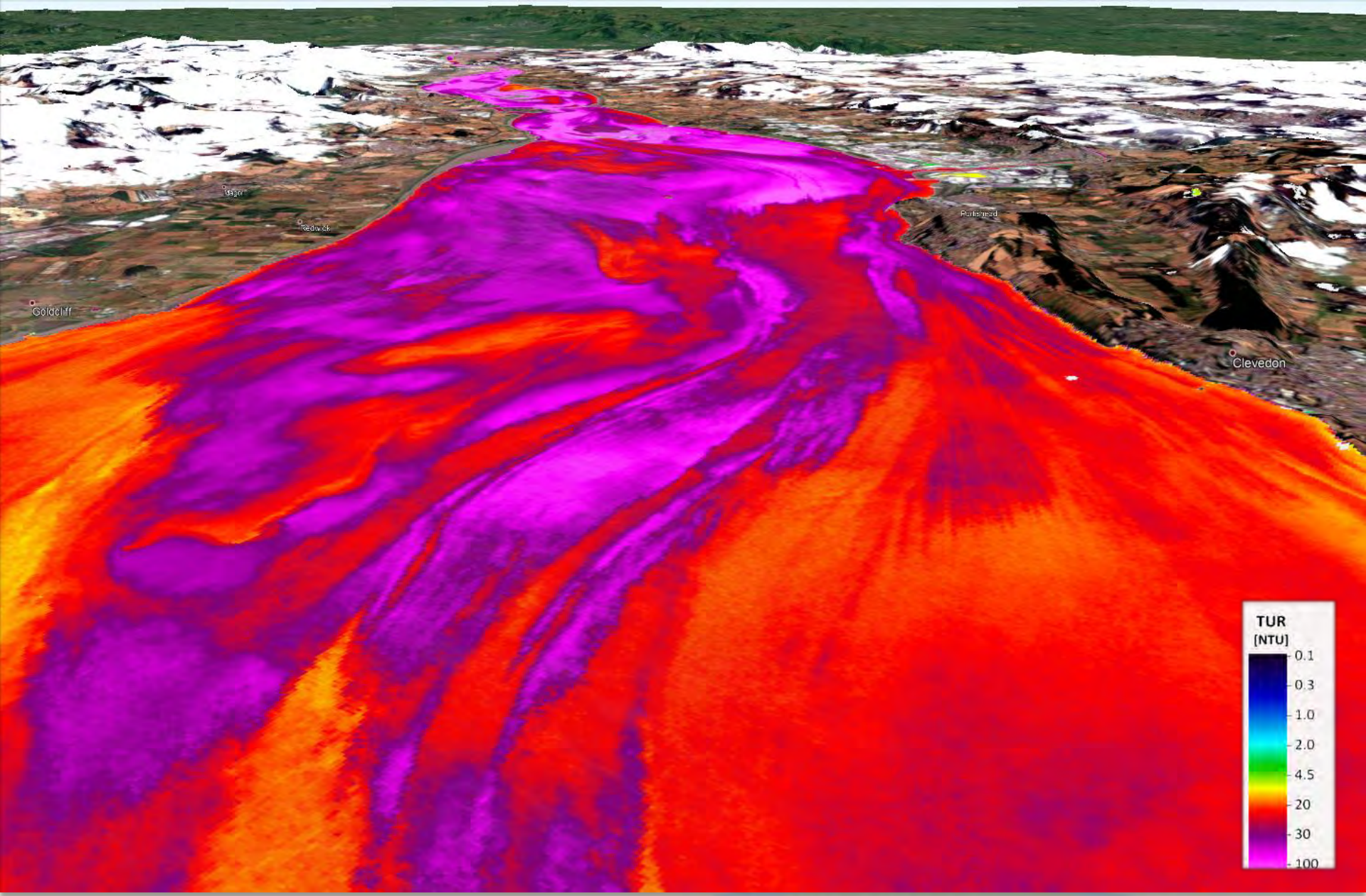
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Severn Estuary – Close to Cardiff

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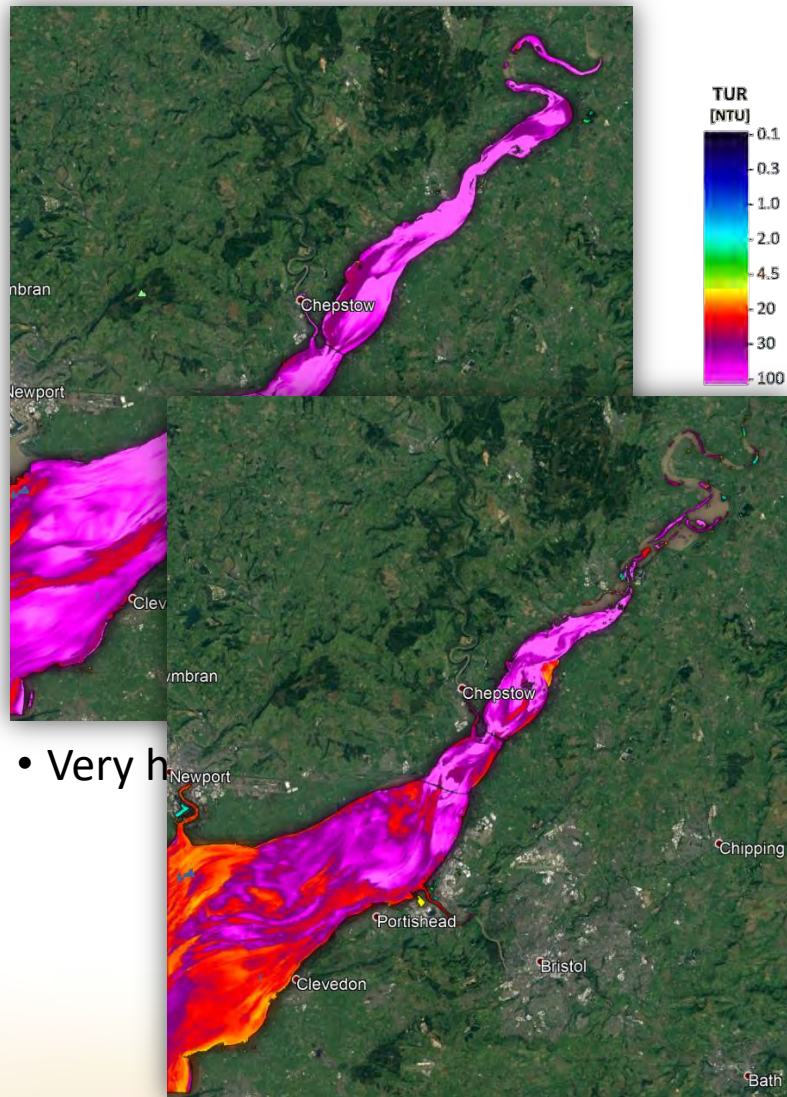


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Monitoring over Time and Tide

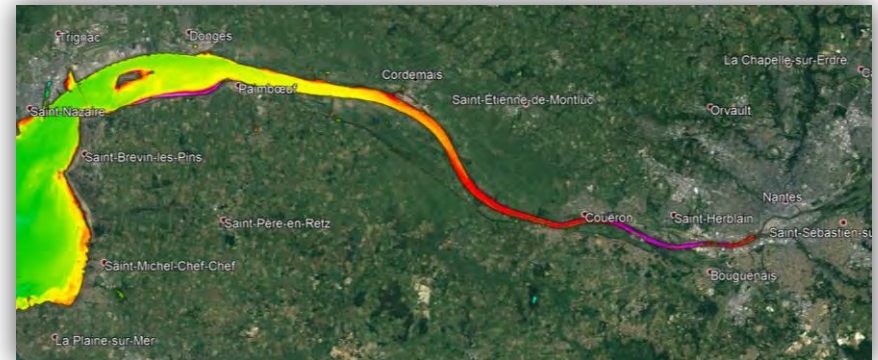


- Very h

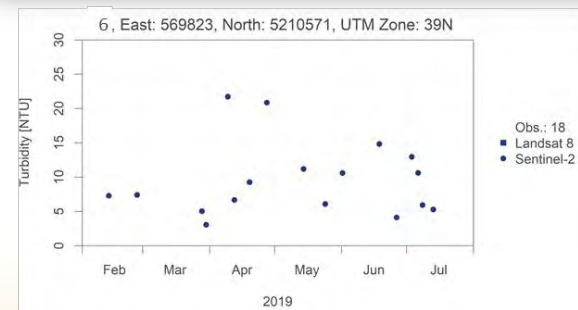
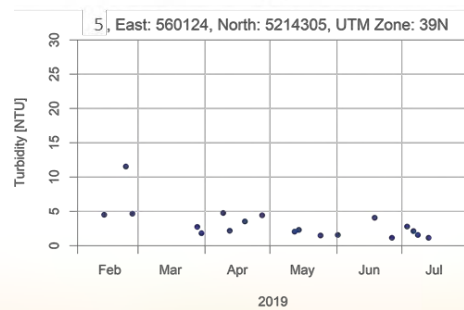
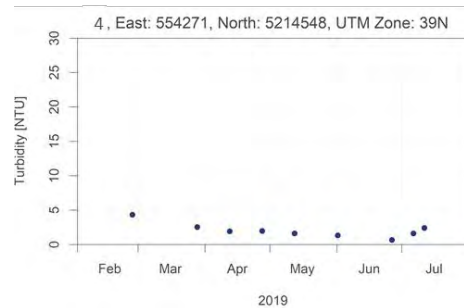
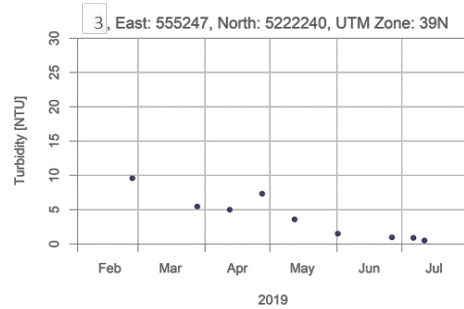
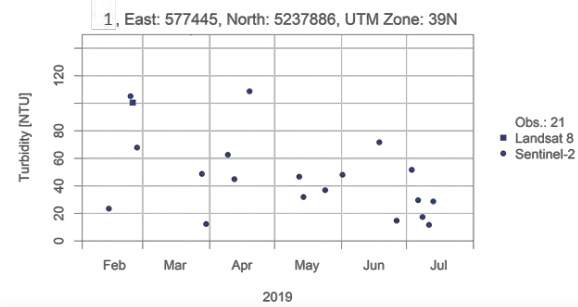
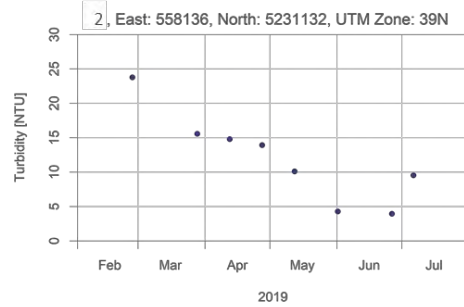
- High tidal range (~6m)



Low tide



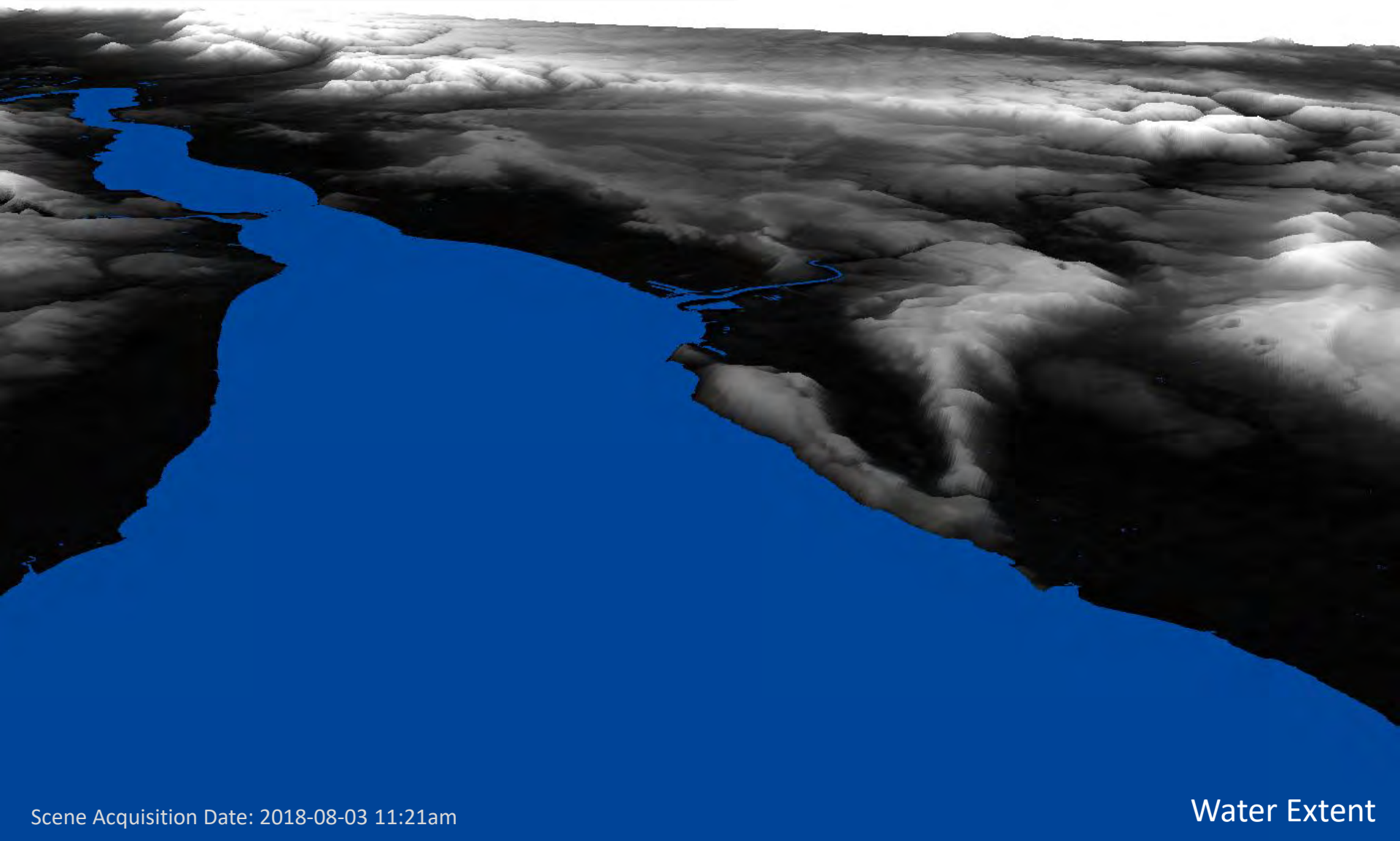
High Tide



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

MEETING



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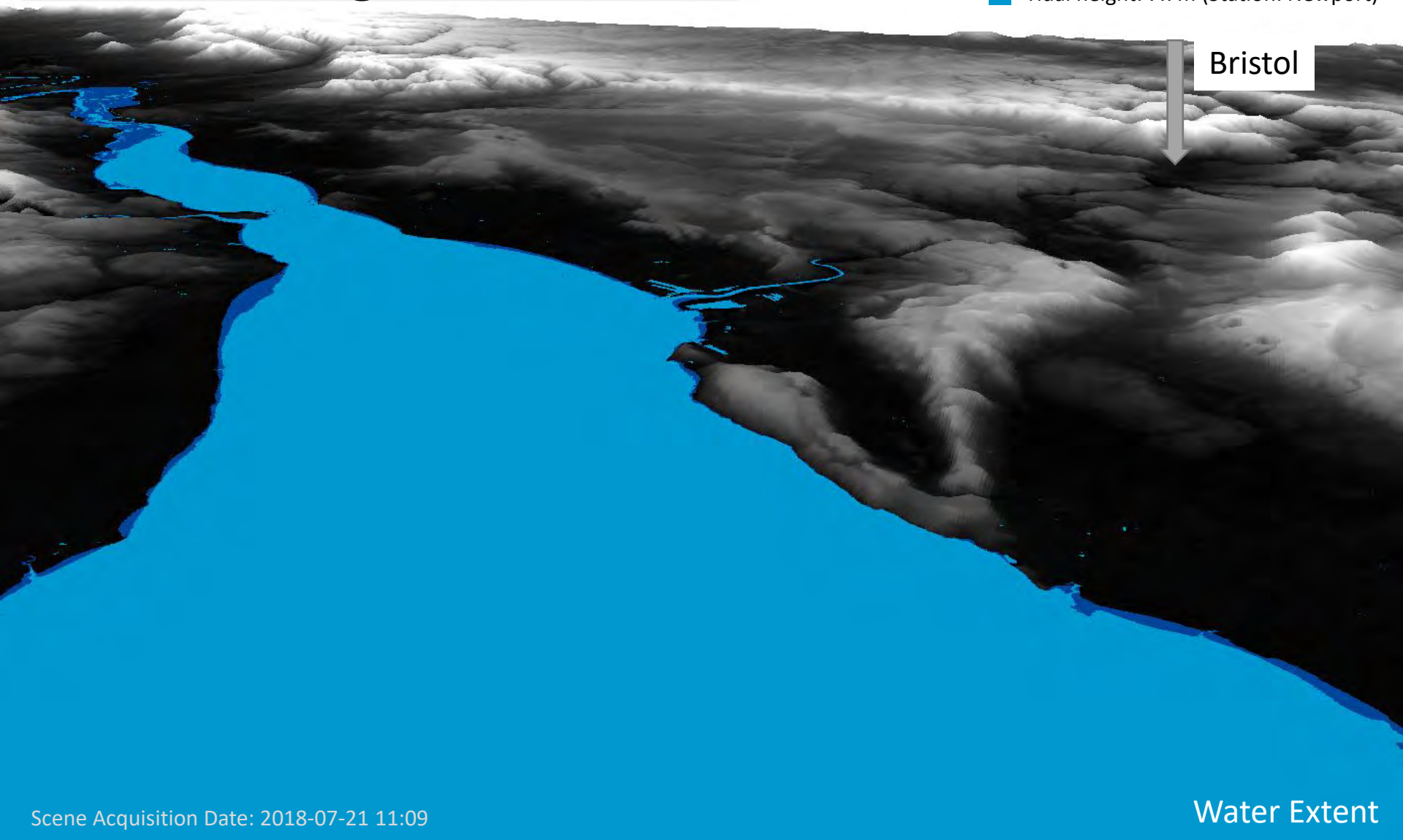
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2. Monitoring Water Extent

■ 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

02/06/2020

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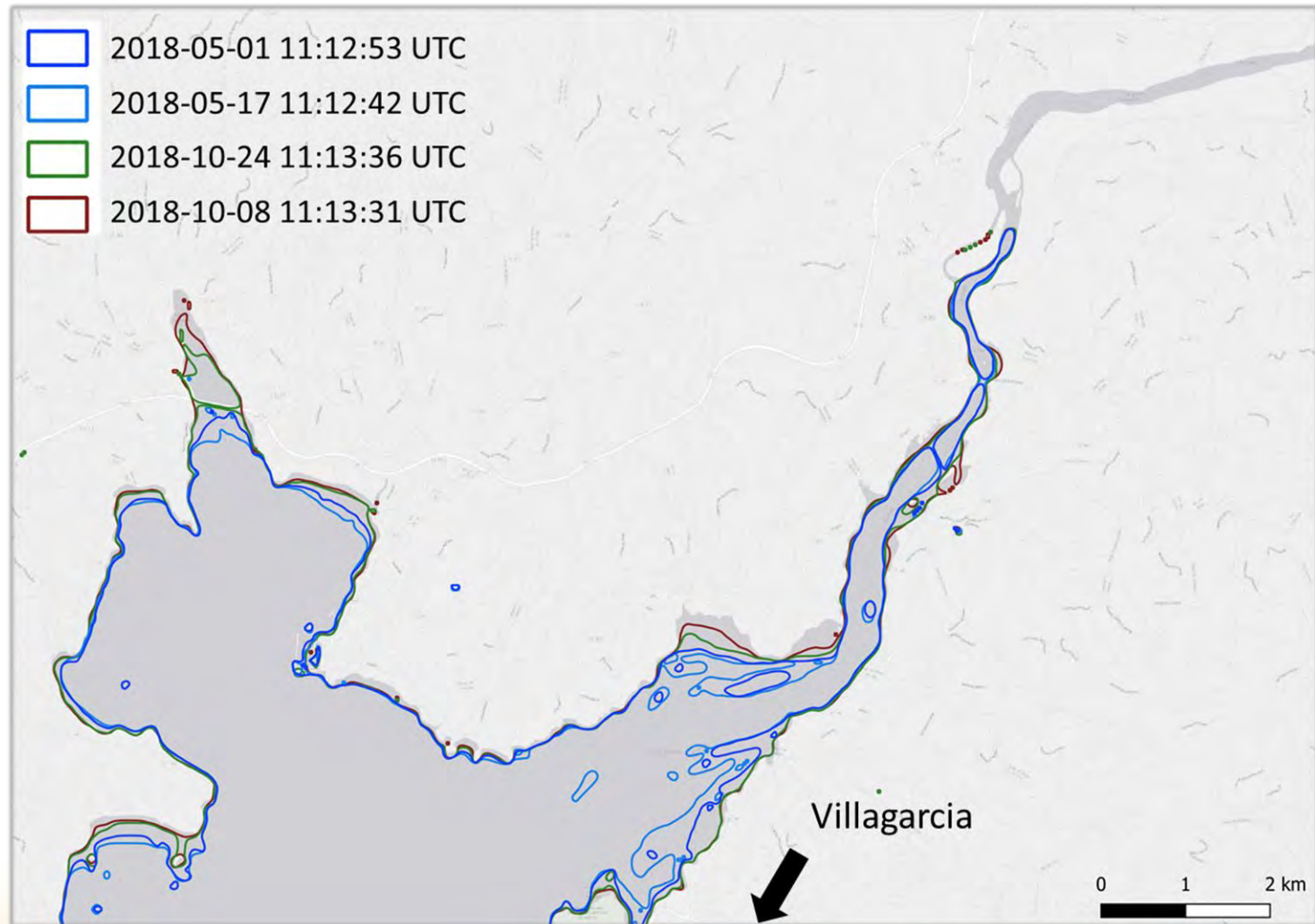


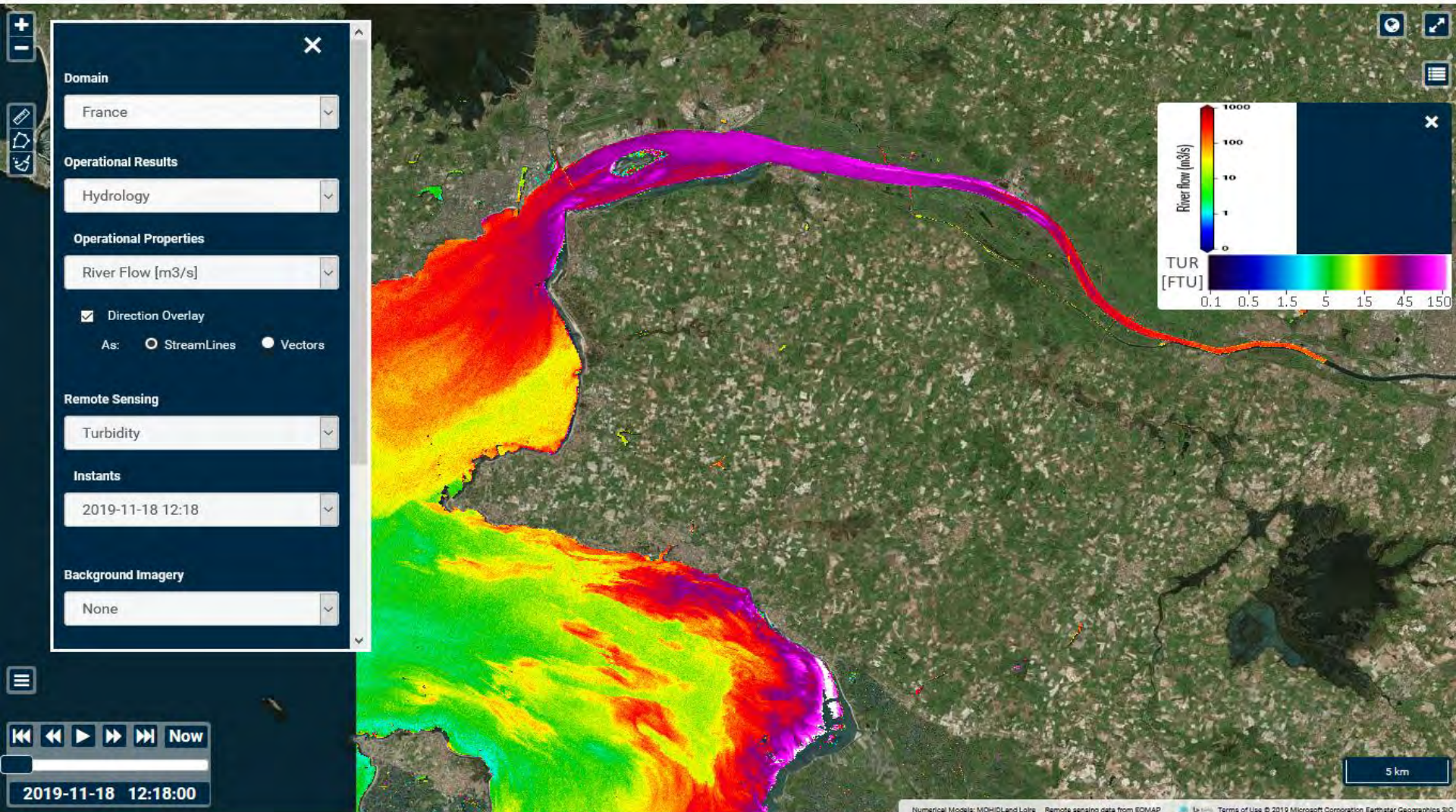
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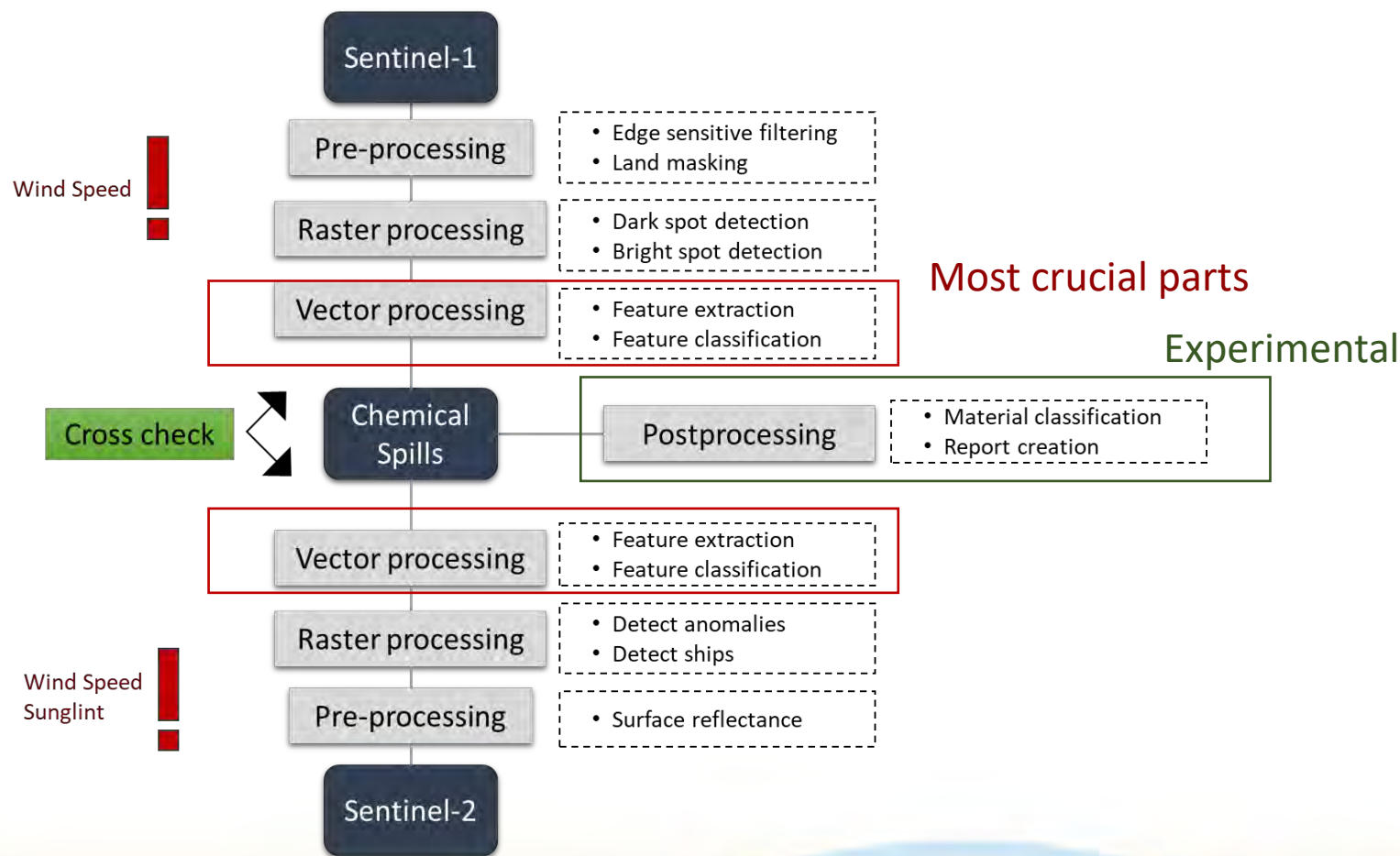
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2. Monitoring Water Extent





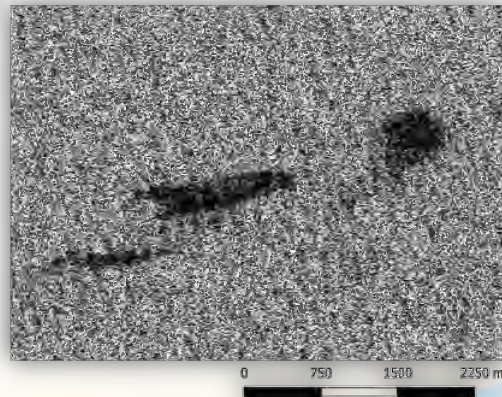
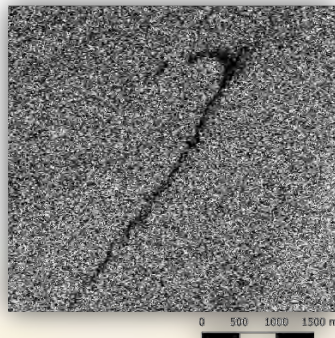
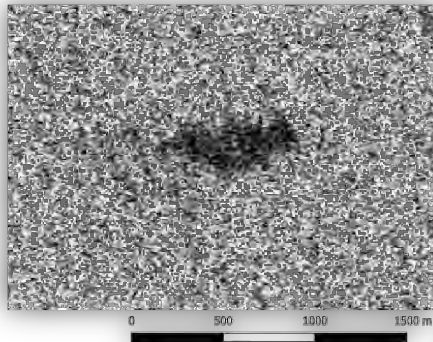
3. Oil Spill Detection – Technical Framework



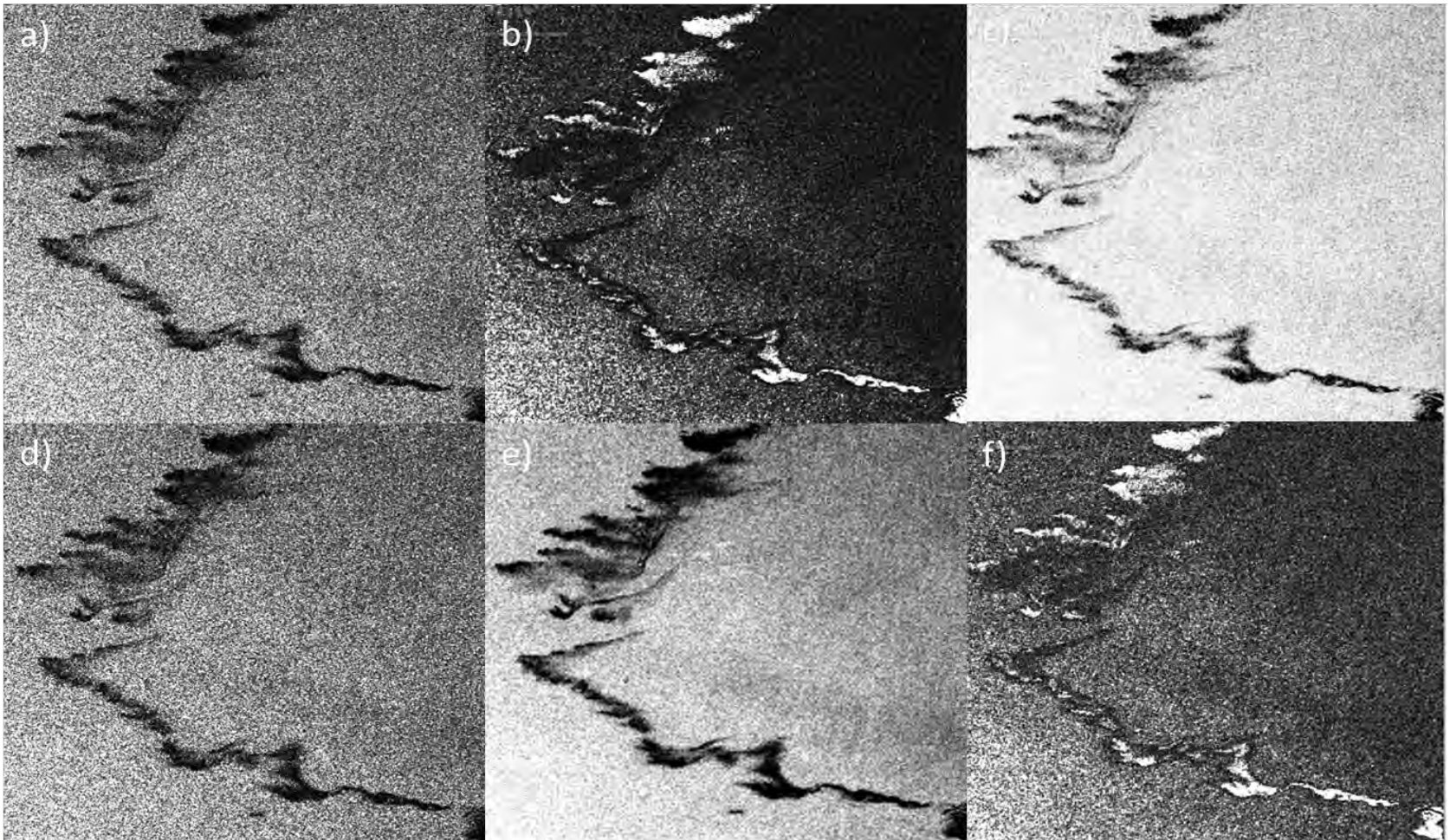
Oil Spill in Radar & Optical

Extensive Database on Oil Spill Properties:

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




Radar texture measures

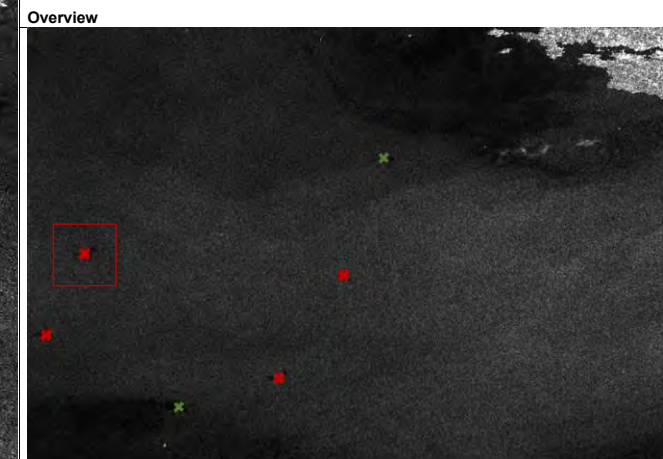


GLCM features calculated from Sentinel-1 SAR imagery (VV polarization). Example from the CLS Virginia collision north of Cape Corse in October 2018. a) sigma nought VV polarization b) GLCM Energy c) GLCM correlation d) GLCM mean e) GLCM variance f) GLCM homogeneity.

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	



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

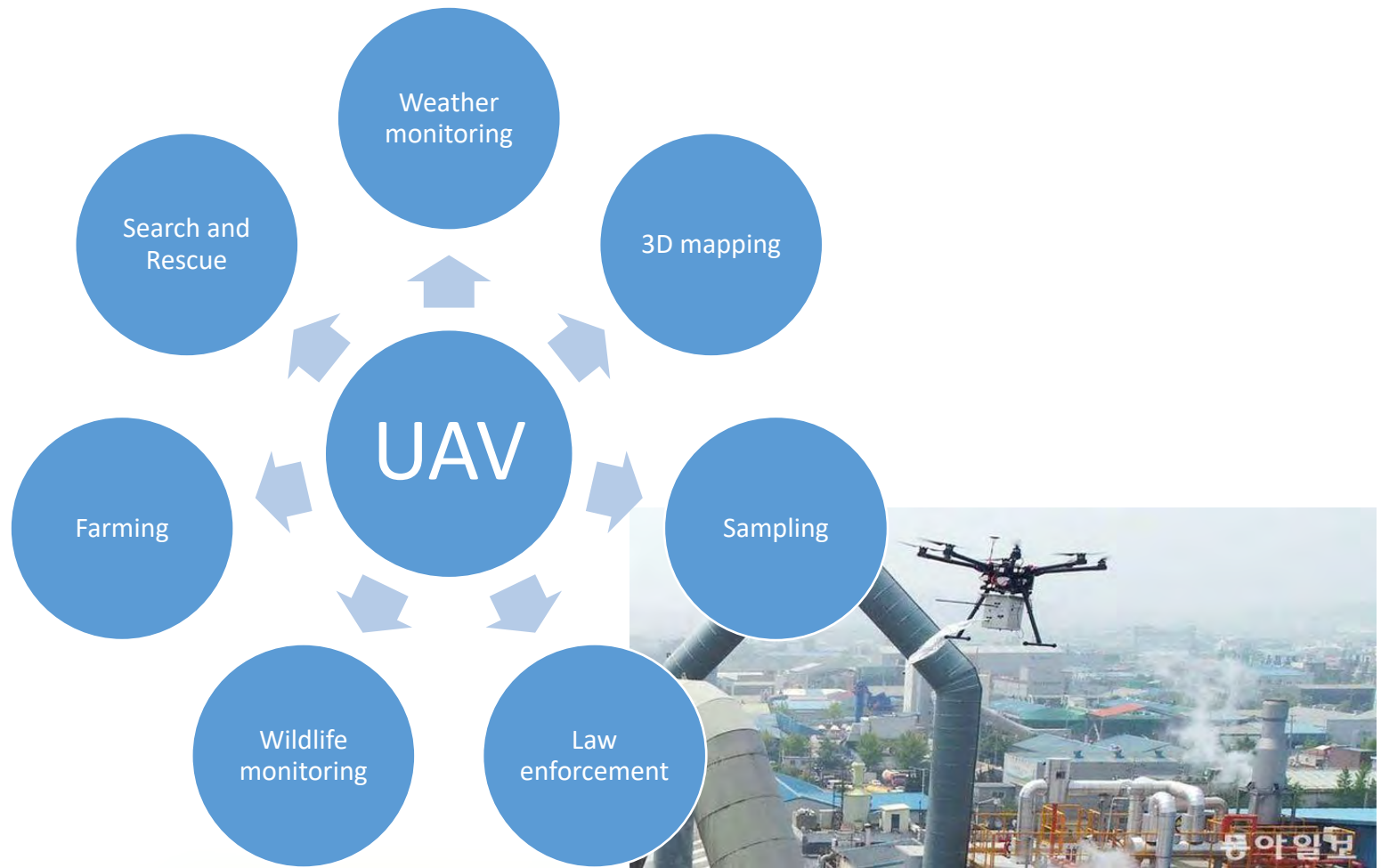


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Drone usage examples



<http://scentroid.com>

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?

•
•
•

- Timeliness

- Automated or even autonomous operation without close-by operator is possible, but legal issues remain
- Time to cover a area

- Drone Flight Time

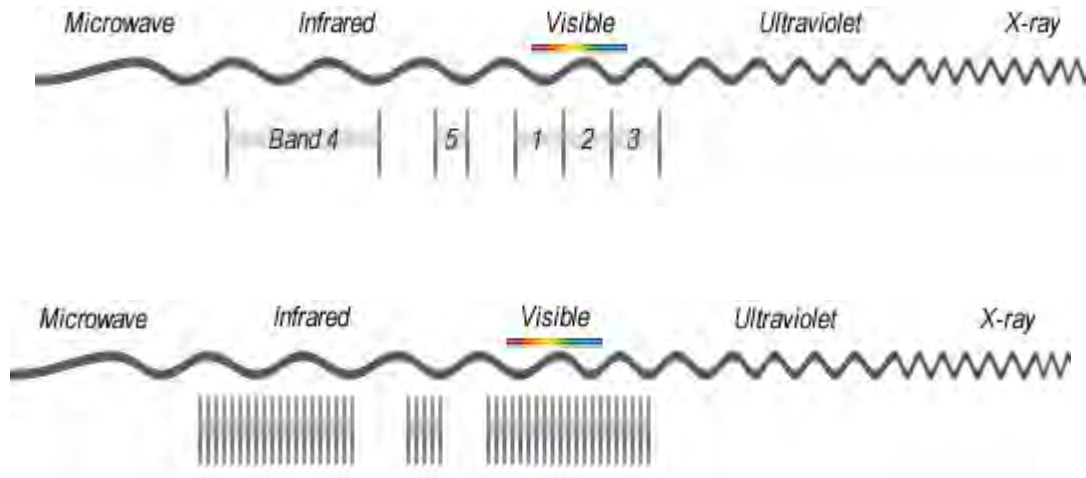
- from 5min for common consumer drones to 24h with a military drone) → Future development (combustion engines, solar power
- wind, snow, humid air, or rain reduce the flight time

- Costs

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



Multispectral vs. Hyperspectral



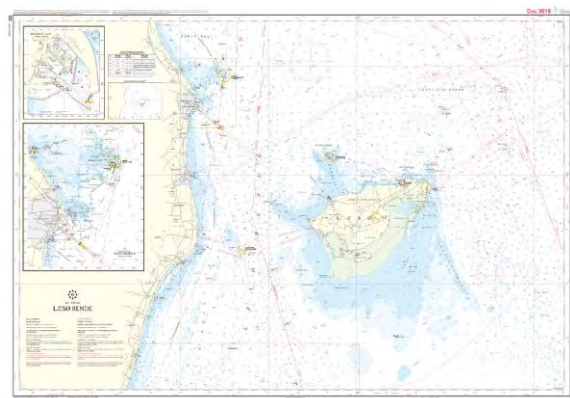
- Multispectral: 3-10 wider bands
- Hyperspectral: Hundreds of narrow bands → Distinguish different chemical materials (~Spectroscopy)

➡ Complexity and Data size (data reduction techniques apply)

gisgeography.com

Working with drone imagery

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



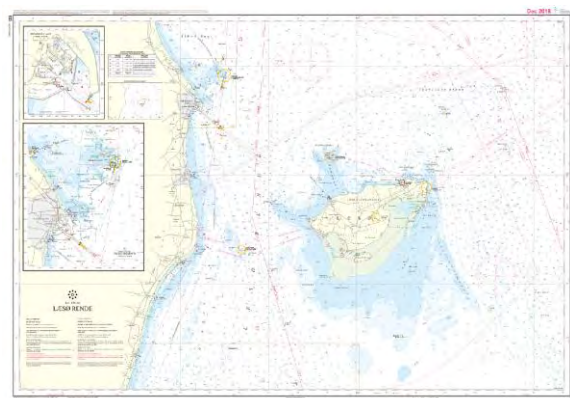
Unreferenced nautical chart

Georeferencing
↘



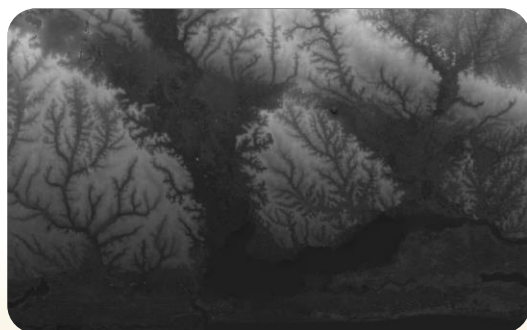
Working with drone imagery

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



Unreferenced nautical chart

Orthorectification

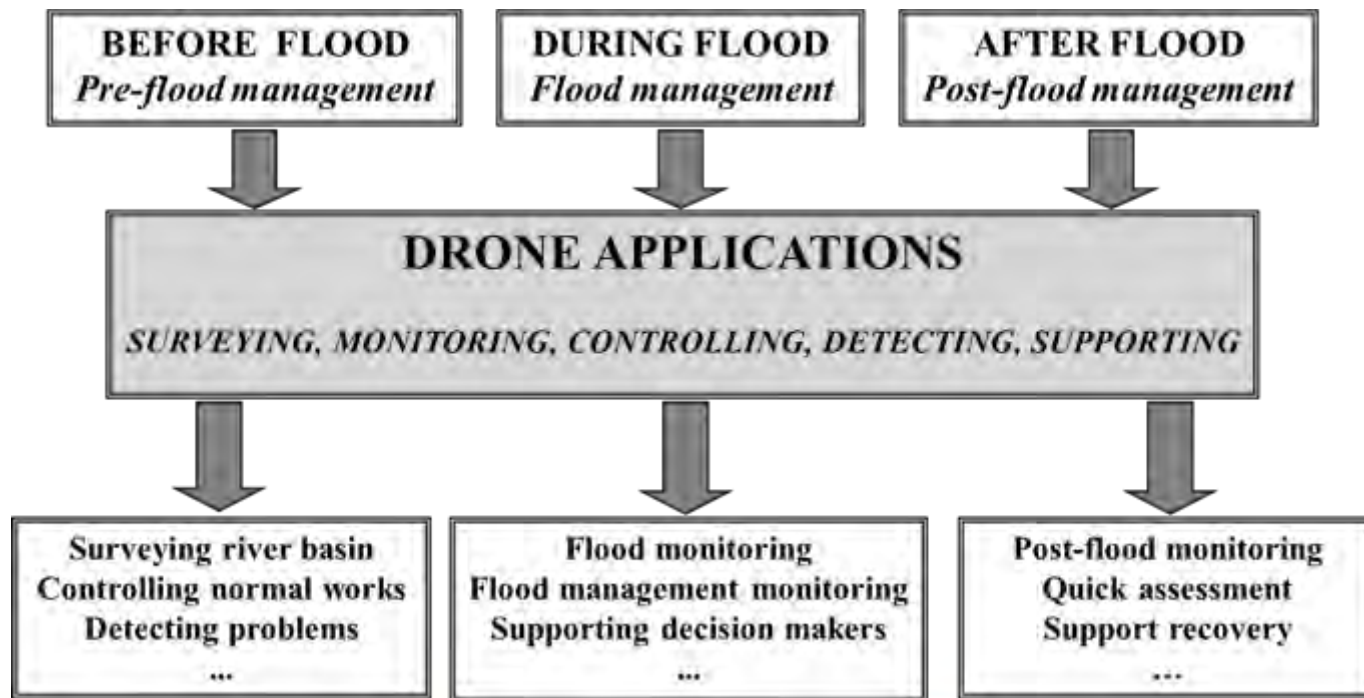


Digital elevation model



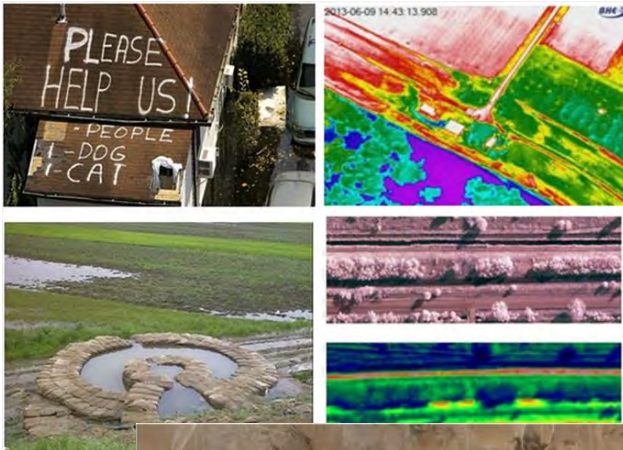
Flood extent monitoring

- 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

SHARADU KILVS 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

8 JANUARY 2017 BY THOMSON REUTERS FOUNDATION FLOOD PROTECTION

f w y+ 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 Kuzito Makoye for Thomson Reuters Foundation



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

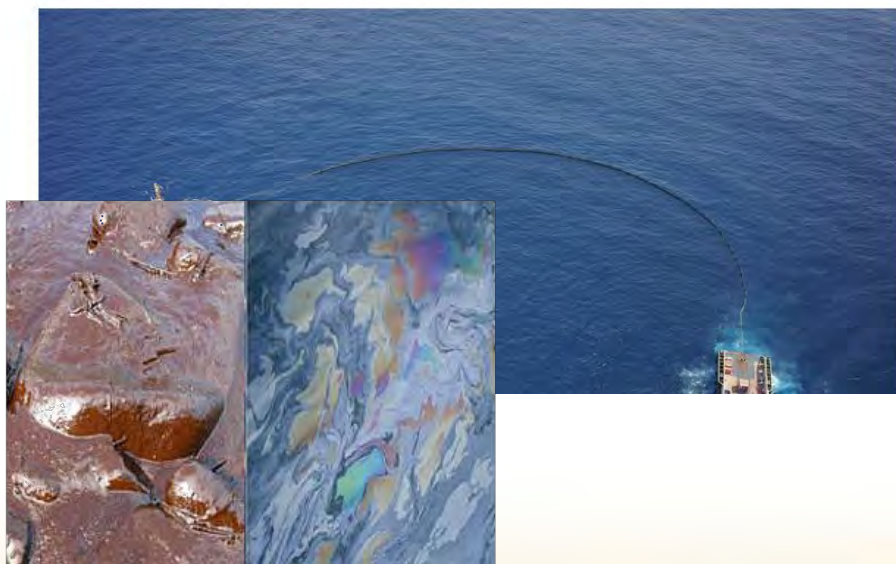
Pollution mapping

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

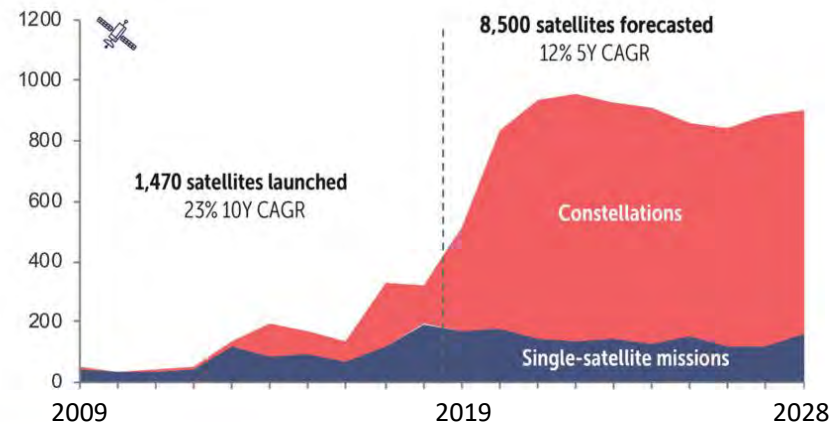
02.06.2020



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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



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Hazard and Risk Prioritisation and Assessment



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Aims

- Define the concepts of Hazard and Risk
- Describe risk assessment process
 - Source-Pathway-Receptor
- Identify how hazards and risks may be prioritised
- Present Hazrunoff hazard prioritisation approach
- Present Hazrunoff Risk assessment tool

Key Definitions

Hazard

“Any source of potential damage, harm or adverse effects”

hazard is an inherent property it cannot be modified.

Risk

“The chance or probability that an adverse effect will occur”

A situation involving exposure to danger

Source Oxford English Dictionary

Risk Assessment

Process by which **Risk(s)** are characterized.

- can be proactive (planning) and reactive (response).
- vital to incident management.
- can relate to both acute (immediate) and chronic (longer term) effects.

Mathematically it can be expressed as:

$$\text{RISK}^* = \text{Severity of Hazard (consequence)} \times \text{Probability of Exposure (Likelihood)}$$

*Risk also incorporates the extent of the effect and numbers affected.
Also influenced by perception



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Source-pathway-receptor approach

- a source (Hazard) e.g. chemicals,
- a receptor (e.g. people, ecological) that may be affected by the chemicals
- a pathway for the chemical hazard to reach the receptor.

All 3 must be present to represent a risk.



Once viable S-P-R Linkages have been identified risks can then be assessed either by quantitative or qualitative judgement of severity and likelihood of exposure

Risk Management

Mitigate or control risk to a level deemed acceptable. Achieved by:

- Breaking S-P-R linkages:
- Reducing likelihood of an event:
- Reducing severity of an event:

Where multiple hazards are identified it is not always possible to manage them all at once.

In such cases it is often useful to undertake **prioritisation** process enabling those hazards that pose the highest relative risk to be addressed first.



© CEDRE



© Hazrunoff

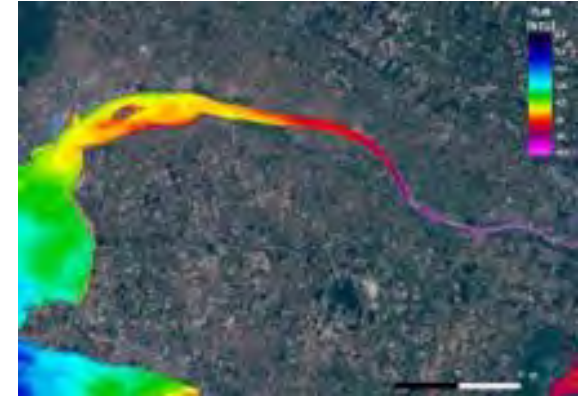
Hazrunoff Prioritisation Framework

Many coastal areas pose risks from former infrastructure such as landfills and industrial plant

Natural processes such as coastal erosion and flooding, can increase the potential for contaminants to impact health and the environment.

Not possible to provide contingencies for every eventuality.

Framework to prioritise chemical hazards, helping to focus resources on key pollutants



© Hazrunoff

An Illustration



© BBC

Huge sand dune designed to prevent major gas terminal falling into sea

In a UK first, 10,000 cubic metres of sand is being pumped every hour to create a 6km (3.7 mile) sand barrier to prevent Bacton gas terminal, which supplies a third of the UK's gas, from tumbling over the edge of a cliff into the sea.

It's hoped it will also save the coastline, as well as the villages nearby.

🕒 18 Jul 2019

[f](#) [💬](#) [🐦](#) [✉](#) [Share](#)



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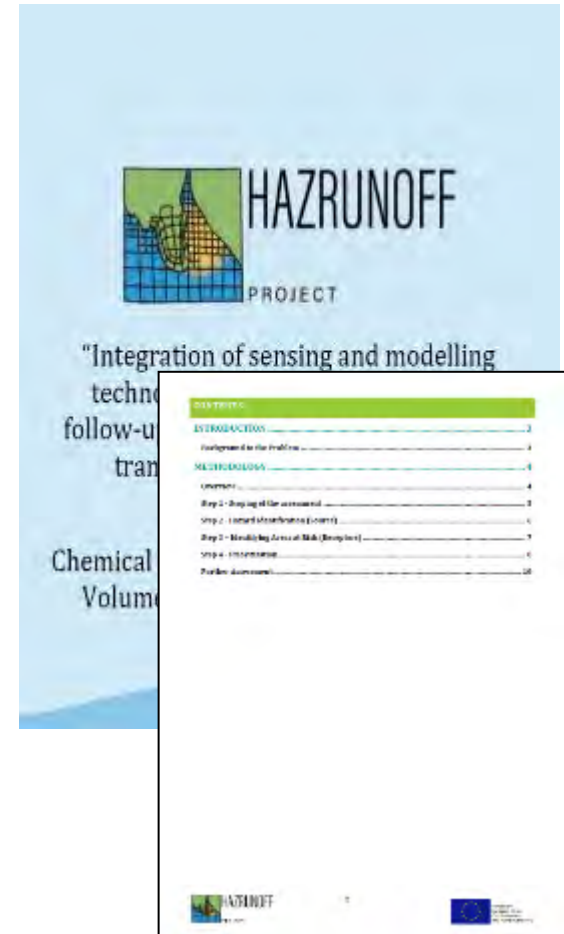
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An approach comprising two main elements

1. Desk based methodology to define:

- **Scope** – Temporal and geographical boundaries
- **Source** - key current and historical coastal activities / infrastructure:
- **Pathway** - Incorporating behaviour of pollutants with geological and hydrogeological \ hydrological factors
- **Receptor** – incorporating health, socio/economic and ecological factors

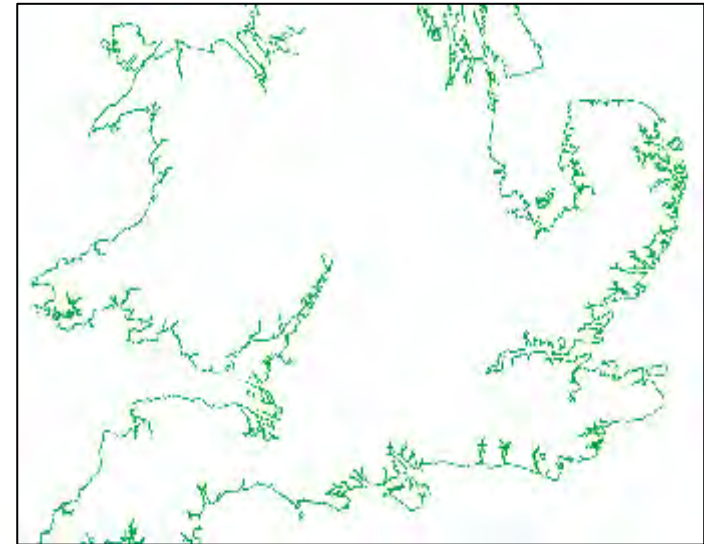
2. Database of key pollutants associated with industrial processes.



<http://www.hazrunoff.eu/planning-training-and-exercising-for-response/>

Scoping – Where are we looking and why?

- Establishment of boundaries for proposed study area and time-frame for data searches.
- Determined by the assessor based upon the underlying objectives. No defined limits.
- Coastal erosion maps, flood zones, 5m contours are helpful indicators.
- Recommended to scope the area to a manageable size and if necessary use multiple assessments for large areas.



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Source – Pathway - Receptor

Past and current industrial infrastructure.

Human Health - populations, amenities

Socio-economic – transport, industry, agriculture / aquaculture

Environmental – rivers, aquifers

Ecological - habitats / species,

Determined from current and historical maps as well as records from regulatory bodies.

Tool can help identify pathways

No linkage = no risk



© Hazrunoff

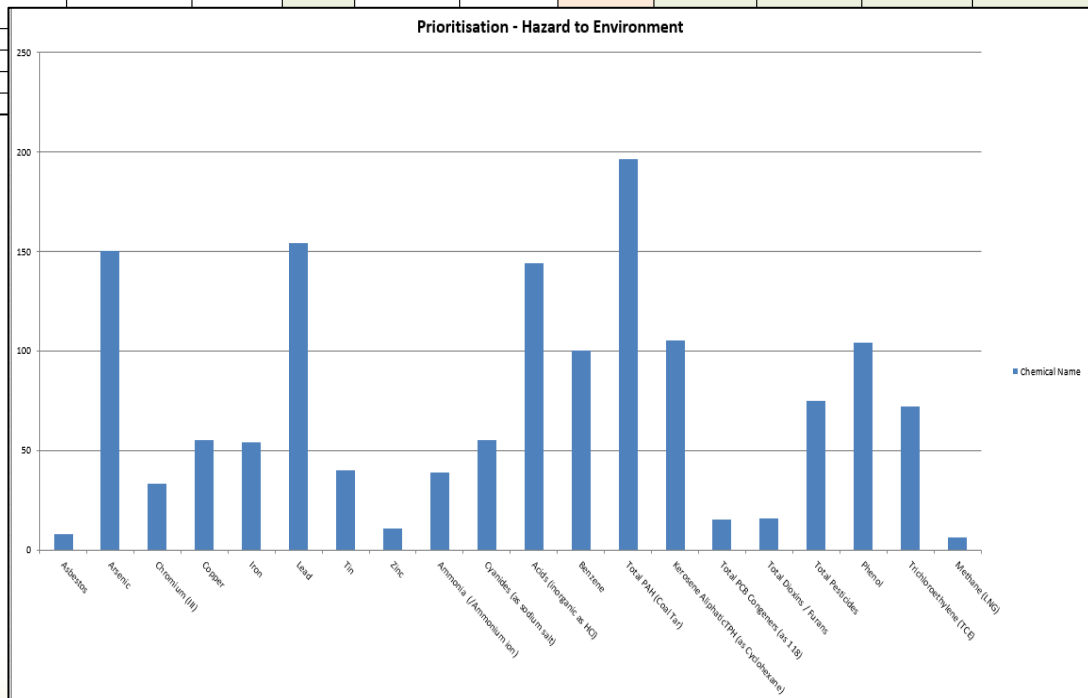
Prioritisation Tool

Entry	Chemical Name	CAS No	Physical State	Behaviour	Acute 0-4	Chronic 0 or 4	Health Score	Aquatic Toxicity 0-4	Bioconcentration 0-4	Persistence 0-4	Eco Score	Flammability 0-3	Reactivity 0-3	Flammable / Reactive Hazard	Total Score (Eco)	Behaviour Score (1-4)	Reactivity Score (1 or 0)	Weighting (Optional)
1	Asbestos	1332-21-4	S	S	0	4	4	0	0	4	4	0	0	0	8	4	0	1
2	Arsenic	7440-38-2	S	S	2	4	6	2	0	4	6	0	0	0	150	4	0	15
3	Chromium (III)	7440-47-3	S	S	2	0	2	3	0	4	7	0	0	0	33	4	0	3
4	Copper	7440-50-8	S	S	1	0	1	3	0	4	7	0	0	0	55	4	0	5
5	Iron	7439-89-6	S	S	1	0	1	1	0	4	5	0	1	0	54	4	0	6
6	Lead	7439-92-1	S	S	2	4	6	3	0	4	7	0	0	0	154	4	0	14
7	Tin	7440-31-5	S	S	2	0	2	0	0	4	4	0	0	0	40	4	0	5
8	Zinc	7440-66-6	S	S	2	0	2	3	0	3	6	0	2	R	11	4	1	1
9	Ammonia (/Ammonium ion)	7664-41-7	L	E	4	0	4	2	0	1	3	1	0	0	39	0	0	13
10	Cyanides (as sodium salt)	143-33-9	S	E	4	0	4	4	0	1	5	0	0	0	55	0	0	11
11	Acids (Inorganic as HCl)	7647-01-0	L	D	4	0	4	4	0	0	4	0	3	R	144	3	1	18
12	Benzene	71-43-2	L	E	4	4	8	2	1	1	4	3	0	F	100	0	1	20
13	Total PAH (Coal Tar)	NA	L	S	2	4	6	4	3	2	9	2	0	F	196	4	1	14
14	Kerosene AliphaticTPH (as Cyclohexane)	110-82-7	L	E	1	0	1	3	3	0	6	3	0	F	105	0	1	15
15	Total PCB Congeners (as 118)	1336-36-3	L	S	0	4	4											
16	Total Dioxins / Furans	NA	S	S	0	4	4											
17	Total Pesticides	NA	S/L	S	4	4	8											
18	Phenol	108-95-2	S	D	4	0	4											
19	Trichloroethylene (TCE)	79-01-6	L	S	2	4	6											

Automated worksheets produce health and ecological prioritisations.

Can apply user defined weightings e.g. frequency of pollutant sources.

Displays results graphically for easy review



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Using the Results

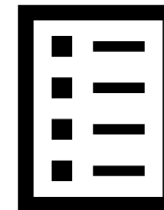
Detailed risk assessments

- Inform fate and transport models
- Inform monitoring programmes
- Inform chemical data sheets



Develop contingency plans

- Develop Exercises and training



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Rapid risk assessment of Data

During an incident responders often have to evaluate large amounts of data.



© Hazrunoff

- Quickly process and display monitoring data.
- Provide an initial assessment of results against health and / or ecological standards.
- Estimate the significance of pollution – statistical analysis.
- How?

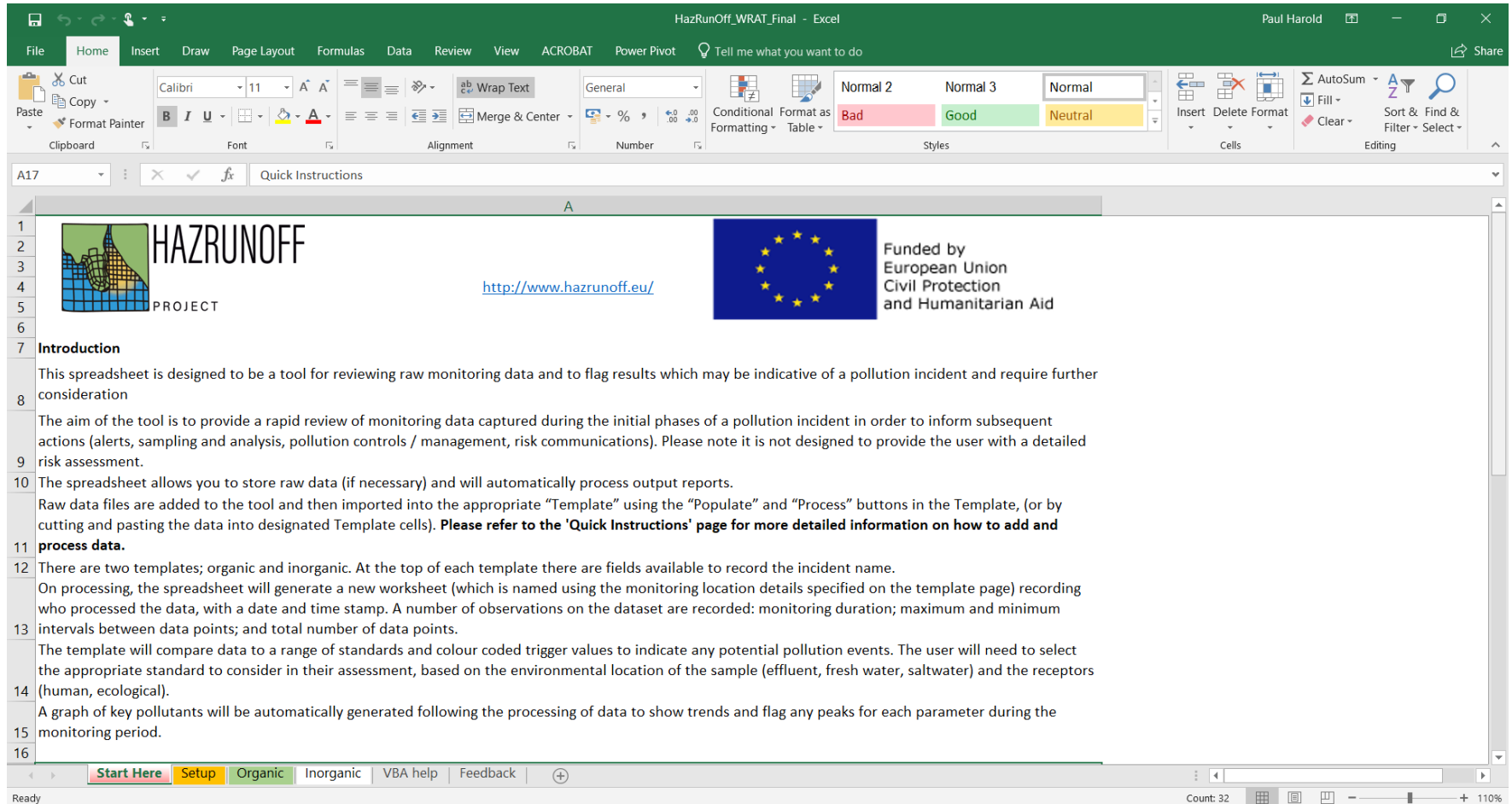


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The Water Risk Assessment Tool (WRAT)



The screenshot shows the Microsoft Excel interface for the HazRunOff WRAT. The title bar reads "HazRunOff_W RAT_Final - Excel" and the user is "Paul Harold". The ribbon includes File, Home, Insert, Draw, Page Layout, Formulas, Data, Review, View, ACROBAT, and Power Pivot. The Home ribbon is active, showing options for Clipboard, Font, Paragraph, Styles, Cells, and Editing. The spreadsheet content includes the HazRunOff logo, a URL (<http://www.hazrunoff.eu/>), the European Union flag, and funding information: "Funded by European Union Civil Protection and Humanitarian Aid". The text area contains an "Introduction" section with the following content:

Introduction

This spreadsheet is designed to be a tool for reviewing raw monitoring data and to flag results which may be indicative of a pollution incident and require further consideration.

The aim of the tool is to provide a rapid review of monitoring data captured during the initial phases of a pollution incident in order to inform subsequent actions (alerts, sampling and analysis, pollution controls / management, risk communications). Please note it is not designed to provide the user with a detailed risk assessment.

The spreadsheet allows you to store raw data (if necessary) and will automatically process output reports.

Raw data files are added to the tool and then imported into the appropriate "Template" using the "Populate" and "Process" buttons in the Template, (or by cutting and pasting the data into designated Template cells). **Please refer to the 'Quick Instructions' page for more detailed information on how to add and process data.**

There are two templates; organic and inorganic. At the top of each template there are fields available to record the incident name.

On processing, the spreadsheet will generate a new worksheet (which is named using the monitoring location details specified on the template page) recording who processed the data, with a date and time stamp. A number of observations on the dataset are recorded: monitoring duration; maximum and minimum intervals between data points; and total number of data points.

The template will compare data to a range of standards and colour coded trigger values to indicate any potential pollution events. The user will need to select the appropriate standard to consider in their assessment, based on the environmental location of the sample (effluent, fresh water, saltwater) and the receptors (human, ecological).

A graph of key pollutants will be automatically generated following the processing of data to show trends and flag any peaks for each parameter during the monitoring period.

At the bottom of the spreadsheet, there are tabs for "Start Here", "Setup", "Organic", "Inorganic", "VBA help", and "Feedback". The status bar at the bottom indicates "Ready", "Count: 32", and "110%".

Download from <http://www.hazrunoff.eu/detecting-sensing-and-sampling/>



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Design Specifications and Aims

- Simple to use downloadable automated tool
- No requirement for internet access
- Accepts raw data from monitors (.txt, .xls and .csv)
- Presents results in graphical and numerical outputs
- Displays against relevant risk based thresholds / standards
 - Drinking Water Standards
 - Environmental Quality Standards
 - Site specific limits
- Indicates potential risks



© Hazrunoff



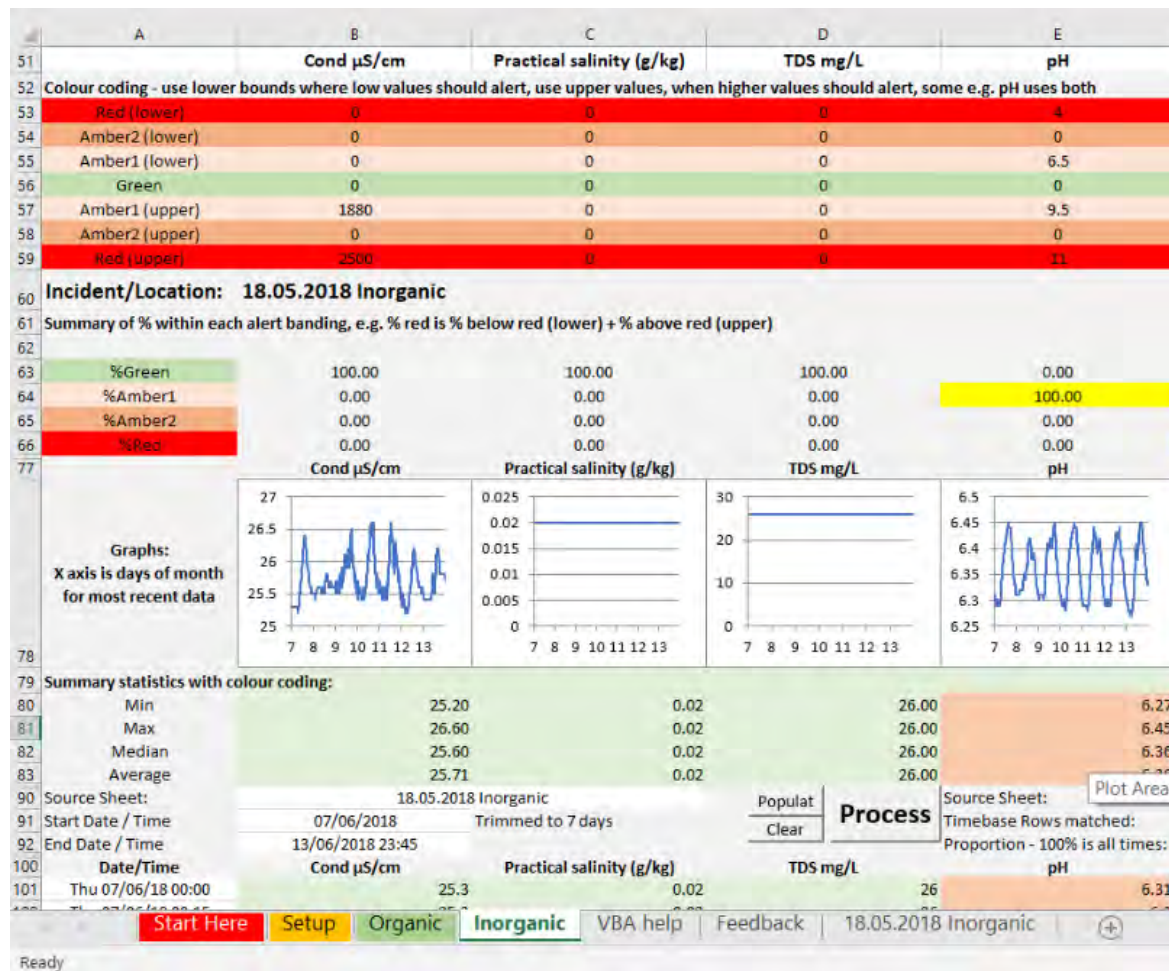
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Results Up to 7 days Data processed in seconds



Default or user defined
Triggers

% samples failing to meet
Trigger

Graphical Indication

Summary of data statistics



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Using the Results

Advise tactical and strategic co-ordination groups

- Immediate risks to health and / or environment
- Trends – is it rising or falling?
- Immediate Protective actions – populations, responders, environments
- Longer term impacts – food chain, ecology



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Questions?



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Hazard Prioritisation and Risk Assessment Exercise

Workshop
xxxxxx



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Aims

- Use planning and response tools developed by Hazrunoff.
- Undertake Hazard Prioritisation Exercise
 - Apply Source-Pathway-Receptor Process
 - Install and use Pollutant Database
 - Evaluate Prioritisation Results
- Complete Risk assessment Exercise
 - Install Water Risk Assessment Tool (WRAT)
 - Import and analyse test data sets
 - Evaluate Results



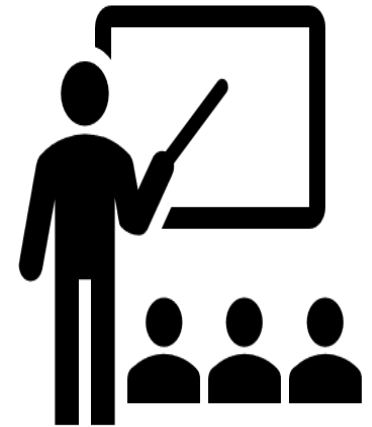
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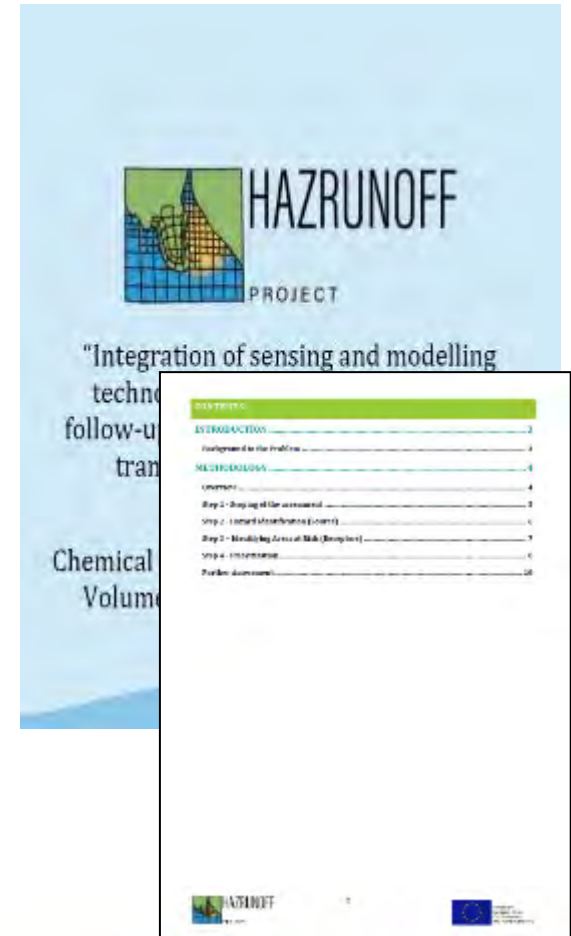
Hazard Prioritisation Exercise

- Concerns have been raised about potential pollution hazards associated with a stretch of river in your area, where erosion and flooding have been occurring.
- Having limited resources you cannot cover every potential eventuality so have been asked to identify priority pollutants that may pose a hazard to health or the environment.



Hazard Prioritisation Exercise

- You have heard of a project called Hazrunoff, which has many tools to help you
- You download the prioritisation tool
- <http://www.hazrunoff.eu/planning-training-and-exercising-for-response/>



Task 1

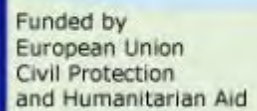
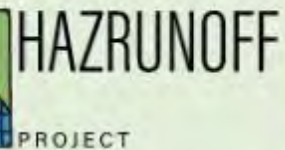
- Following the framework what are the key initial steps you should undertake ?
- 5 minutes group discussion
 - Scoping of your area
 - Area of concern
 - 5 m contour line
 - Sources of pollution
 - Potential receptors



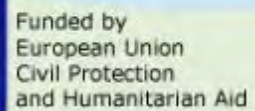
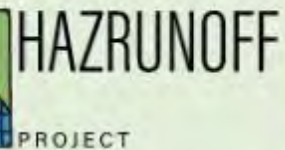
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This is an aerial map of the Nantes area, France. A red boundary outlines a specific region. Within this region, a blue line highlights a path that starts near the Loire river, passes through Bouguenais, and ends near the Nantes Atlantique airport. The map shows various roads, including the Loire river, and labels for locations like Saint-Herblain, Bouguenais, and Nantes. The Google My Maps logo is visible in the bottom left corner.



Source

- WWT
- Oil Terminal
- Aggregates
- Chemicals (Wine?)
- Dock
- Dock
- Power - Sub-station
- Waste - Recycling
- Aggregates
- Dock

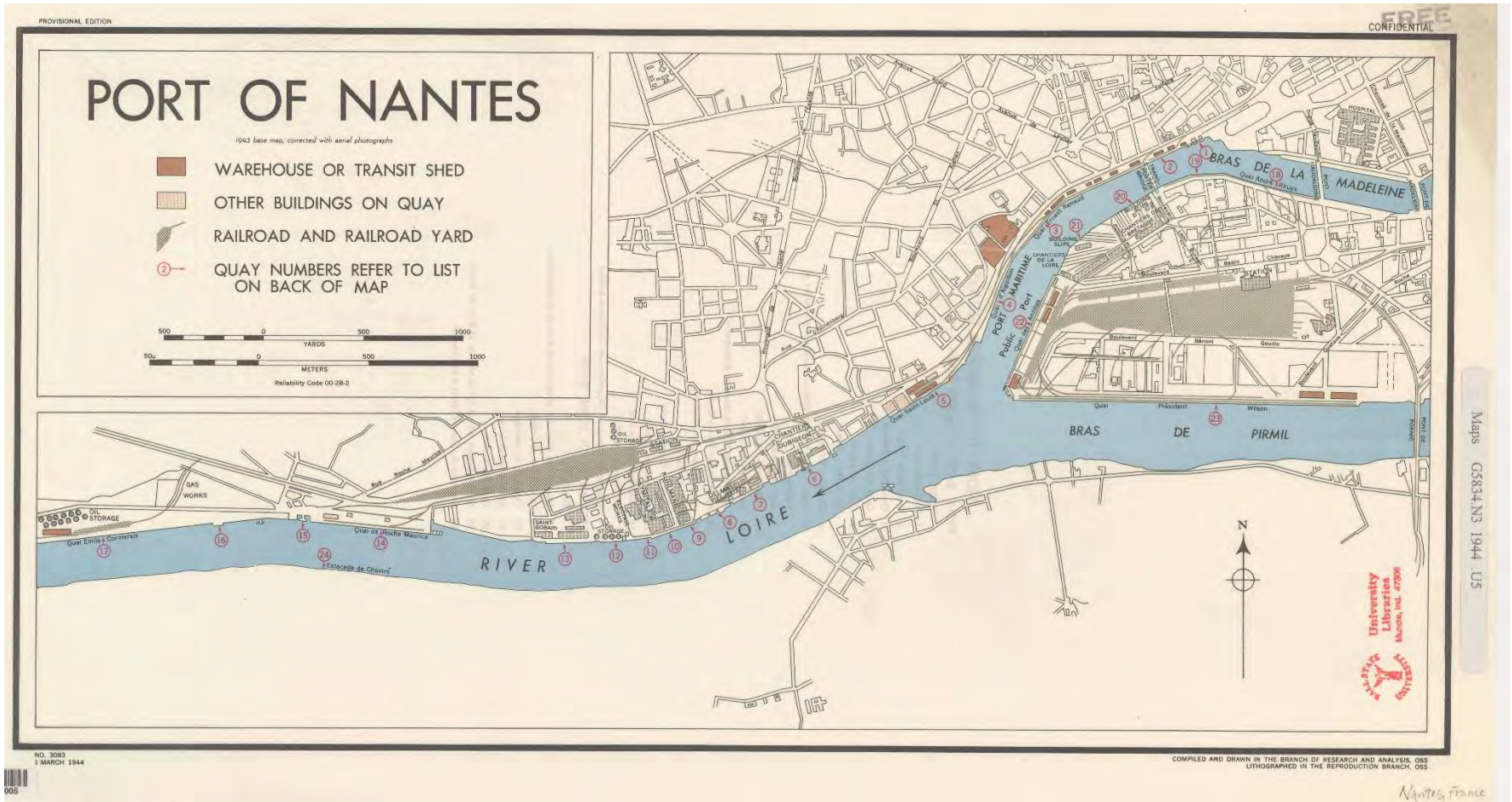


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Source - Historical



Source - Historical

- Oil - 1944
- Oil - 1944
- Power - Electric Works - 1944
- Power - Gasworks 1944

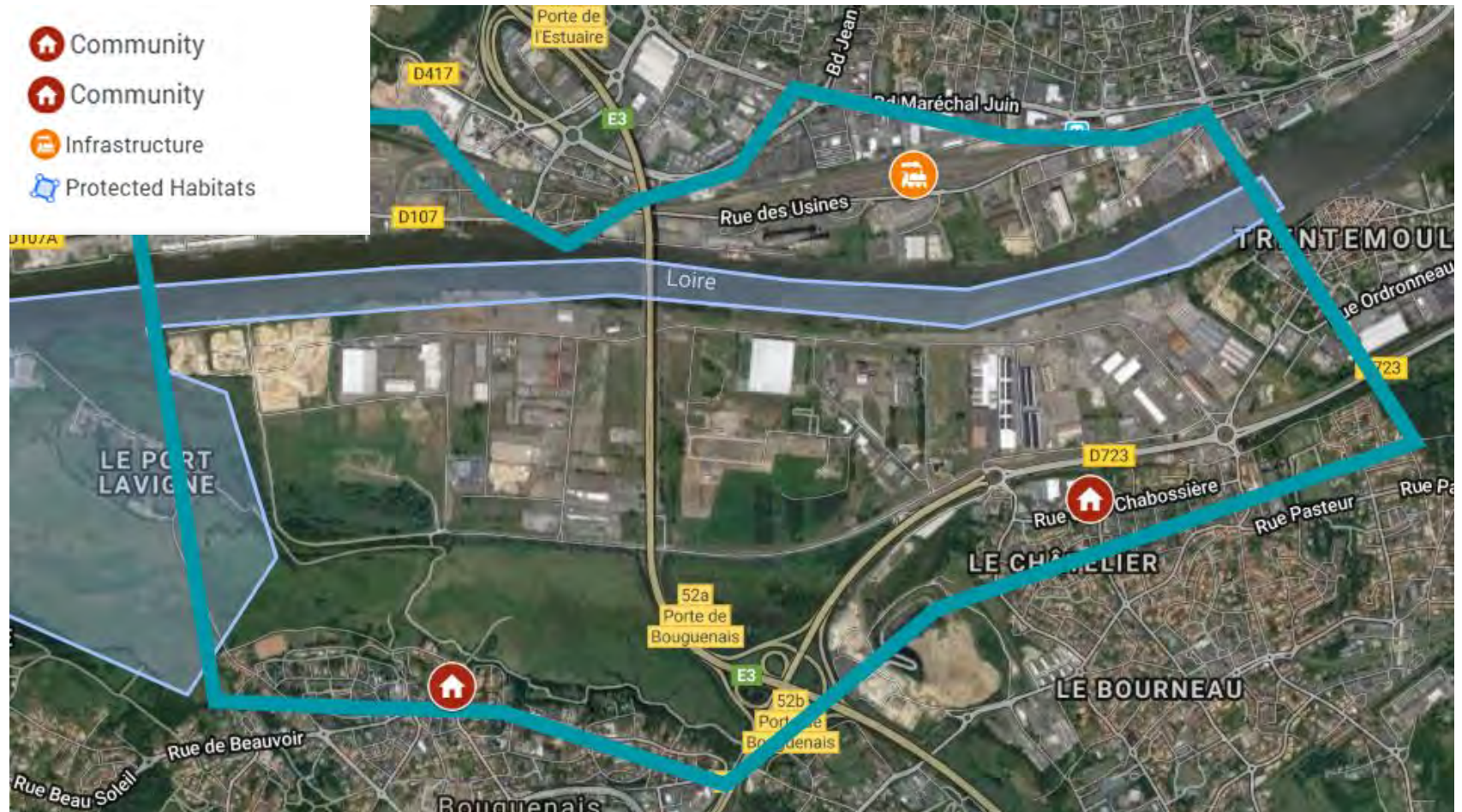


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Receptors



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Pollutants

1	Number of facilities	Industry	Key Chemical Pollutant Types													
2			Asbestos	Metals and Metalloids	Ammonia	Nitrates / Nitrites	Coal tar PAH	PCB	Dioxins	BTEX	Oils	Phenols	Pesticides	Chlorinated Solvents	Alcohols	TBT / organo tin
3		Principal														
4		Docks	(++)	(+)			(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(++)
5		Oil and gas Refining / storage	(+)	(+)			(++)	(+)		(++)	(++)	(+)	(+)		(++)	
6		Power (not nuclear)	(+)	(++)	(+)		(++)		(+)		(++)		(+)			
7		Gasworks, Coke Works Coal Carbonisation	(+)	(++)	(++)		(++)			(++)		(++)				
8		Aggregates / Cement	(+)	(++)			(++)		(++)		(+)					
9		Iron and steel making	(+)	(++)	(++)		(++)	(++)	(+)	(++)	(++)	(++)				
10		Sewage Works		(+)	(++)	(++)						(+)	(++)			
11		Landfills / infilled ground	(++)	(++)	(++)		(++)	(++)	(+)	(+)	(+)	(+)	(+)	(++)		
12		Railway Engineering	(++)	(++)			(++)	(++)	(+)	(++)	(++)	(++)	(++)	(+)	(+)	
13		Agriculture			(++)	(++)				(+)	(+)		(++)			
14		Mining		(++)												
15		Burial Grounds			(++)	(++)							(++)			
16		Airports	(+)				(+)	(+)		(++)	(++)					
17		Military Facilities	(++)					(++)		(++)	(++)		(+)			
18		Food Processing (Fish)			(++)		(+)									
19		Ancillary														
20		Chemical Works (General)*	(+)		(+)	(+)	(+)	(+)		(++)	(++)	(+)	(+)	(+)	(+)	
21		Tank / Drum Cleaning								(++)	(++)	(+)		(+)	(+)	
22		Metal works - Finishing	(+)	(+)	(+)			(+)		(++)	(++)			(++)	(+)	
23		Animal rendering			(+)	(+)							(++)			
24		Ship breaking	(++)	(++)				(++)		(++)	(++)	(+)		(++)	(+)	(++)
25		Electrical Substations						(++)			(+)		(+)			
26		Garages / Petrol Stations	(+)							(++)	(++)					



Summary Table

Source	Number	Pollutants



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Summary Table

Source	Number	Pollutants
Waste Water	1	NO3, PO4, Ammonia , Pesticides, metals
Oil Terminal	3	PAH, BTEX , Alkanes / Alkenes
Chemicals (Wine)	1	BOD
Aggregates	2	pH / Bases, metals
Docks	3	Asbestos, Ammonia (refrigeration), TBT
Power Electricity	2	PCB, PAH, BTEX, metals
Power Gas	1	PAH, BTEX , Phenols, Ammonia , CN, metals
Waste	1	Asbestos, metals , oils, chlorinated solvents



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Task 2

- Use the tool to prioritise the identified pollutants for human health and ecological receptors
- Evaluate Results
- 5 minutes



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Prioritisation

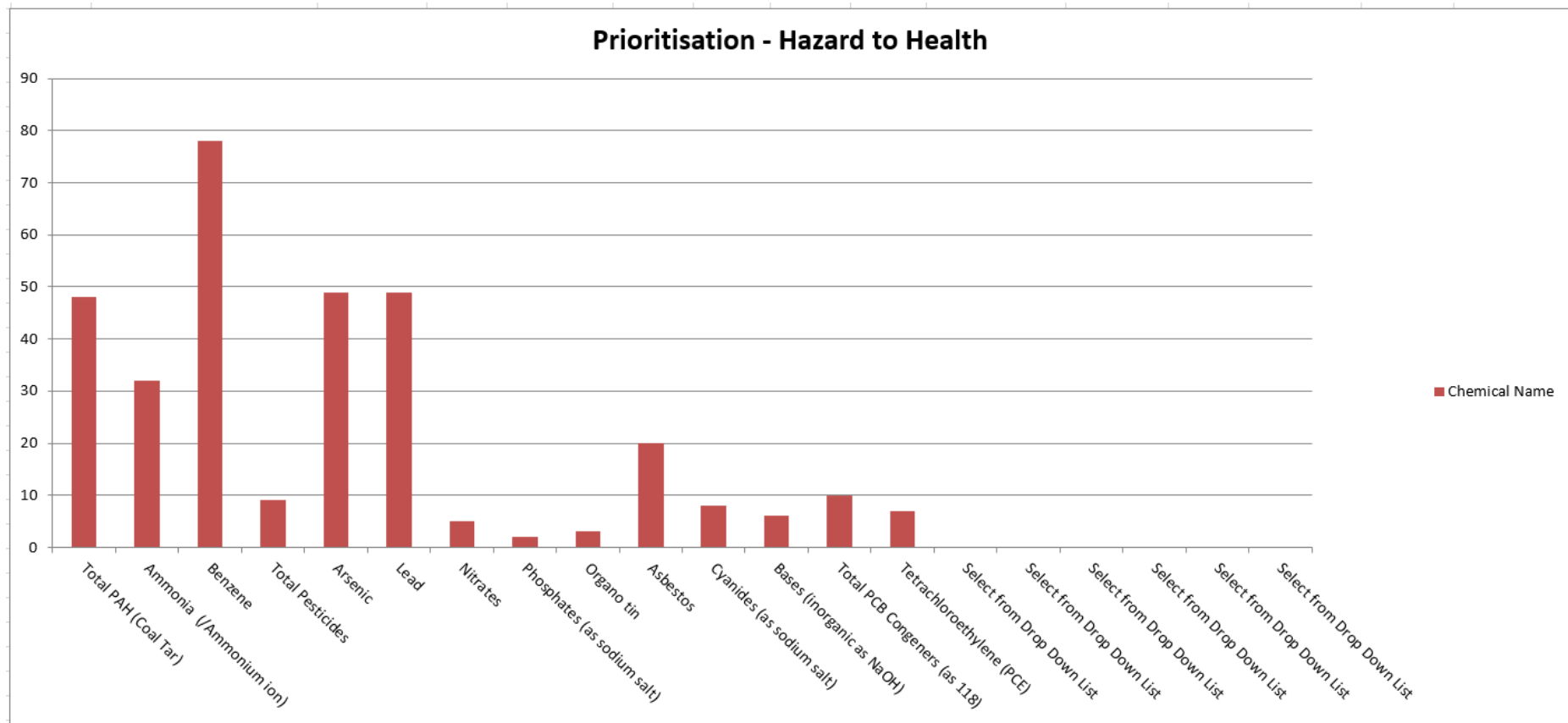
R28																		
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
3																		
4	Chemical Name	CAS No	Physical State	Behaviour	Acute 0-4	Chronic 0 or 4	Health Score	Aquatic Toxicity 0-4	Bioconcentration 0-4	Persistence 0-4	Eco Score	Flammability 0-3	Reactivity 0-3	Flammable / Reactive Hazard	Total Score (Health)	Behaviour Score (1 - 4)	Reactivity Score (1 or 0)	Weighting (Optional)
5	Arsenic	7440-38-2	S	S	2	4	6	2	0	4	6	0	0	0	49	1	0	7
6	Lead	7439-92-1	S	S	2	4	6	3	0	4	7	0	0	0	49	1	0	7
7	Ammonia (/Ammonium ion)	7664-41-7	L	E	4	0	4	2	0	1	3	1	0	0	40	4	0	5
8	Benzene	71-43-2	L	E	4	4	8	2	1	1	4	3	0	F	78	4	1	6
9	Total PAH (Coal Tar)	NA	L	S	2	4	6	4	3	2	9	2	0	F	48	1	1	6
10	Asbestos	1332-21-4	S	S	0	4	4	0	0	4	4	0	0	0	20	1	0	4
11	Nitrates	UN1477	S	D	2	0	2	1	0	1	2	0	3	R	5	2	1	1
12	Phosphates (as sodium salt)	7558-79-4	S	D	0	0	0	3	1	1	5	0	0	0	2	2	0	1
13	Cyanides (as sodium salt)	143-33-9	S	E	4	0	4	4	0	1	5	0	0	0	8	4	0	1
14	Bases (inorganic as NaOH)	1310-73-2	S	D	3	0	3	2	0	0	2	0	2	R	6	2	1	1
15	Total PCB Congeners (as 118)	1336-36-3	L	S	0	4	4	3	4	4	11	1	0	0	10	1	0	2
16	Total Pesticides	NA	S/L	S	4	4	8	4	4	3	11	0	0	0	9	1	0	1
17	Tetrachloroethylene (PCE)	127-18-4	L	S	2	4	6	2	2	1	5	0	0	0	7	1	0	1
18	Organo tin	36643-28-4	S	S	2	0	2	4	2	2	8	0	0	0	9	1	0	3
19	Kerosene AliphaticTPH (as Cyclohexane)	110-82-7	L	E	1	0	1	3	3	0	6	3	0	F	18	4	1	3
20	Phenol	108-95-2	S	D	4	0	4	3	1	0	4	2	0	F	7	2	1	1
21	Select from Drop Down List	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22	Select from Drop Down List	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23	Select from Drop Down List	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
24	Select from Drop Down List	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25																		



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Benzene, PAH, Metals, Ammonia



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Using the Results

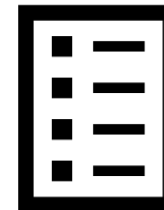
Detailed risk assessments

- Inform fate and transport models
- Inform monitoring programmes
- Inform chemical data sheets



Develop contingency plans

- Develop Exercises and training

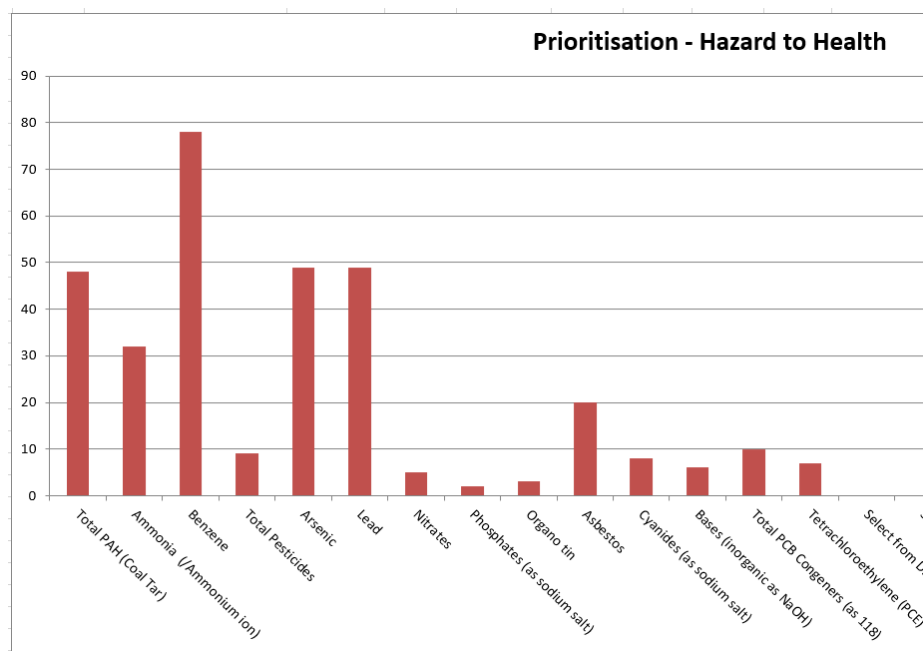
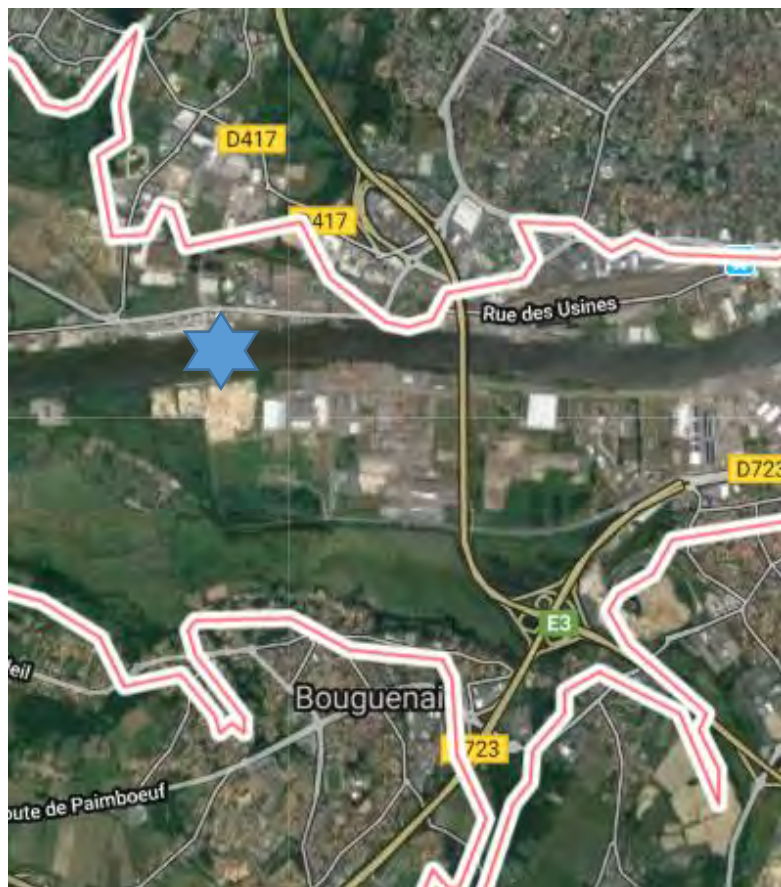


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Continuous Monitors installed for priority pollutants



BTEX, PAH, Ammonium, EC
(metals)



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Task 3

- Download the Water RAT tool
- Use the tool to assess the monitoring data provided.
- Evaluate your results
- 10 minutes

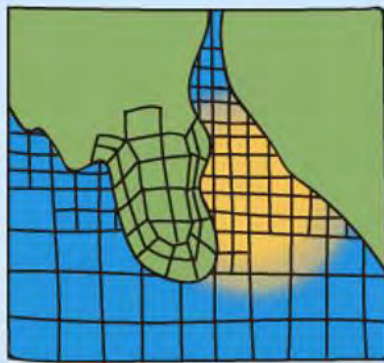
Download from <http://www.hazrunoff.eu/detecting-sensing-and-sampling/>



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Water: Rapid Assessment Tool Instructions for use



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Civil Protection
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ENDEX / Final Remarks

Help Advise tactical and strategic management & co-ordination groups

“Peace-time”

- Prioritise Potential Hazards
- Identify areas to study in depth / monitor

Incident

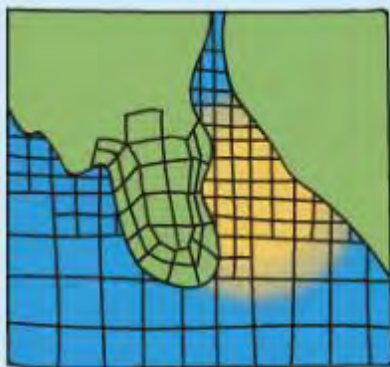
- Assess Immediate risks
- Inform response
- Aid warning and informing
- Assess Longer term issues



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Training course

MARINER PROJECT

Enhancing HNS preparedness
through training and exercising

[CETMAR on behalf of MARINER partners]



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MARINER: Enhancing HNS preparedness through MARINER training and exercising



Objective:

Improve regional cooperation in preparedness and response to HNS spills by:

- Compiling HNS R&D outcomes and key resources and making them accessible to planners and responders
- Upgrading and/or improving tools to support decision making and response;
- Improving training and exercise capabilities;
- Increasing awareness and encouraging information exchange.



Co-financing Programme: Call 2015 for prevention and preparedness projects in the field of civil protection and marine pollution. DG-ECHO.

Policy area of activity: Preparedness.



Start date: 1st January 2016

End date: 31st January 2018



European Commission contribution: 748.910 EUR (75 %)

Total budget: 998.547 EUR



<http://mariner-project.eu/>



HAZRUNOFF
PROJECT



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and Humanitarian Aid

Partners & Advisory Board



1. Centro Tecnológico del Mar – Fundación CETMAR [Link](#) *Coordinator*
2. INTECMAR - Instituto Tecnológico para o Control do Medio Mariño de Galicia [Link](#)
3. Universidade de Vigo [Link](#)
 - ❖ Salvamento Marítimo – SASEMAR
 - ❖ Ministry of Agriculture and Fisheries, Food and Environment
 - ❖ Galician Coastguards



4. Action Modulers [Link](#) (Currently Bentley [Link](#))
5. CIIMAR: Interdisciplinary Centre of Marine and Environmental Research [Link](#)
 - ❖ Maritime Authority Directorate General. Marine Pollution Response Directorate



6. Public Health England [Link](#)
 - ❖ Maritime & Coastguard Agency

**7 partners from 4 countries
advised by key governmental agencies**



7. Cedre - Centre of Documentation, Research and Experimentation on Accidental Water Pollution [Link](#)
 - ❖ Ministry of the Ecological and Inclusive Transition



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Working streams & outcomes



Website Results: <http://mariner-project.eu/results/category/>



INTRANET

Home | About | Results | Knowledge tool | Events | Contact

Knowledge compilation
and facilitation



Modelling and
environmental impact



Response protocols



MARINER main outcomes are summarized in the project website:
<http://mariner-project.eu/assets/pdf/results.pdf>

Training



Dissemination



MARINER Results
overview



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Working streams & outcomes



Enhancing HNS preparedness through training and exercising



MARINER was a D6-ECHO funded project that aimed to improve regional cooperation in planning, preparedness and response to HNS spills by improving training and exercise, increasing awareness and information exchange, and by capitalization and translation of HNS relevant R & D projects' outcomes into operational products.

MARINER run from January 2016 to January 2018. Here you can find a list of the project publicly available outputs. To learn more about the project please visit www.mariner-project.eu

Click on the image to visualise the MARINER Mindmap with an overview of project working streams and results



KNOWLEDGE COMPILATION AND FACILITATION



MARINER Knowledge Tool: Database accessible through a user-friendly online browser that allows carrying out advanced and basic searches on resources relevant for different areas of HNS preparedness and response.

e-Booklets Compiling key resources from the knowledge tool, under specific knowledge areas.



Contingency plans & response Risk Analysis Training and exercising Environmental impact HNS characterisation Modelling tools

MODELLING AND ENVIRONMENTAL IMPACT

MARINER modelling Platform



Software (3D HNS spill model) and interface (Common Operating Picture - COP) for predicting the fate, behaviour and environmental / public health risks from a chemical spill in the Atlantic area.

OGC GML schema for HNS Spills



To assure the interoperability among different agencies when they share information about HNS spill events, a Geography Markup Language GML schema was proposed.

Standard symbols and styles for mapping



This report presents the state-of-the art in the use of different symbols for hazard and warning situations.

Modelling of HNS hazards to the environment



Toxicological parameters selected



Modelling HNS hazards for predicting effects on the marine amphipods population

Guidelines and protocols for environmental impact assessment



Compilation of chemical, biological and ecological information to produce guidelines for HNS environmental impact assessment.

Comparing MARINER system with other systems



Analysis of the performance of the 3D-HNS MOHID model with other models currently in use.

RESPONSE PROTOCOLS

Protocols for responding to HNS spills at sea



This guide for responders includes adapted protocols to deal with HNS spills in the marine environment: pre-planning considerations, communication and operational procedures, and technical considerations.

Video: dealing with HNS spills at sea



EXTENDED

TRAINING

Training package on HNS spill management



Exercise Web Tool for bespoke desk-top maritime HNS exercises



Training package on HNS modelling and environmental impact



E-learning: International Health Regulations and HNS maritime incidents



DISSEMINATION

MARINER Layman's report



1st MARINER Project Workshop



2nd MARINER Project Workshop



Final Project Conference



MARINER Introductory video



Awareness raising video



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Working streams & Outcomes



• HNS knowledge compilation & facilitation



Enhancing HNS preparedness through training and exercising




Funded by European Union Civil Protection and Humanitarian Aid


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e-Booklets Compiling key resources from the knowledge tool, under specific knowledge areas.




Contingency plans & response




Risk Analysis




Training and exercising



Environmental impact



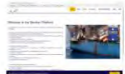
HNS characterisation



Modelling tools


MODELLING AND ENVIRONMENTAL IMPACT

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This report presents the state-of-the-art in the use of different symbols for hazard and warning situations.

"Identification and compilation of existing HNS preparedness and response knowledge generated"

The MARINER Knowledge Tool.

Online repository on marine research and technical resources focused on the preparedness and response to HNS (Hazardous and Noxious Substances) spills.

Resources extracted from :

-EU and national research and cooperation projects addressing maritime pollution and chemical spills.

-Key organizations on the fields of maritime pollution and health and environmental protection.



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Working streams & Outcomes



- **HNS knowledge compilation & facilitation**

www.mariner-project.eu



Home About Results **Knowledge tool** Events Contact



INTRANET

<http://knowledgetool.mariner-project.eu/>

MARINER KNOWLEDGE TOOL

Welcome to MARINER Knowledge Tool

User-friendly access to an inventory of HNS preparedness and response resources generated in the frame of research projects (i.e. Knowledge Outputs) or by specialised organisations. [Read more...](#)



Projects

Inventory of relevant research and cooperation projects on HNS and their Knowledge Outputs



Organisations

Inventory of key organisations working on maritime pollution and their main Resources



Resources

Inventory of all the Knowledge Outputs -compiled from projects- and the Resources -from organisations- dealing with HNS

Electronic booklets clustering relevant resources from the tool by areas of knowledge



Contingency plans & response



Risk Analysis



Training and exercising



Environmental impact



HNS characterisation



Modelling tools



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Working streams & Outcomes



• RESPONSE PROTOCOL

"Identification of expertise from chemical industry, civil protection and fire's crews and their response protocols and equipment to be adapted for marine events".



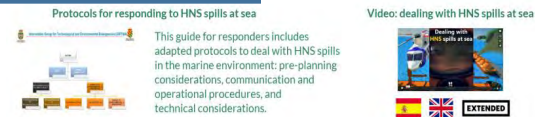
-Guide for Responders.

-Protocols to deal with HNS spills in the marine environment.

-Analyses land services operations and protocols for pre-planning considerations, communication and operational procedures and technical considerations.

-Evaluates protocols covering different behaviours of HNS (evaporators, floaters, sinkers, and dissolvers) and recommendations to deal with HNS spills at sea.

RESPONSE PROTOCOLS



TRAINING



DISSEMINATION



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Working streams & Outcomes



• RESPONSE PROTOCOL

Modelling of HNS hazards to the environment



Toxicological parameters selected
Modelling HNS hazards for predicting effects on the marine amphipods population

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Compilation of chemical, biological and ecological information to produce guidelines for HNS environmental impact assessment.

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RESPONSE PROTOCOLS

Protocols for responding to HNS spills at sea



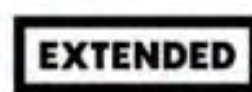
This guide for responders includes adapted protocols to deal with HNS spills in the marine environment: pre-planning considerations, communication and operational procedures, and technical considerations.

Video: dealing with HNS spills at sea



-Video on training

Video: dealing with HNS spills at sea



TRAINING

Training package on HNS spill management



Exercise Web Tool for bespoke desk-top maritime HNS exercises



Training package on HNS modelling and environmental impact



E-learning: International Health Regulations and HNS maritime incidents



DISSEMINATION

MARINER Layman's report



1st MARINER Project Workshop



2nd MARINER Project Workshop



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The MARINER project made a great effort to implement sea response protocols for HNS spills as is shown in this video:

<https://vimeo.com/257102781>

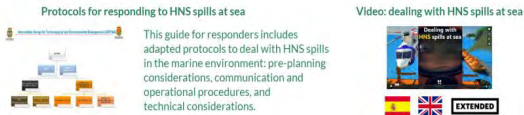
Working streams & Outcomes



• TRAINING



RESPONSE PROTOCOLS



TRAINING



DISSEMINATION

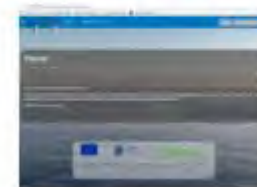


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Training package on HNS spill management



Exercise Web Tool for bespoke desk-top maritime HNS exercises



Training package on HNS modelling and environmental impact



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Working streams & Outcomes



• TRAINING

MARINER Exercise Tool on HNS incidents

- The tool combines: HNS information, modelling interface and a library of exercise materials providing scenarios
- Users can select HNS type, scale, location and conditions and populate the database with regional data
- It generates desktop exercises simulating maritime HNS incidents adapted to local conditions

ZIP File: word documents for the exercise including scenario setting, injects and supporting materials, and modelling animations

The collage displays various components of the MARINER Exercise Tool. Key elements include:

- Requests Status:** A dashboard showing the status of requests and a button to 'Download Simulation Report'.
- Spill Scenario:** A form for setting up a spill scenario, including fields for 'Incident Response Centre', 'Coast Guard', and 'Area of Interest'.
- Summary Page:** A detailed page for 'ETHANOLAMINE' and 'DISSOLVER' incidents, providing information on hazards, response procedures, and emergency services.
- Map Interface:** A map showing the location of the incident and surrounding areas.
- File Explorer:** A view of the generated files, including folders like 'AreaAtTheHighestRisk' and 'Exercise77928475'.
- EVALUATION REPORT:** A form for evaluating the exercise, including fields for 'Exercise', 'Date', and 'Facilitated By'.

Working streams & Outcomes



• TRAINING

Training Package on HNS spill management

14 presentations + 4 infographs

Modules

- 1 - General aspects on HNS
- 2 - Prevention & preparedness
- 3 - Response
- 4 - Post-crisis actions



MARINER is co-financed by the European Union in the framework of the Green Civil Protection Mechanism. DG-ECCHO



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Working streams & Outcomes

• TRAINING

Training package on HNS modelling and impact assessment

Main page Discussion

Main Page

Welcome to the "Training Package on HNS Modelling and Environmental Impact" from MARINER project.

The material was organized by CIIMAR (Helena Oliveira, Joana Soares, Miguel Santos) and Bentley Systems.

The material is separated in the following sections:

Unit 1 - Introduction to Hazardous and Noxious Substances (HNS)

Unit 2 - Environmental Impacts

Unit 3 - Environmental Monitoring

Unit 4 - Advanced Tools for Preparedness & Response:

Unit 4.1 - Situational Awareness & Common Operating Picture

Unit 4.2 - Integration of online databases in preparedness & response

Unit 4.3 - Modelling Fate & Behaviour of HNS

Unit 4.4 - Coastal Vulnerability Mapping: r



Hazardous and Noxious Substances Spill Incidents

climar

Advanced Search

Spill Incidents

Ship name	Incident date	Incident location
Anglo Maritime	1984	Croatia
Chor 6	1987	Italy
Val Rosetta	1988	Italy
Apri	1988	The Netherlands
Pradanger	1979	USA
Pravon Papi	1988	USA
Indigo	1988	Croatia
Pavilio	1984	The Channel
Batavien	1982	Brussels
Anna Bova	1988	The Netherlands
Punta Roca	1984	USA
Kalmar	1984	France
Belo	2001	Spain
Jose Maria Cuenca (name)	1988	Spain
Stel Pirene	2000	USA

Modelling tools for chemical spills at sea



Rodrigo Fernandes
(Bentley Systems)

Bentley ciimar

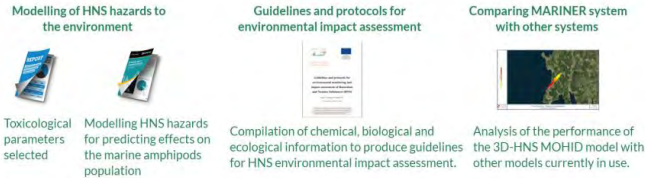
MARINER

EUROPEAN UNION

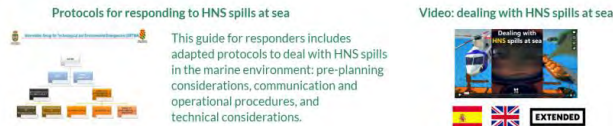
Working streams & Outcomes

• DISSEMINATION

Training package on HNS modelling and impact assessment



RESPONSE PROTOCOLS



TRAINING



DISSEMINATION



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LAYMAN report



MARINER events



MARINER Videos



Awareness Raising

<https://vimeo.com/224075676>



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MARINER



Universidade de Vigo



Protecting and improving
the nation's health



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Incident Response – Protecting the Public

Public Health England
Workshop
xx/xx/xxxx

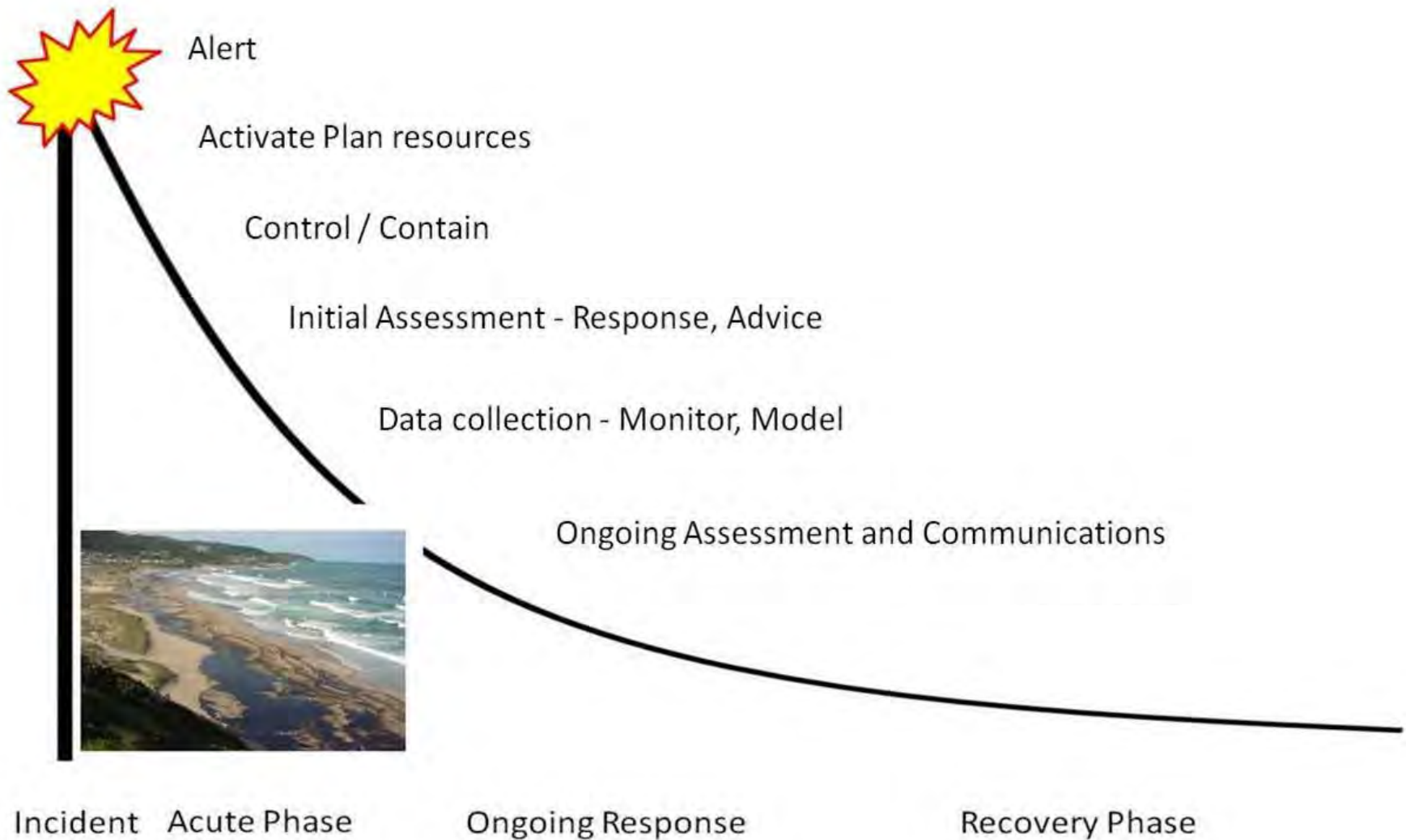


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Aims

- Define the stages of incident response
- Describe Response Phase for public protection
 - Zoning
 - Mass decontamination
 - Shelter Vs Evacuation
- Describe Risk Communication Approaches,
 - Warning and informing
 - Role of Social Media
- Define Recovery Phase and key actions

Incident Phases



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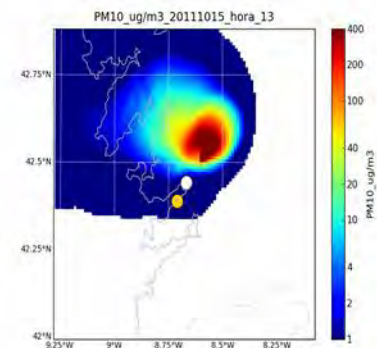
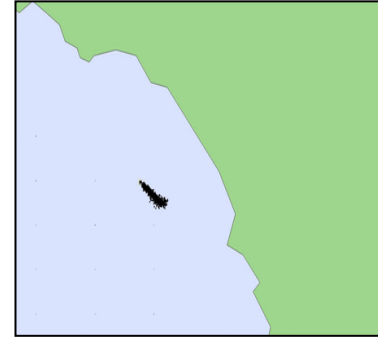
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Public Health Response - Initial Assessments

Initial risk assessment needs to be completed before response can be formulated.

- Key aspects to be determined will include.
- Location of the incident?
- Quantity and type of chemicals involved?
- Location, numbers and types of receptors involved?
- Immediate threats are there casualties?
- Meteorological conditions?
- Resources available and timescales to mobilise these?

A critical aspect of response is to obtain information on conditions on the ground.



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Public Health Response - Immediate Actions

- If an incident occurs the immediate priorities will be to
 - Make area safe (Zoning)
 - Treat / decontaminate casualties
 - Reduce wider exposure by advising people to leave affected areas (evacuation) or stay indoors (shelter in place)
 - Protect sensitive ecosystems and infrastructure



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Zoning

Zoning is a specialised activity influenced by many factors such as the hazards involved, weather conditions, key receptors logistical issues.



Hot Zone:
Exclusion area
Responders only with full PPE.



Warm Zone:
Decontamination area
Evacuation



Cold zone:
Command and control.
Public staging area

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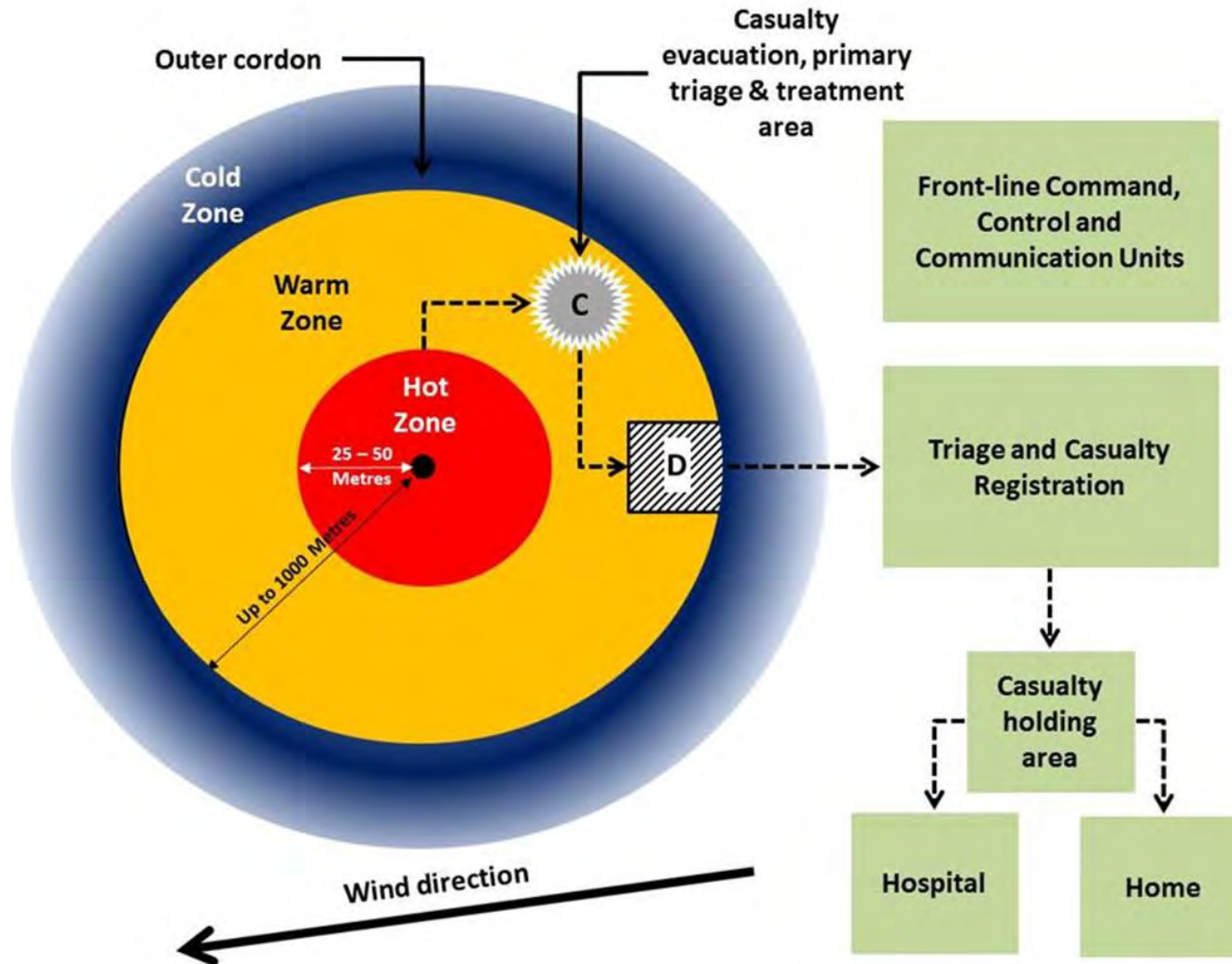


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Zoning



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Mass Decontamination

- To remove the hazardous substance and thus limit casualty exposure
- To prevent secondary contamination of responders and public



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Should be performed:

- By **skilled responders** with appropriate personal protective equipment (PPE)
- In the **warm zone, upwind** of the incident
- Following removal of contaminated clothing from casualty - at the head working towards the toes
- Using absorbent cloths and / or warm water (**Rinse-wipe-rinse**)
- **Determined on a chemical and incident (resource) specific basis.**



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Case Study – Graniteville

January 2005 - rail accident in South Carolina - tank cars of pressurised liquid chlorine ruptured.

The chemical rapidly vaporised on exposure to the atmosphere.

Chlorine - Hazards

Pale-green gas with characteristic odour - bleach.

Heavier than air so will keep low to the ground

Exposure to high concentrations may be fatal.

Minor exposures may result in burning sensation of the eyes and throat.

Moderate exposure may cause breathing difficulties.

Longer term may cause lung damage.

Powerful oxidising agent.



Graniteville – Immediate Actions

Approximately 15 minutes - 300m exclusion “hot-zone” defined (Standard ERG Guidance).

Marshalling of firefighting personnel and equipment at a staging area **upwind** of the release site.

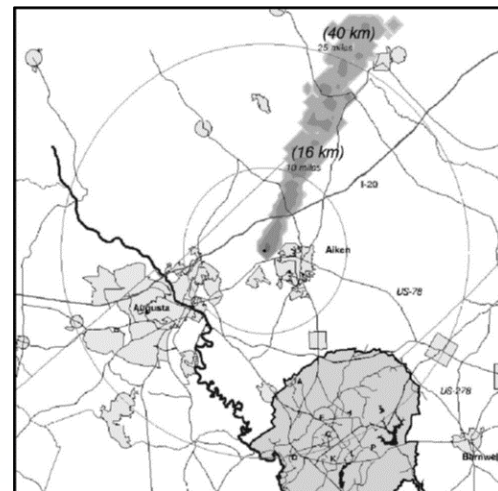
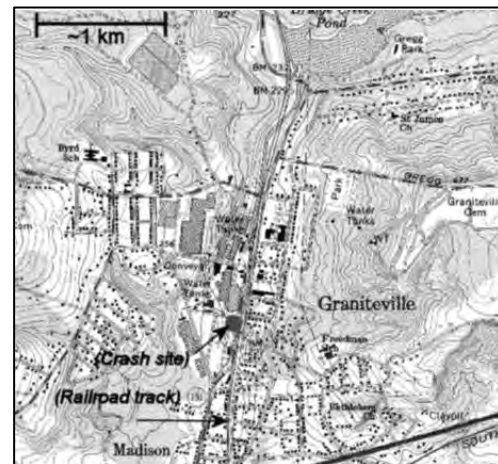
Within 50 minutes - decontamination stations organized upwind and at boundary of hot zone.

After 1 hour firefighter entry teams, wearing personal protective equipment entered the “Hot Zone”.

Triaged and casualties removed to one of the decontamination stations.

Nine people died, 72 were hospitalized, 525 were examined as outpatients.

5,400 residents within a mile of the crash site were forced to evacuate their homes.



Wider Population Protection - Sheltering

Often the default advice where there is risk of wider impacts (e.g. smoke or vapours):

- **Go-in, Turn-on, Tune-in** (to media sources)
- Keep doors and windows closed
- Close blinds and curtains if risk of explosion
- Turn off air condition / ventilation
- If necessary seal doors and windows with damp towels
- Use showers to knock-out gases if appropriate
- **Ventilate properties when danger has passed**



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Sheltering - Considerations

Sheltering will be helpful when the wind direction is changeable or buoyant but will not protect indefinitely

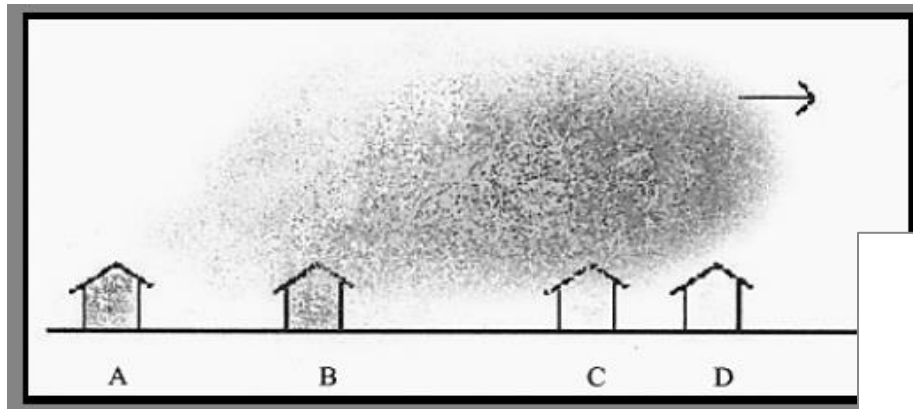
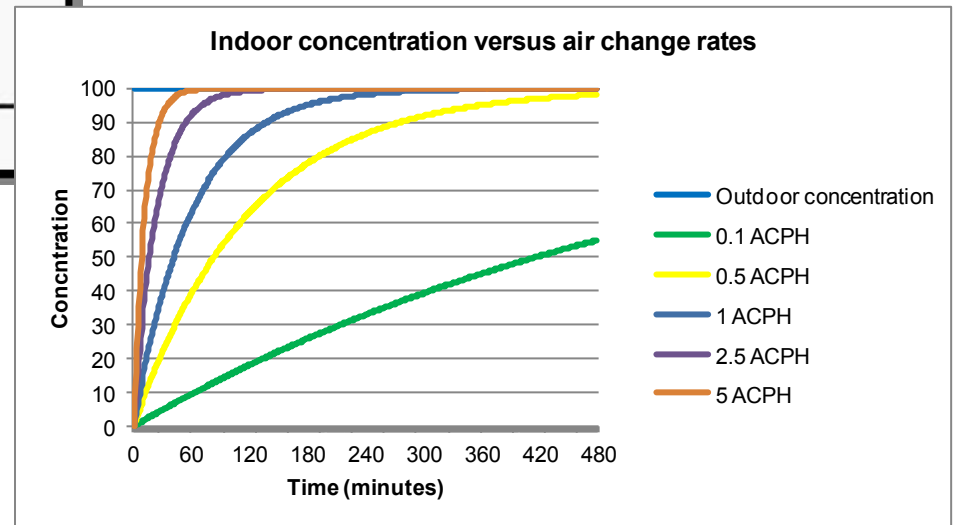


Figure. The movement of a plume at a given moment in time



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Wider Population Protection - Evacuation

Where sheltering cannot afford adequate protection.

Requires people to leave their homes / workplaces

Often used for non-residential situations e.g. workplace, outdoor scenarios.

Process needs to

- Be co-ordinated with multiagency input
- Be mindful of **susceptible individuals** e.g. young, elderly and infirm.
- Have transport and reception facilities available



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Evacuation - Considerations

- May be logistically difficult
 - Time of day
 - Panic / Grid-locking
 - Reluctance
- May increase exposure
- Therefore, normal advice to shelter.
- Exceptions:
 - Risk of fire/explosion
 - Build up of dangerous levels
 - Prolonged events



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Case Study – Tyre Fire Wales - Wider Protection

June 2011 - fire at an unoccupied warehouse on an industrial estate in South Wales.

Source material comprised 5,000 tonnes of tyre „flock”

The fire continued to burn over the three-week period producing dense smoke.

Very quickly - Major incident declared.

A strategic coordination group (SCG) led by the local authority was established to provide risk assessment and incident management / Advice.

Key strategic decisions needed around risks to the public and the need for shelter and / or evacuation.

Real-time ambient air quality monitoring was implemented to assist in decision making .



https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/203631/CHaP_Report_21.pdf



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Should you stay or should you go?

Default public health advice - Shelter

Informed primarily by air monitoring.

But also

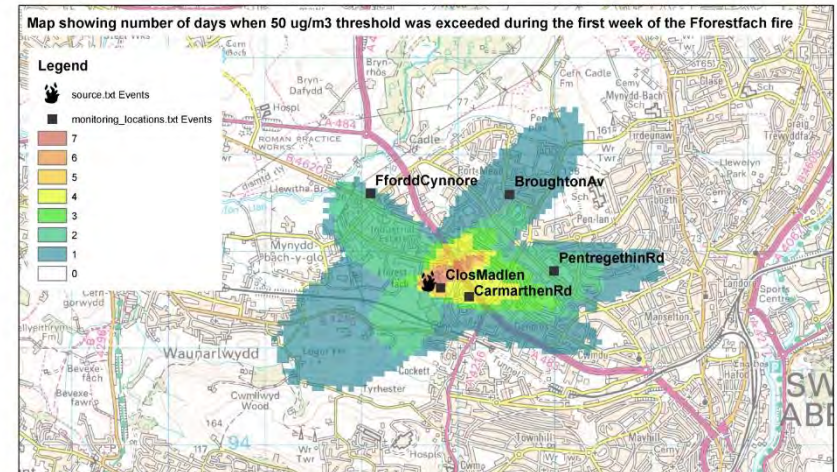
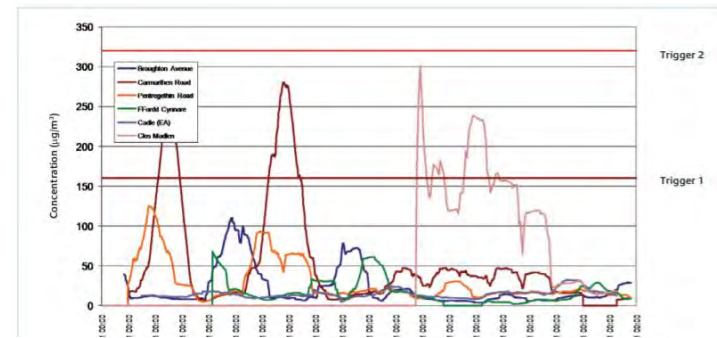
- fire fighting activities,
- meteorological forecasts,
- logistics.

Public Health Outcomes

Communities up to 2 km from the incident (estimated population 24,812) potentially exposed.

98 health concerns reported during incident

Reports consistent with smoke exposure: coughs, sore throats, eye irritation, headaches and nausea.



Ozone

Nitrogen Dioxide

Sulphur Dioxide

PM2.5 Particles

PM10 Particles

Nitrogen Dioxide

Based on the hourly mean concentration.

Index	1	2	3	4	5	6	7	8	9	10
Band	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Very High
µg/m³	0-67	68-134	135-200	201-267	268-334	335-400	401-467	468-534	535-600	601 or more

<https://uk-air.defra.gov.uk/air-pollution/daqi>



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Recommended Actions and Health Advice

Air Pollution Banding	Value	Accompanying health messages for at-risk individuals*	Accompanying health messages for the general population
<u>Low</u>	<u>1-3</u>	Enjoy your usual outdoor activities.	Enjoy your usual outdoor activities.
<u>Moderate</u>	<u>4-6</u>	Adults and children with lung problems, and adults with heart problems, who experience symptoms , should consider reducing strenuous physical activity, particularly outdoors.	Enjoy your usual outdoor activities.
<u>High</u>	<u>7-9</u>	Adults and children with lung problems, and adults with heart problems, should reduce strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also reduce physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should consider reducing activity, particularly outdoors.

Banding is based upon specific chemical concentrations and exposure duration

<https://uk-air.defra.gov.uk/air-pollution/daqi>



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Getting Advice to the Public - Risk Communication

Clear mechanisms for effective and early communication. Forms an essential component of emergency planning, preparedness and response.

Risk communication

Developed at the planning stage.

Predetermined materials regarding hazards and response.

Should be done in liaison with all stakeholders including local communities, businesses and action groups.

Crisis communication

During an incident

Involving essential advice such as sheltering, evacuation, all-clear messages etc. via various media



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Messages - Warning and Informing

What do you want the public to do?

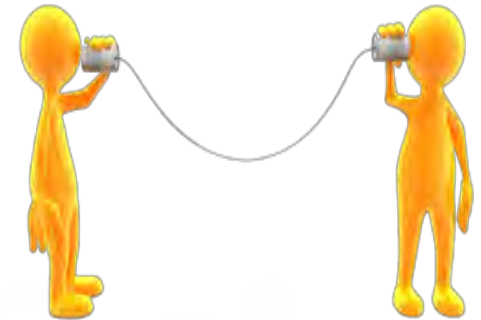
- Incident details:
 - what has occurred
 - who is in charge
 - actions being taken
 - who is at risk (from what, how)
 - where to get further information
 - where to get treatment / support

Single source for communications
usually the lead agency.

All forms of media

**Simple,
Timely,
Accurate,
Relevant,
Credible,
Consistent**

WHO Guidelines



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The Role of Social Media

- Now an Essential means to monitor and disseminate messages

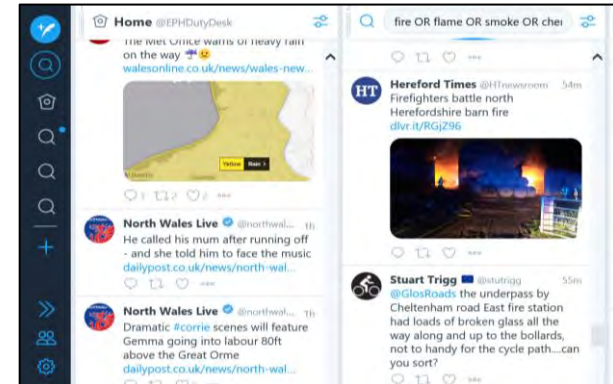
Free

Tweet deck provides “live” searches of key terms within defined geographical locations

Commercial Products

Many available

- Search multiple platforms.
- Real-time display to multiple users
- Comprehensive data analytics
- Alerts when detecting increased traffic



<https://tweetdeck.twitter.com/>



<https://www.brandwatch.com/>



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Case Study – Essex Beach Incident

Busy beach during August bank holiday.

Beachgoers reported breathing difficulties following swimming / contact with sea water.

Police, ambulance and fire service attended.
Public warned to stay out of the sea.

PHE further advice via local authority / NHS 111-
shower and drink fresh water.

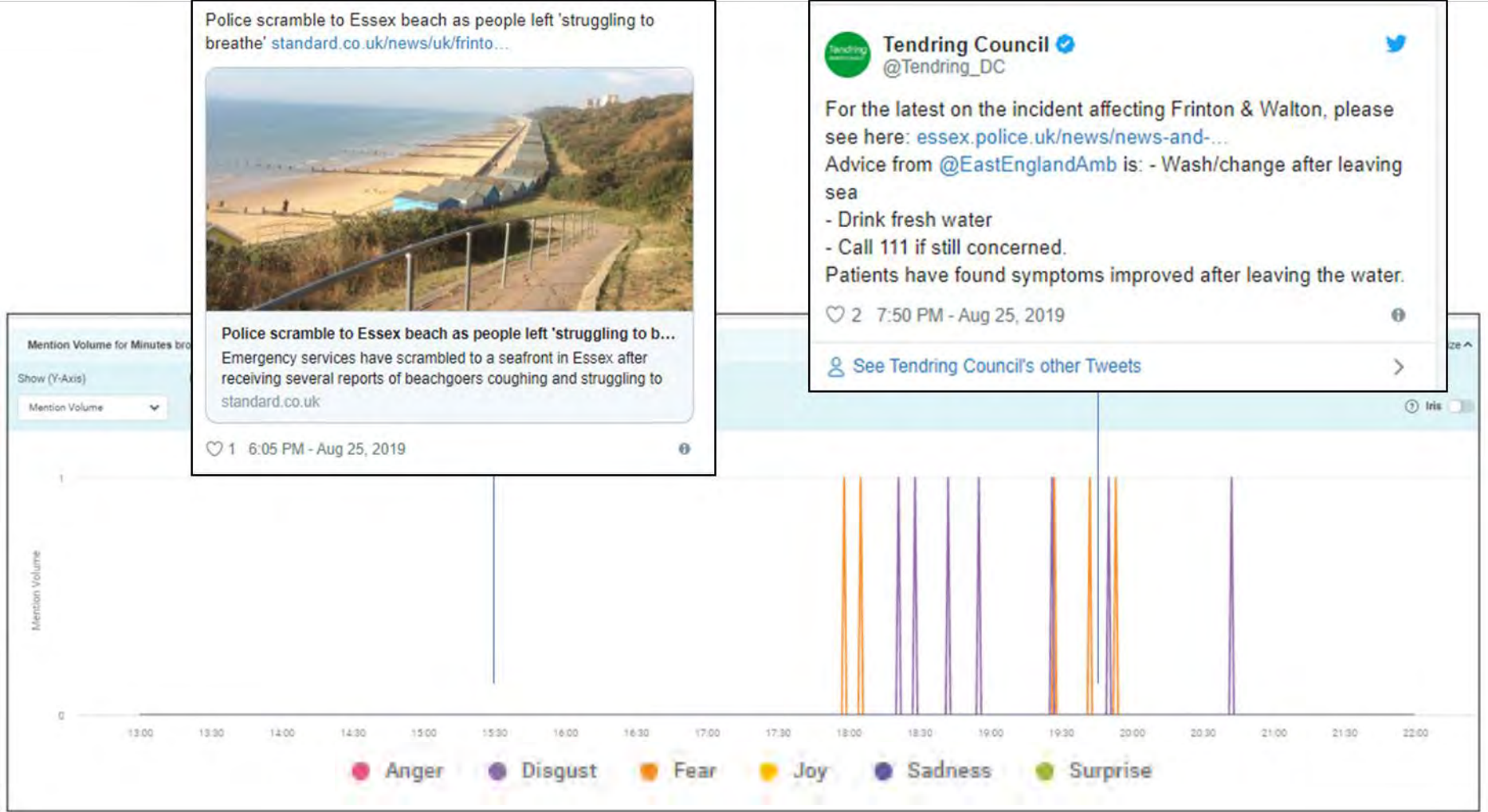
Multiple persons attended local hospital.

All affected persons recovered overnight.

Cause unknown – MCA - no evidence of spillage from vessels. Possibly marine algae – unconfirmed.



Impact of PH messages – Essex Beach Incident – Day 1

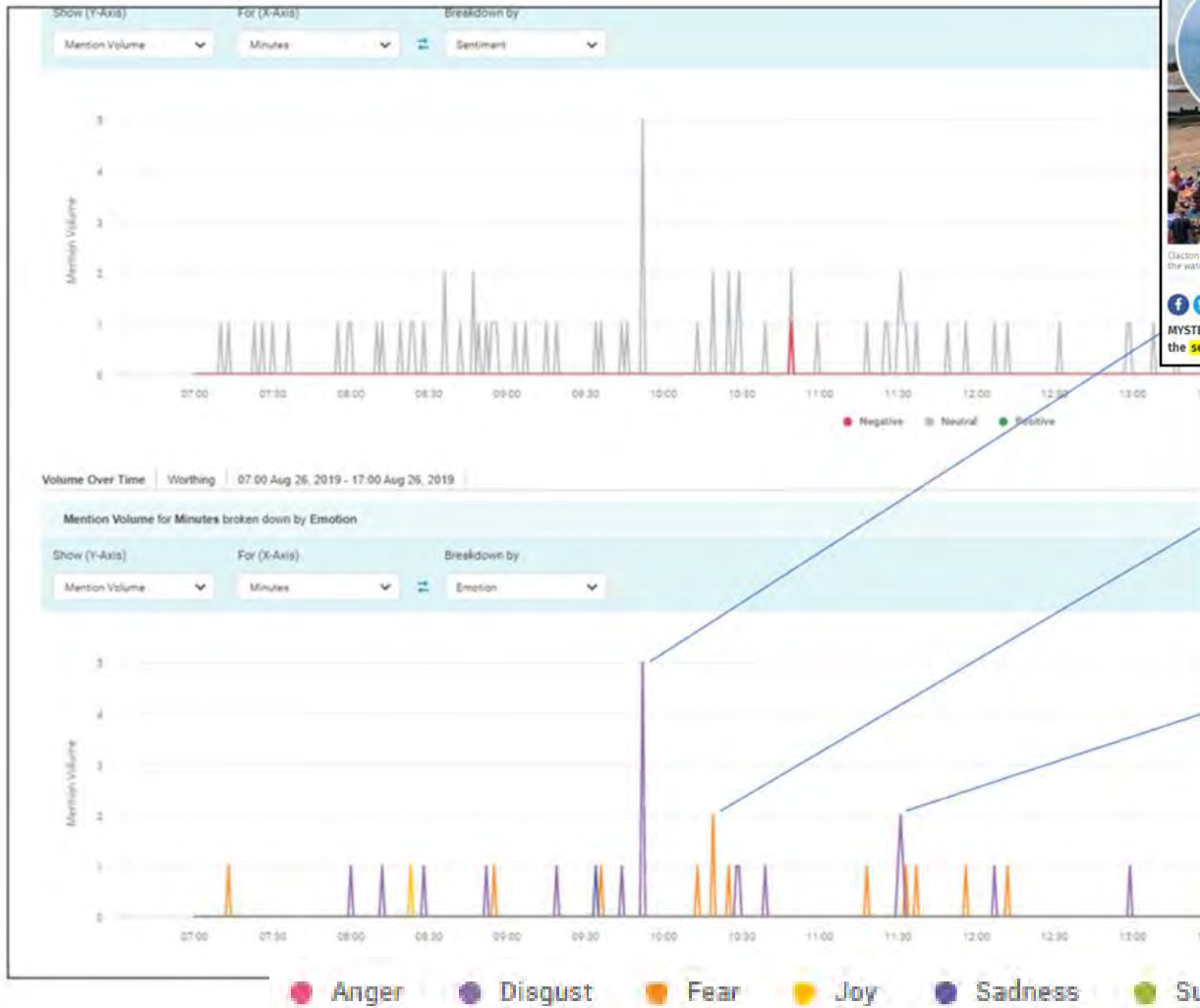


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Essex Beach Incident – Day 2



News

Everything we know after children fell ill after swimming in sea off north Essex coast



Most read Commented

When is someone going to investigate this? Two weeks ago Worthing beach was evacuated for same reason. Previously Beachy Head. SOMETHING is going on. Joint the dots. What is happening? Frinton-on-Sea: Police called as beachgoers left 'struggling to breathe' [bbc.co.uk/news/uk-england...](https://www.bbc.com/news/uk-england-47888888)



Beachgoers left 'struggling to breathe'
Emergency services were called after people at a beach in Essex reported having difficulty breathing. [bbc.co.uk](https://www.bbc.com/news/health-47888888)

Tourists reassured the south Essex sea is safe after concerns raised along coast

By Matthew Critchall



Safe - South Essex

7 comments

Tourists and sunseekers have been reassured the sea around south Essex is safe after concerns were raised along the Essex coast.

Get involved with



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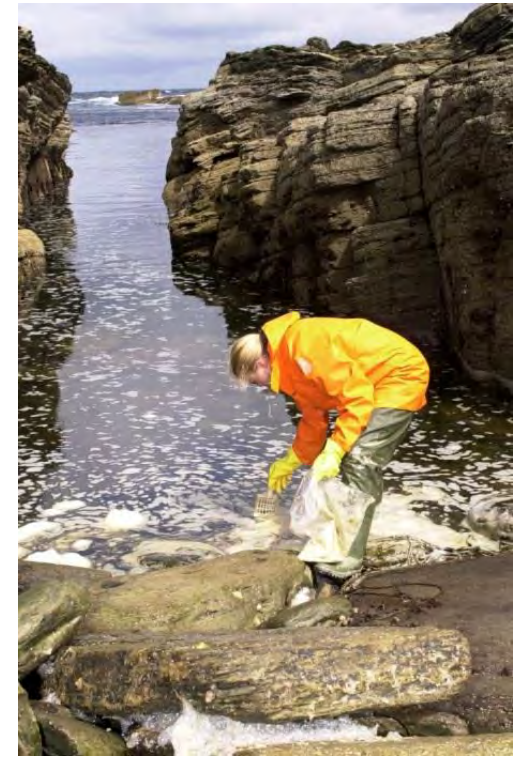


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Ongoing Response

As the incident continues, focus will shift from the impacts on scene to the wider implications of exposure. It requires knowledge of

- Pollutant behaviour in environment
 - Proximity of communities and ecosystems
 - Meteorological forecasts
 - Modelling forecasts
 - Monitoring and sampling
- Provides a basis for continuously assessing and reviewing the risk to the public and the wider environment.



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Recovery

Longer term actions following the incident

- Victim support and follow-up – Physical and psychological treatment, aid for welfare, employment etc.
- Remediation – Clean up of contamination
- Restoration – Returning the environment to its original state
- Rehabilitation – Adapting ways to get things back to normal
- Investigation and applying lessons learnt



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Further Useful Information / Materials

Manual for Public Health management of Chemical Incidents (WHO 2009)

https://www.who.int/environmental_health_emergencies/en/

Arcopol Project – response tools / Risk Communications

<http://www.arcopol.eu/?/=lang/en>

Arcopol E-learning – Shoreline Response (guest log in)

<http://www.cardiffmet.ac.uk/health/ITC/Pages/Public-Health-Management-for-Incidents-and-Events.aspx>

Emergency Response Guidebook 2016 (US Dept of Transport)

<https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg>

Hazrunoff (Social Media study) <http://www.hazrunoff.eu/tools-for-situation-awareness-emergency-response/>

Uk Recovery Handbook for chemical incidents (UK HPA 2013)

<https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications>

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Questions?



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Practical exercise on HNS behaviour SEBC understanding

CEDRE

Florence PONCET
Stéphane LE FLOCH



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Contents

- Explosivity and flammability
- Toxicological threshold values
- Environmental limits
- Example of environmental programme



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Why do we need thresholds limits?

- Cartography: according to modelling forecasts of chemicals dispersal
- Evaluation: giving information to response teams
- Emergency measures: population evacuation, fishing exclusion zone...



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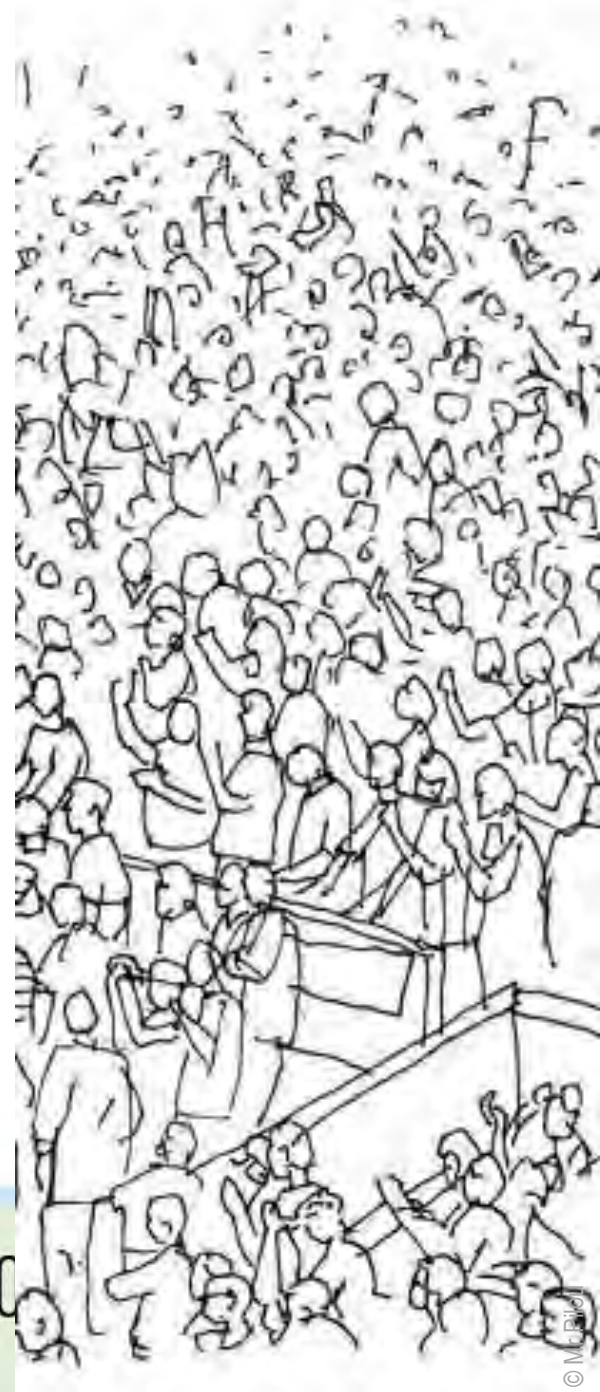


What is a toxicological threshold value?

- Definition: the minimum concentration of a substance that causes a negative effect, that may be of varying severity, on a human population for a given exposure time
- Determining: extrapolation to humans of data obtained from experiments on animals



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What do we need toxicological threshold value?

- To know if intervention is possible
- To evaluate if population need to be confined or evacuated



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Which are the limits of this values?

- No globally harmonized system
- Each type of value has its own definition and was developed in specific purposes



Immediately Dangerous to Life or Health (IDLH)

- 1994** Maximal concentration in the air until which one worker can escape without risking to die or to feel irreversible effects on the health following severe respiratory or eye irritation and other noxious effects (disorientation or lack of coordination)
- 1987** Maximal concentration in the air until which a person exposed for at most 30 minutes can run away without risk of irreversible effects for the health.




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AEGL values

Concentration of a substance in the air over which...

- 
- 3 ...the potentially **mortal** effects or the **deaths** could arise within the population.
 - 2 ...the **irreversible** effects, the **severe harmful** effects or **long-term opposite** effects could be observed within the population.
 - 1 ...the population could present signs of notable **discomfort** and **irritation** or other signs that are **non-sensory** and **asymptomatic**. These effects are **non-invalidating** and **reversible** after exposure cessation.




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EPRG values

Maximal atmospheric concentration below which...

- 
- 3 ...It is likely that almost all the individuals could be exposed during more than one hour without feeling or developing of effect threatening their life.
 - 2 ...it is likely that almost all the individuals could be exposed during more than one hour without feeling or developing irreversible or incapacitating effects.
 - 1 ...it is likely that almost all individuals could be exposed more than one hour without feeling more than light passing effects or detecting a smell.



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TEEL values

Concentration limit below which...

3

... it is likely that almost all the individuals could be exposed without feeling or developing effect threatening their life.

2

... it is likely that almost all the individuals could be exposed without feeling or developing irreversible or incapacitating effects.

1

... it is likely that almost all the individuals could be exposed without feeling more than light passing effects or detecting a smell.

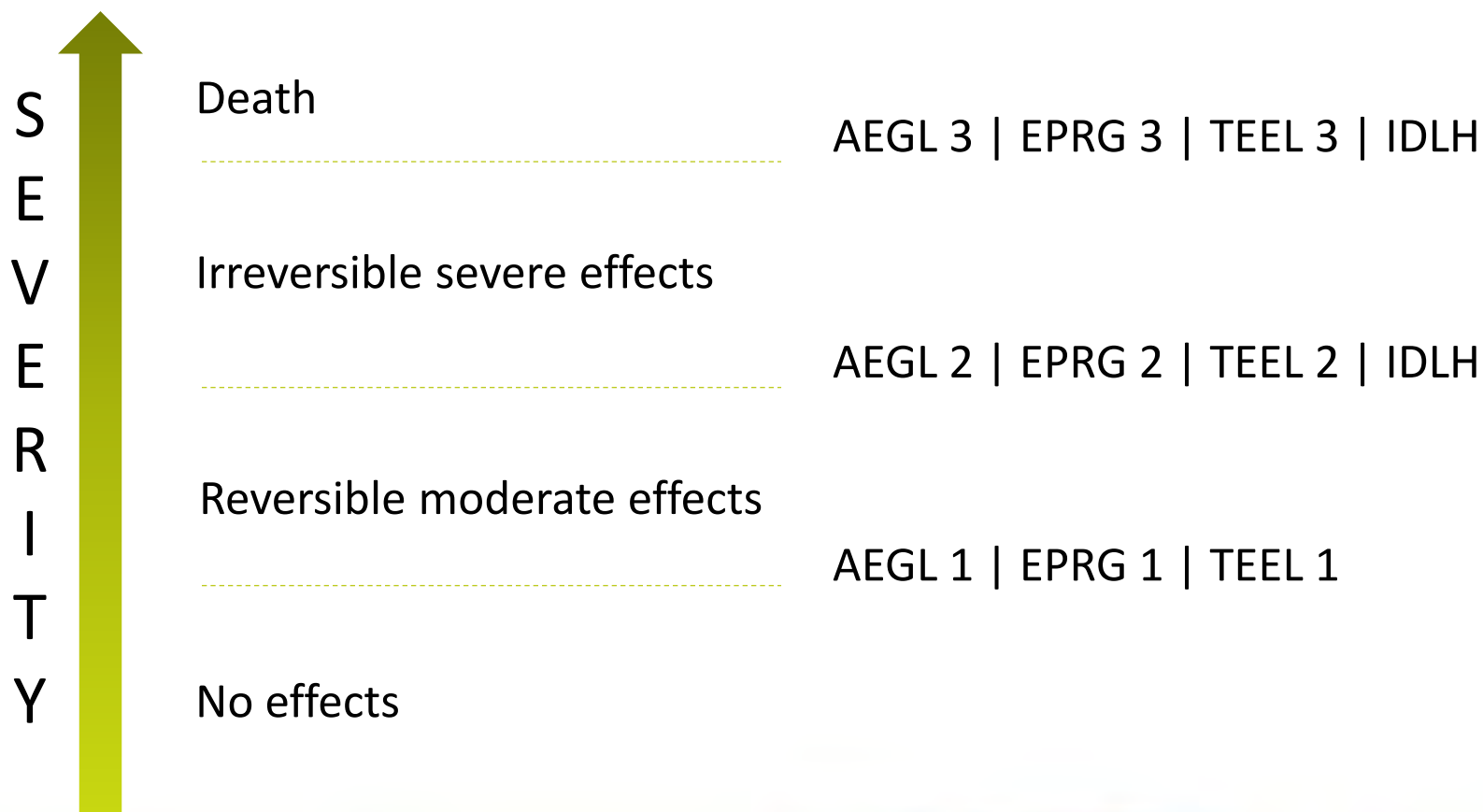


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To summarize



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To summarize

Value	Target population	Publishing agency	Time of exposure	Values published
IDLH	Workers	National Institute for Occupational Safety and Health (NIOSH)	30'	390
AEGL	General population, including sensitive individuals	National Academy of Sciences	10', 30', 1h, 4h, 8h	70
EPRG	General population	American Industrial Hygiene Association (AIHA)	1h	145
TEEL	General population, including sensitive individuals	US Department of Energy	1h	> 3,000

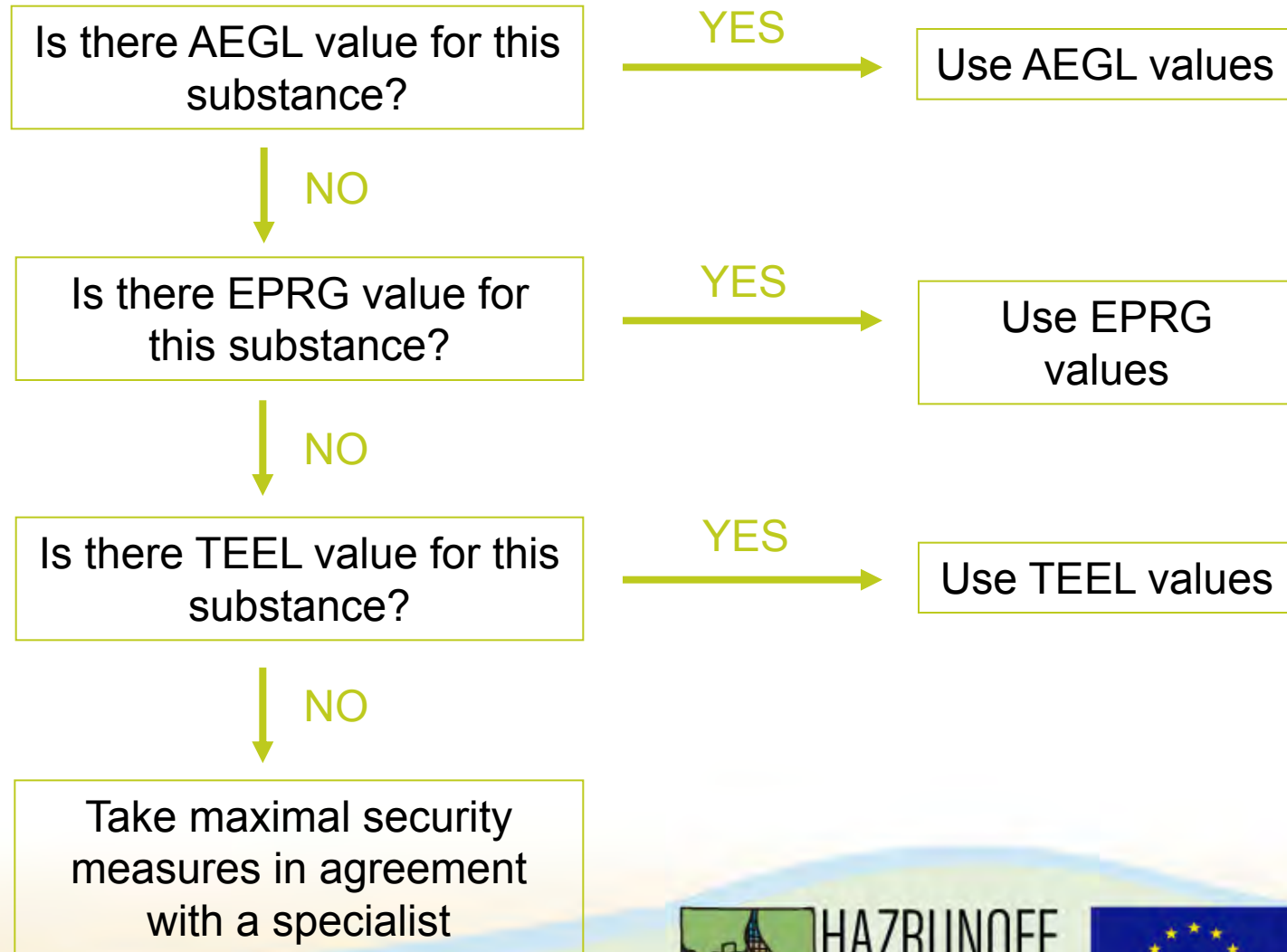


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Choosing the right value in case of an incident



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Examples – 1 h exposure

Chemicals	AEGL 3	EPRG 3	TEEL 3
Ammonia	1,100 ppm	750 ppm	n/a
Carbone monoxide	330 ppm	500 ppm	n/a
Chlorine	20 ppm	20 ppm	n/a
Hydrogen bromide	120 ppm	n/a	n/a
Nitrous oxide	n/a	n/a	20,000 ppm

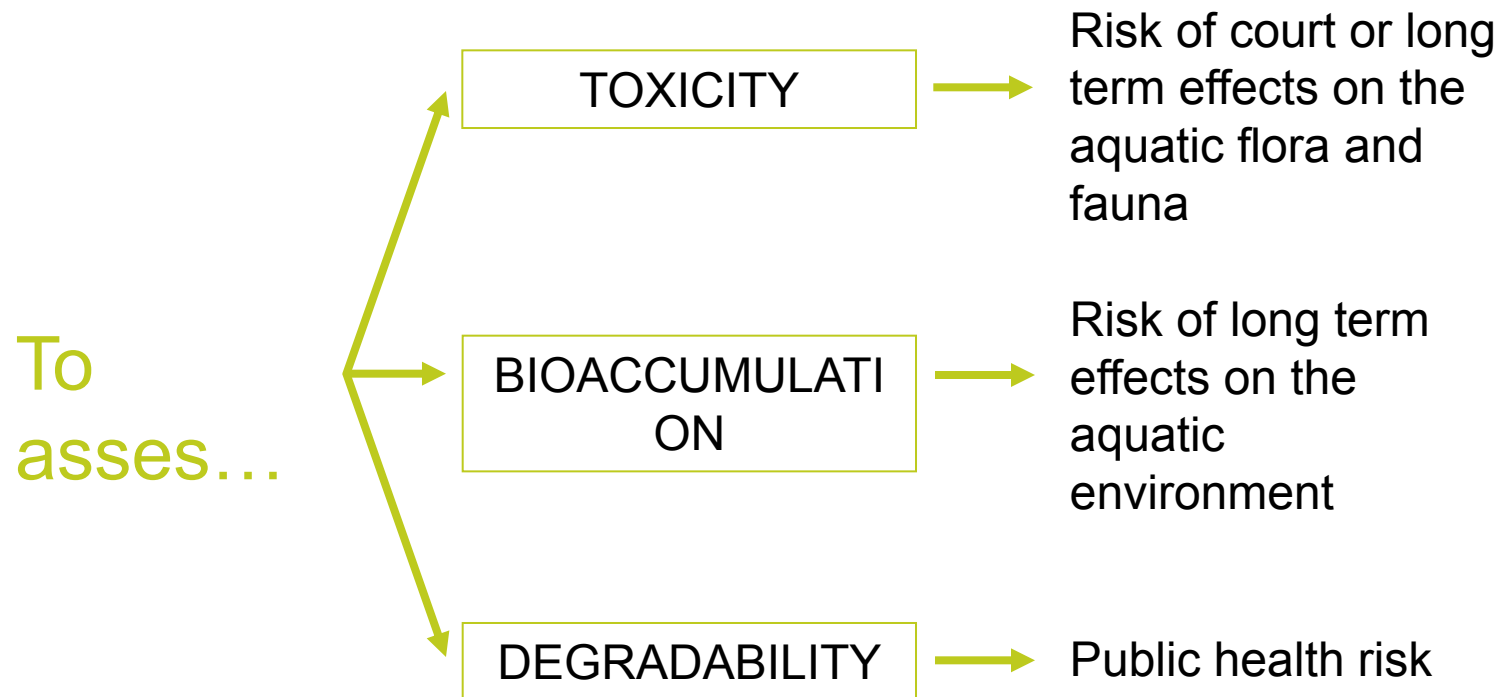


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Why do we need environmental limits?



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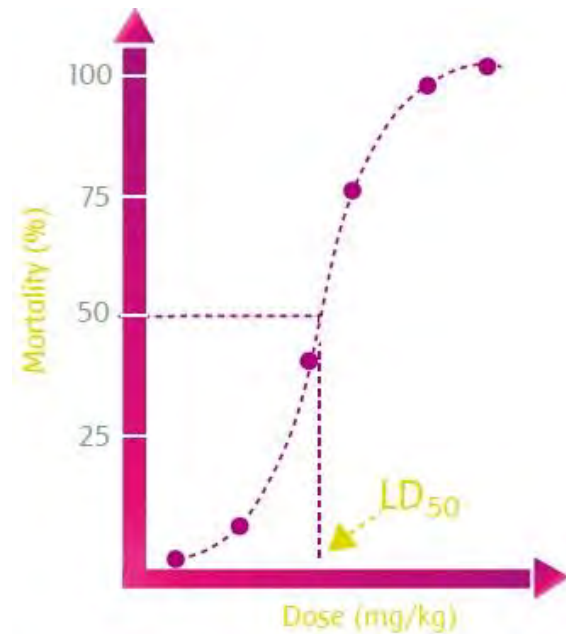
LD₅₀ and LC₅₀

LD₅₀:

The dose of a substance that will kill 50% of a given population in specific experimental conditions. It is expressed in milligrams of a substance per kilogram of animal body mass (mg/kg).

LC₅₀:

In the case of a gas or liquid, the median lethal concentration (LC₅₀) is calculated and expressed in milligrams per litre (mg/L) or parts per million (ppm).



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DDT (rainbow trout)	3 to 6 µg/L
Lindane (rainbow trout)	20 to 36 µg/L
TEPP (rainbow trout)	500 to 980 µg/L

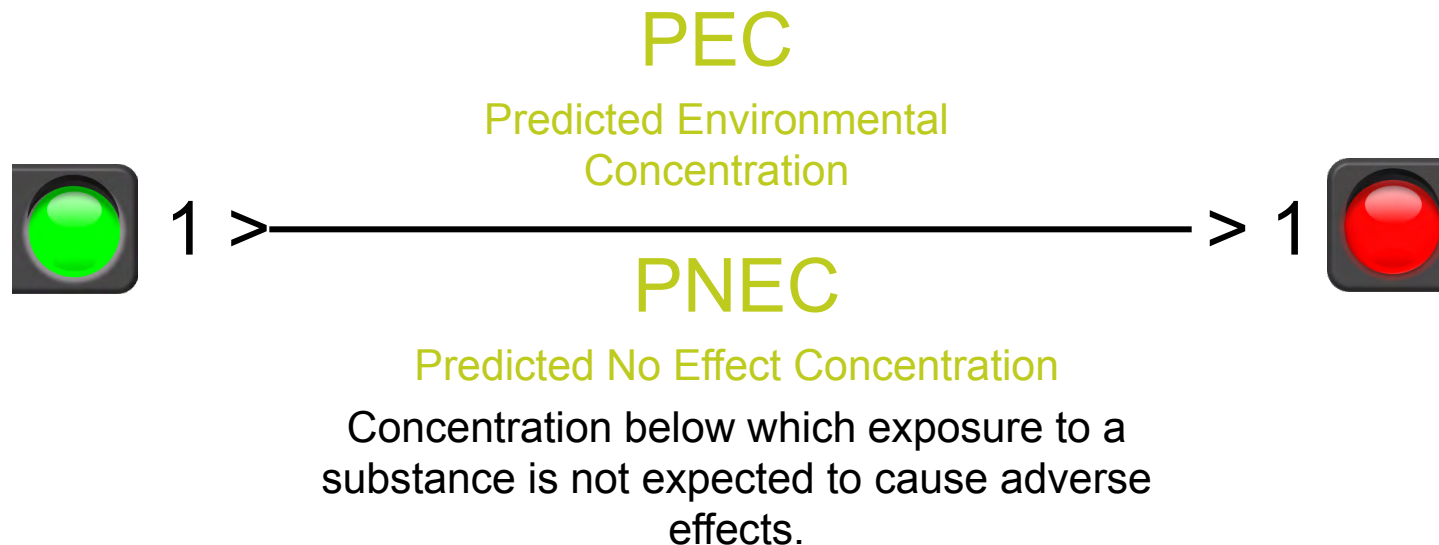


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PEC/PNEC



Chromium	0.6 µg/L
Benzene	8 µg/L
Chloroform	146 µg/L
Methanol	154 mg/L



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BCF (Bioconcentration factor)

[substance] in organism

[substance] in water

$BCF > 4,000$

Very
bioaccumulable

$4,000 > BCF > 500$

Bioaccumulable

$BCF < 500$

Little
bioaccumulable

Vinyl chloride	10 to 40 L/kg
Xylene	72 to 106 L/kg
Mercury	5,000 to 9,000 L/kg



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Kow and Log Kow

$$\text{Kow} = \frac{\text{[substance] in octanol}}{\text{[substance] in water}}$$

Kow defines the ability for a substance to be lipid soluble, so its ability to bioconcentrate in the tissues.

Non accumulable  $1 < \text{Log Kow} < 7$  Highly accumulable

Vinyl chloride	1.58
Chloroform	2.13
DDT	6.4



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Half life

Time in the course of which a fraction representing 50 % of the initial quantity is degraded.

Abiotic degradation:

Hydrolyse

Photodegradation

Styrene (air)	7 to 16 h
------------------	-----------

Biodegradation:

Water

Sediment

Glyphosate (seawater)	47 to 315 d
--------------------------	-------------



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Example of a biomonitoring:

Assessing the environmental impact of the *COSTA CONCORDIA* wreck through an integrated, multidisciplinary weight of evidence approach



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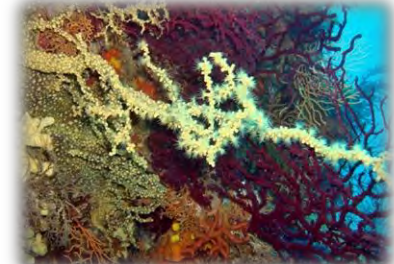
Example of a biomonitoring



A multidisciplinary weight of evidence approach for environmental risk assessment at the Costa Concordia wreck: Integrative indices from Mussel Watch



Francesco Regoli^{a,*}, David Pellegrini^b, Anna Maria Cicero^c, Marco Nigro^d, Maura Benedetti^a, Stefania Gorbi^a, Daniele Fattorini^a, Giuseppe D'Errico^a, Marta Di Carlo^a, Alessandro Nardi^a, Andrea Gaion^b, Alice Scuderi^b, Silvia Giuliani^b, Giulia Romanelli^c, Daniela Berto^e, Benedetta Trabucco^c, Patrizia Guidi^d, Margherita Bernardeschi^d, Vittoria Scarcelli^d, Giada Frenzilli^d



f.regoli@univpm.it

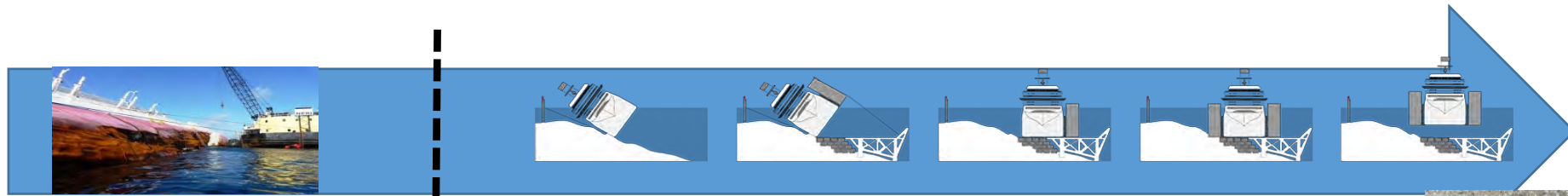


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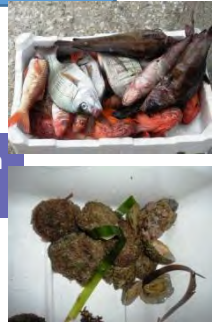
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Treatment of the Costa Concordia wreck



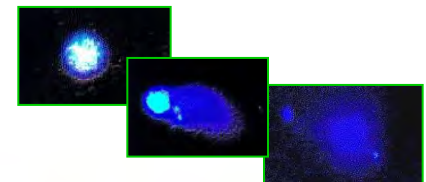
EMERGENCY PHASE

PARBUCKLING PROJECT



Implementation of an environmental biomonitoring programme

Sampling dates	I Campaign Jan 2012	II Campaign Mar 2012	III Campaign Apr 2012	IV Campaign May 2012	V Campaign Jun 2012	VI Campaign Jul 2012	VII Campaign Oct 2012	VIII Campaign Dec 2012	IX Campaign Jan 2013	X Campaign Apr 2013
To look for which pollutants	Bioavailability <ul style="list-style-type: none"> - Trace metals - Polycyclic Aromatic Hydrocarbons PAHs - Volatile hydrocarbons C6-C10 - Aliphatic hydrocarbons C10-C40 					<ul style="list-style-type: none"> - Halogenated pesticides - Polychlorinated biphenyls PCBs - Organotin compounds - Flame retardants (PBDE) - Anionic surfactants 				
By biomarkers measurements	Detoxification-Exposure biomarkers <ul style="list-style-type: none"> - Metallothioneins - Peroxisomal proliferation - Cytochrome P450 and bile metabolites - Acetylcholinesterase Oxidative stress <ul style="list-style-type: none"> - Antioxidants and antioxidant enzymes - Total antioxidant capacity 					Cellular damage <ul style="list-style-type: none"> - Lysosomal stability - Lipofuscin and neutral lipids - Lipid peroxidation Genotoxic effects <ul style="list-style-type: none"> - DNA integrity - Micronuclei and nuclear alterations 				



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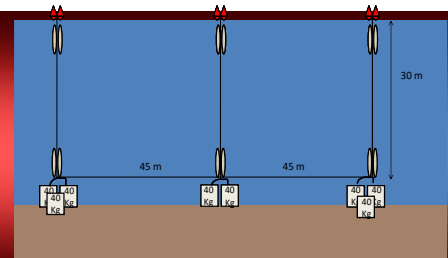
Implementation of the environmental monitoring



Concordia wreck

Active Mussel Watch

Short term chemical spill and impact
3 sites, 2 depths



Bioavailability and long term effects in native fish Species of different trophic levels

- Scorpion fish (*Scorpaena* sp.)
- Red mullet (*Mullus barbatus*)
- Forkbeard (*Phycis blennoides*)
- Stargaze (*Uranoscopus scaber*)



Rocky shore invertebrates, algae:
different exposure route and chemical persistence on rocks.

- *Thais haemastoma*
- *Patella* sp.
- *Codium bursa*



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How to expose the results

Need to express the results in an understandable way... **and not –only- in a purely scientific way!**

Methodology followed

- Calculation for each biomarker of the variation compared to Threshold, corrected for statistical significance and importance of biomarker (score)
- Assignment of each biomarker response to 1 of 5 classes of effect
- Calculation and Classification of cumulative HQ in a level of hazard according to % distribution of biomarkers in the 5 classes

Tab_biomarker

LOE3 biomarkers

ID:

281

Latitude:

Longitude:

Area_code:

Isola del Giglio

Site_code:

Concordia

Reference_Area_code:

Isola del Giglio

Reference_Site_code:

Concordia

Sampling_date:

01/04/2012

Sampling_code:

conc_pes_apr_12

Core_code:

Core_level:

Experimental condition:

Wild organisms

Exposure_time:

Species:

Scorpaena_spp

Sample_code:

Scorpaena_scrofa_nave_apr_12

Reference_Sample_code:

Scorpaena_scrofa_bianco_apr_12

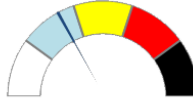
Note:

Scorpaena_scrofa

RESULTS

	Weighted mean	n° biomarker
Class A	0	12
Class B	1,288312	2
Class C	1,477815	2
Class D	0	0
Class E	0	0

Cumulative HQ for biomarkers	Level of hazard for biomarkers
HQ 1,477815	SLIGHT



Absent

Slight

Moderate

Major

Severe

UNOFF



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Biomonitoring results

- Bioavailability data exclude serious contamination events from the wreck or a consistent increase of environmental pollutants
- Nonetheless, **moderate or episodic spills with reversible effects have been detected**, differing between the emergency phase and the operations for removal
- The more evident bioaccumulation trend in *T. haemastoma* suggests different exposure dynamics on rocky shores due to a re-washing effect
- Consistently with bioaccumulation, biomarkers did not reveal major effects on the health condition of both transplanted or native organisms, still allowing a very sensitive detection of early biological disturbance
- The Weight of Evidence approach and the presented model were confirmed useful to summarize large datasets of different typologies of data, for characterizing environmental quality and risk assessment in a comprehensive process of “site-oriented” management decisions

<http://www.disva.univpm.it/content/ecotoxicology-and-environmental-chemistry?language=en>



f.regoli@univpm.it



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Key points

Substance hazard

Ecotoxicology data

Response of relevant biomarkers

Impact at the population and/or community levels

Need to mix different tools



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Humanitarian Aid**



<http://www.hazrunoff.eu/>



@hazrunoff





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Modelling in the response strategy

Instituto Superior Técnico

Lígia Pinto

Ana Oliveira



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Outline

Introduction to the HazRunoff modelling tools (watershed, estuarine and meteorological models):

- Models description; input data and models outputs;
- Model results exploitation: an example based on one of the HazRunoff case study using HazRunoff platform.

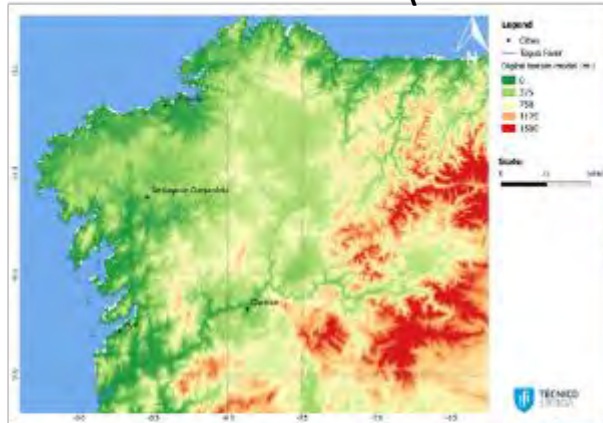
Water pollutant and debris dispersion model:

- Model description and input data;
- Practical exercise on how to perform a lagrangian simulation using the HazRunoff platform

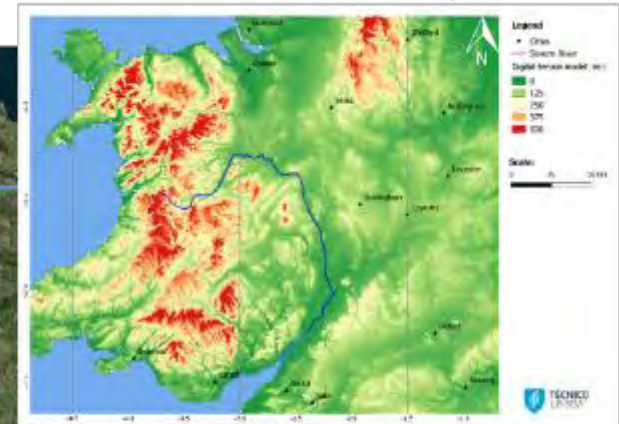
Final debrief / question and answer session

HazRunoff study areas

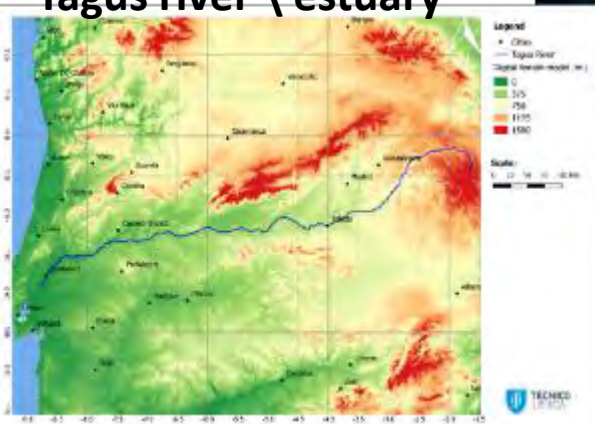
Ulla and Sar rivers \ Ria Arosa



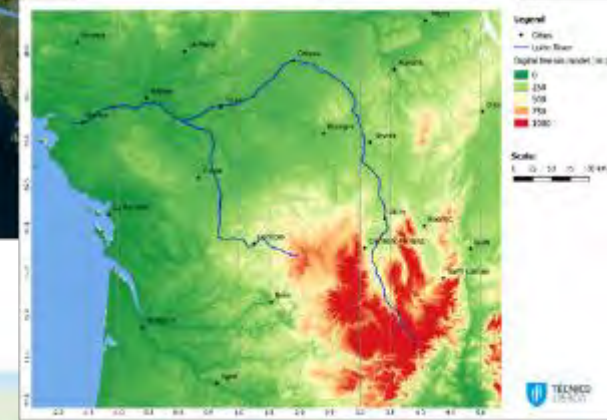
Severn river \ estuary



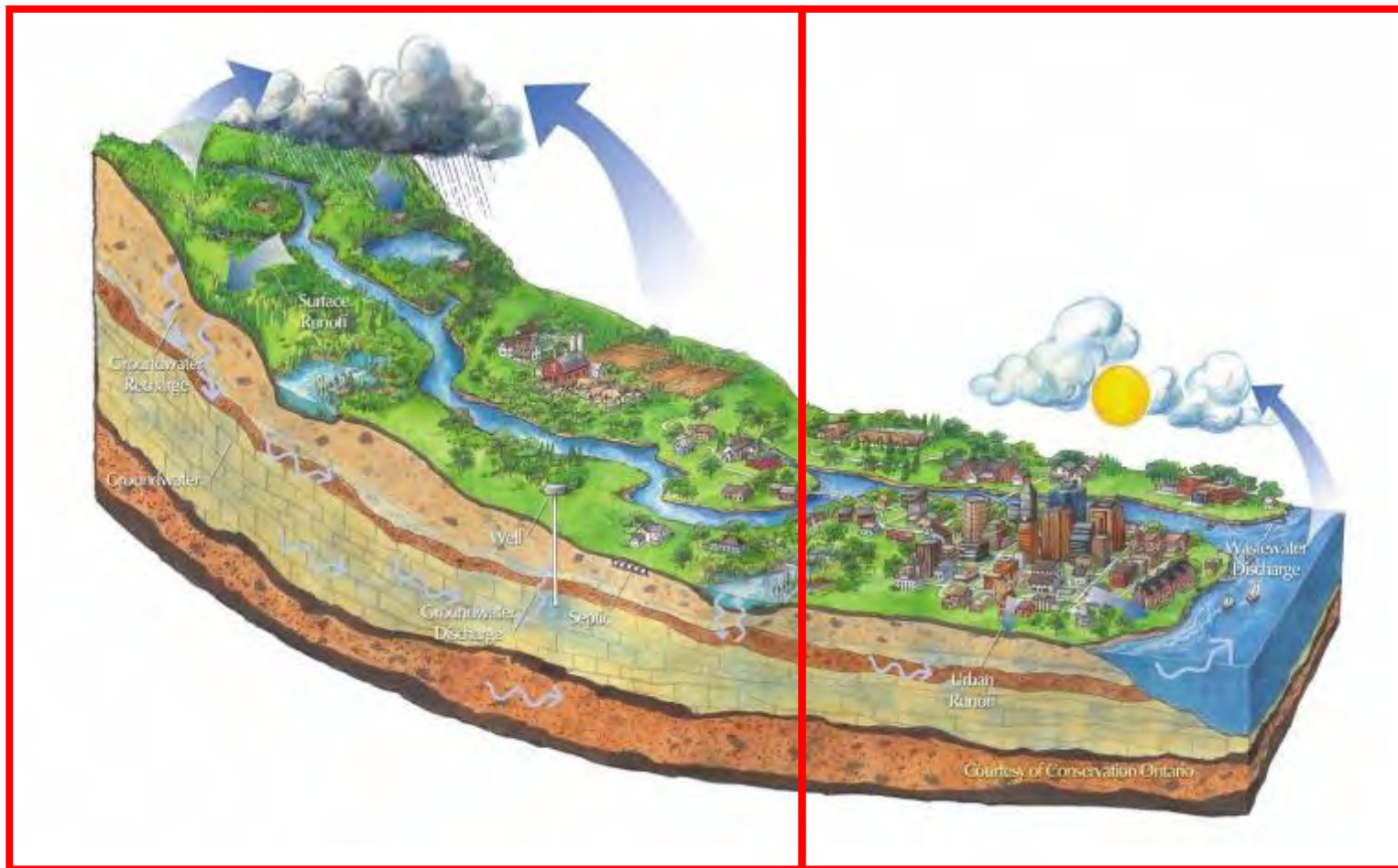
Tagus river \ estuary



Loire river \ estuary



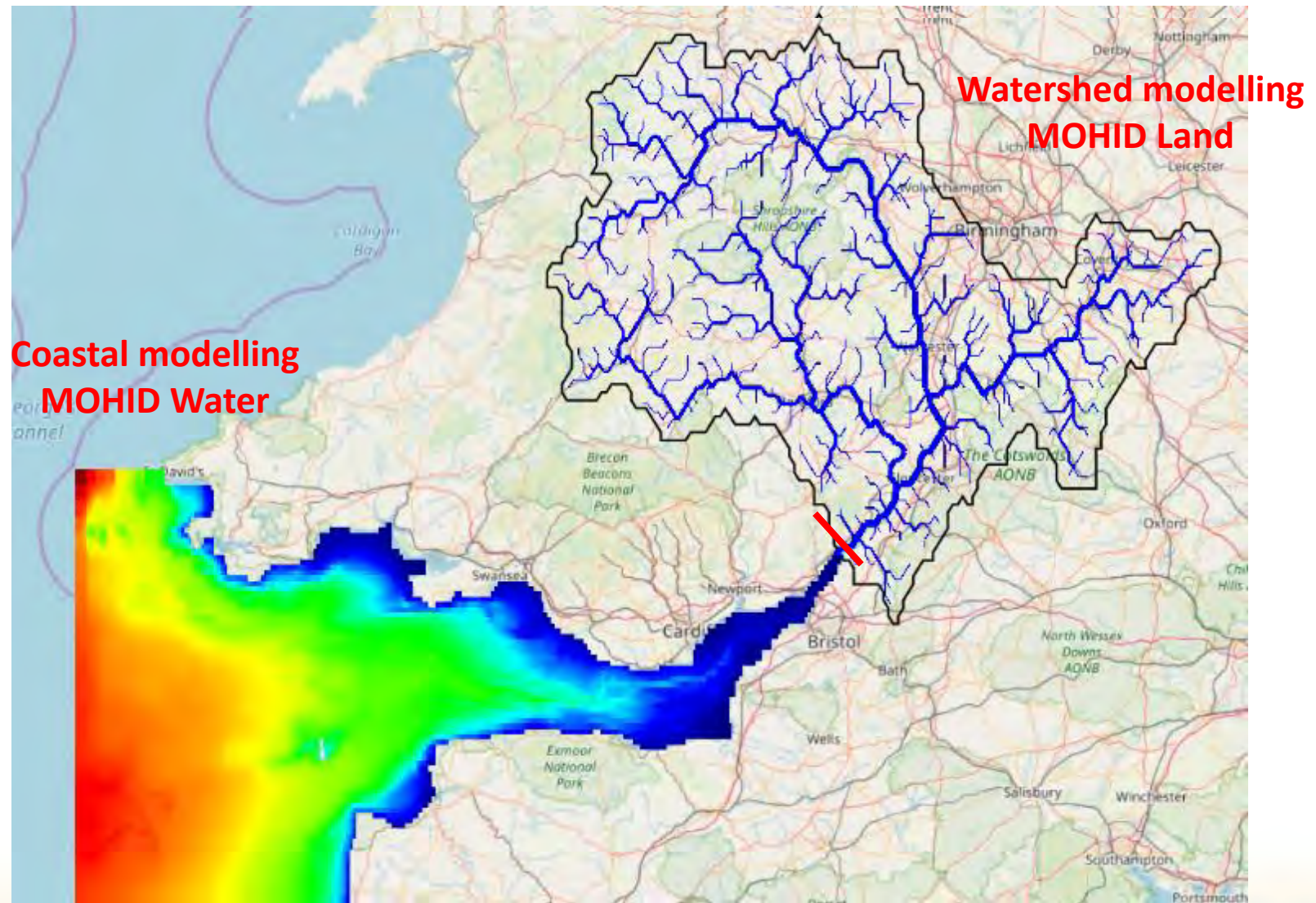
Watershed – Estuary – Coastal zone connection

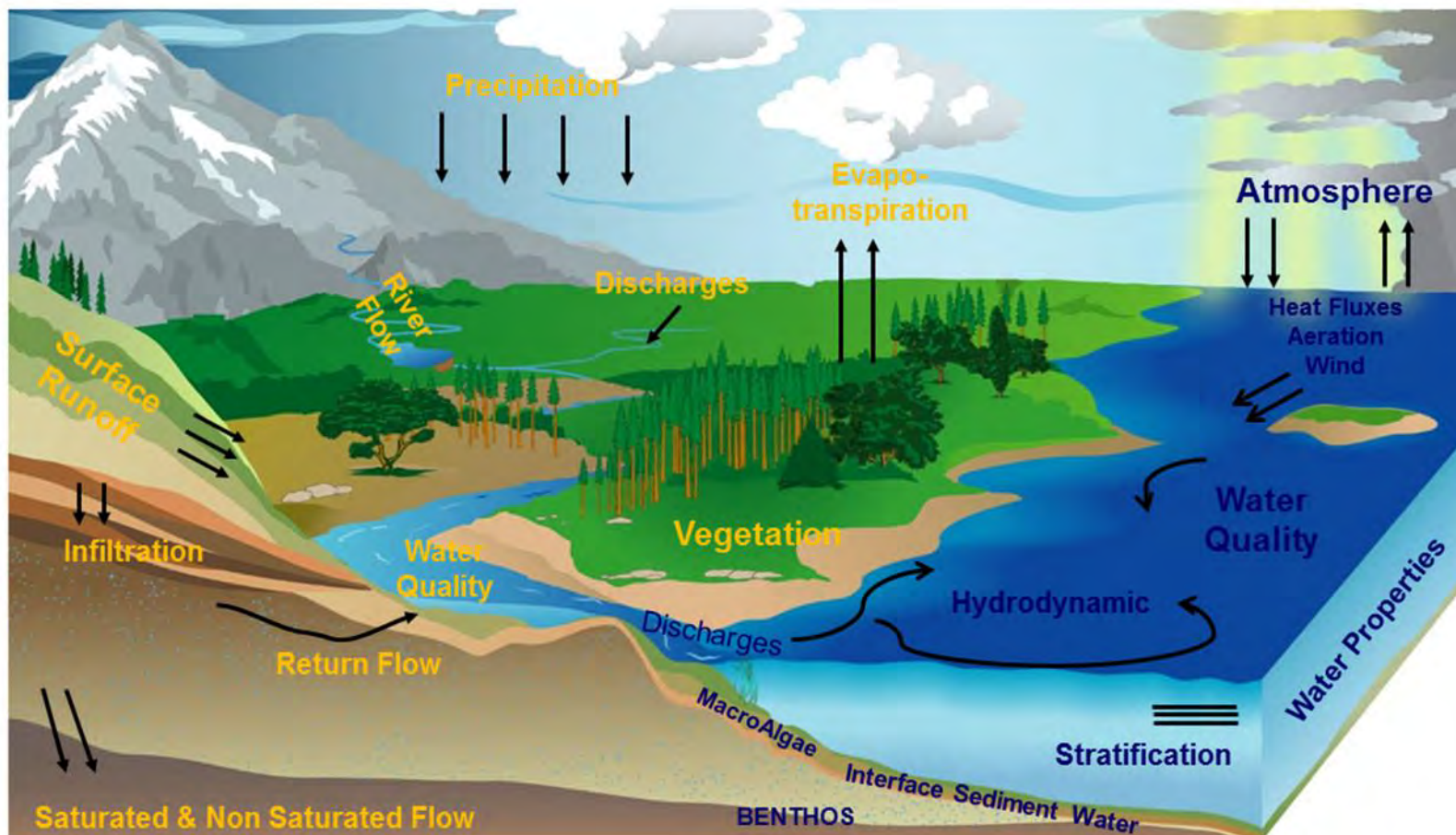


Watershed modelling

Coastal modelling

Watershed – Estuary connection in MOHID model



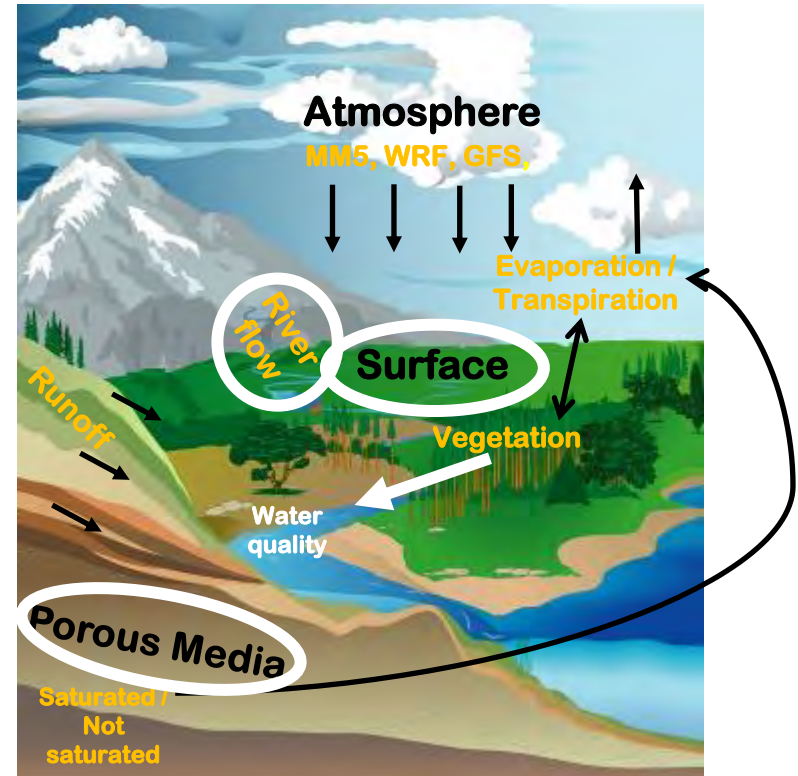


MOHID Land

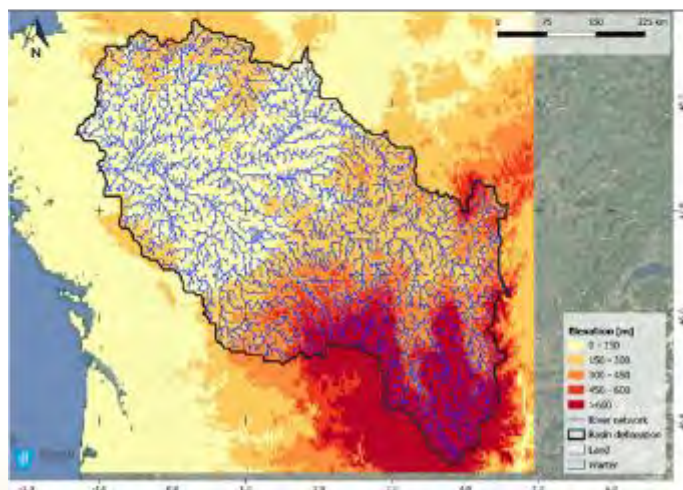
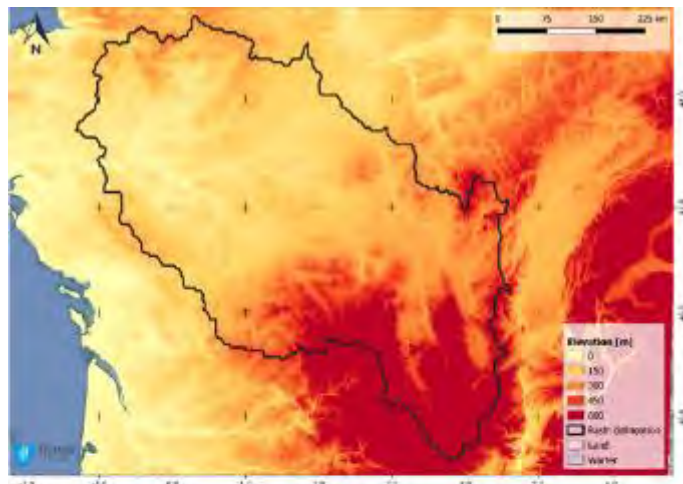
MOHID Water

MOHID Land – Watershed Modelling

- According to a bidimensional regular grid and based on meteorological information, the precipitated water is estimated for each grid cell.
- Water deposited in each cell is distributed by the surface, as runoff, by the porous media, as infiltration, and by the drainage network.
- Water fluxes between the porous media, the surface and the drainage network are calculated.
- Water extraction occurs by evaporation and transpiration.
- Properties related to water quality are estimated in the porous media, in the surface and in the drainage network.
- Main input of nutrients comes from the vegetation.



MOHID Land – input data



Digital Terrain Model

Interpolation to
MOHID grid

Delineation of
watershed and
drainage network

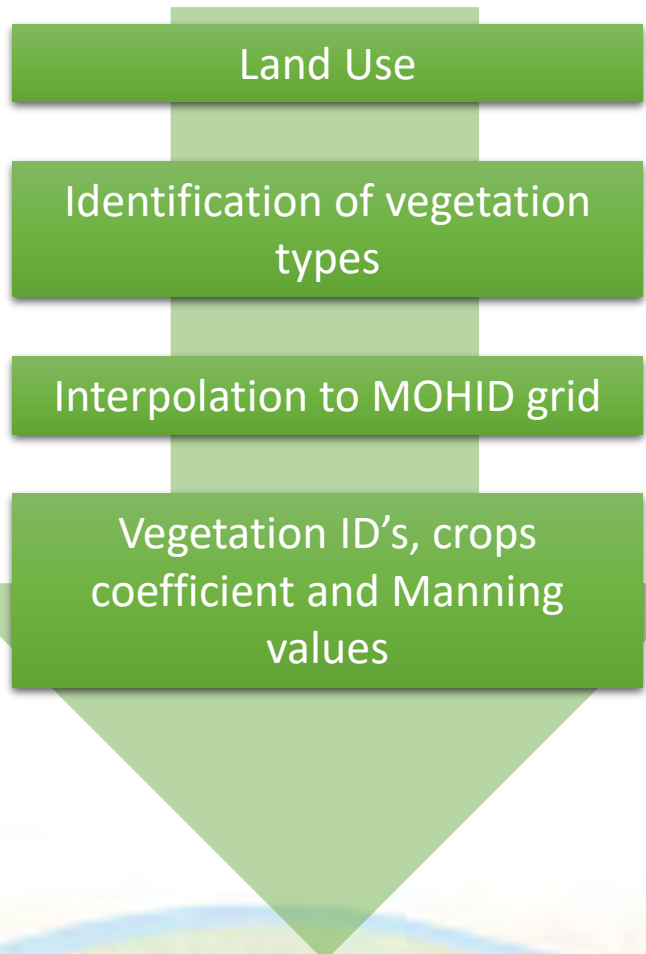
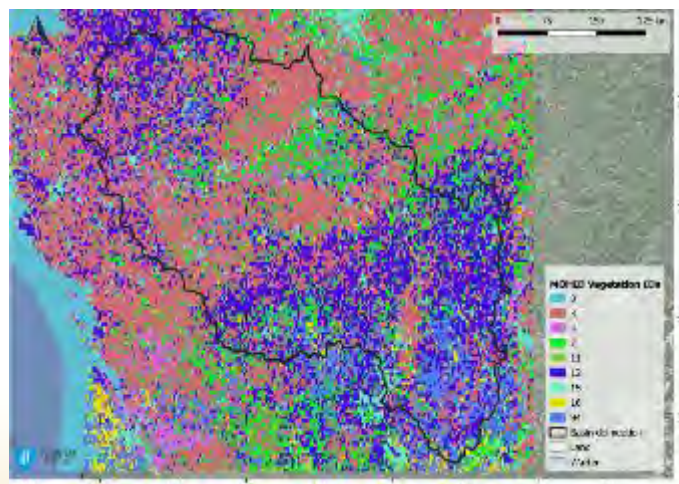
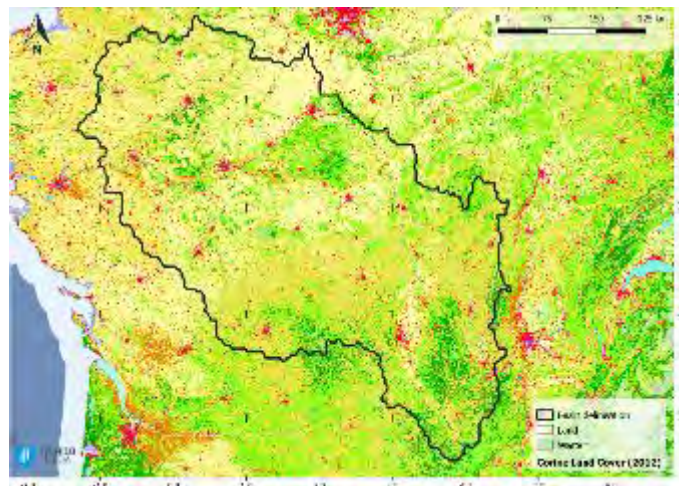


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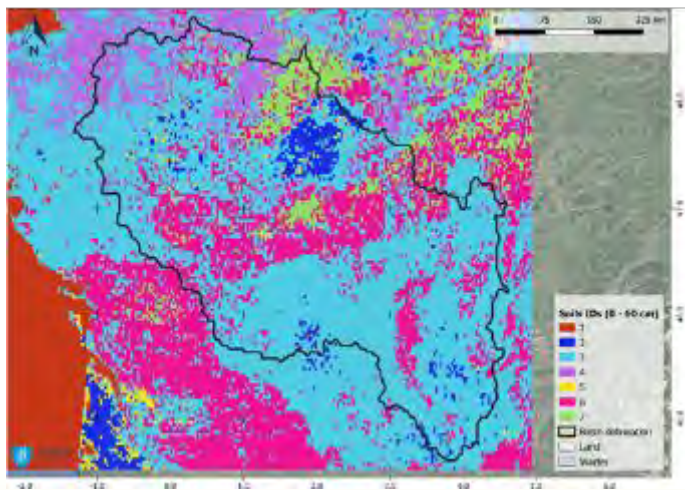


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MOHID Land – input data



MOHID Land – input data



Soil hydraulic properties

Definition of number of layers

Interpolation to MOHID grid

ID's to identify soils with different hydraulic properties (different soil type)



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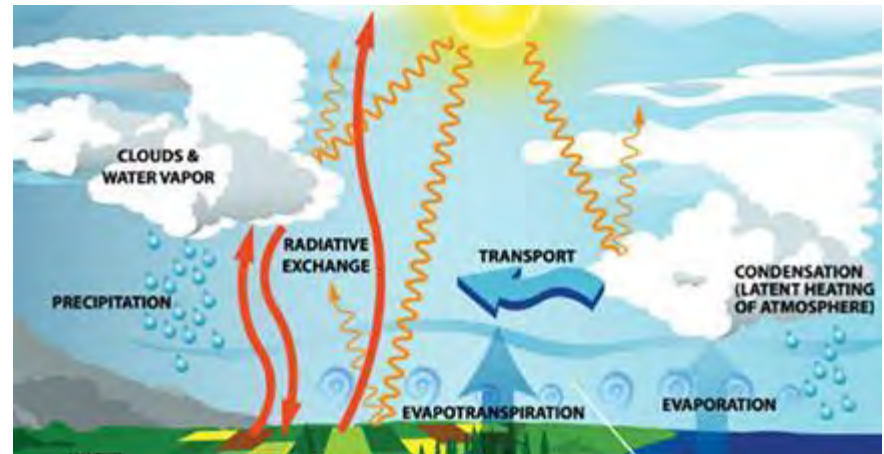
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Mohid Land – input data

Boundary conditions

Atmospheric:

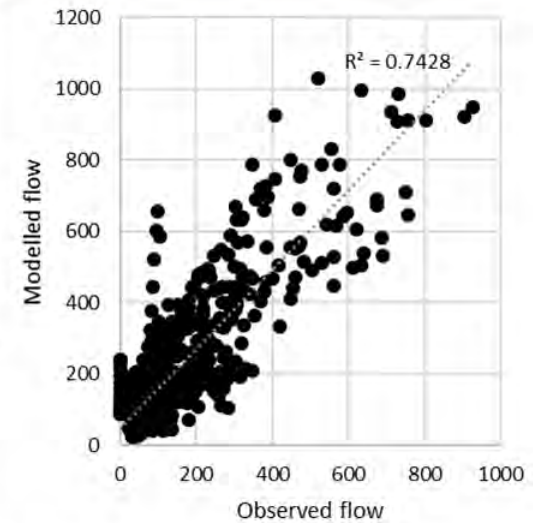
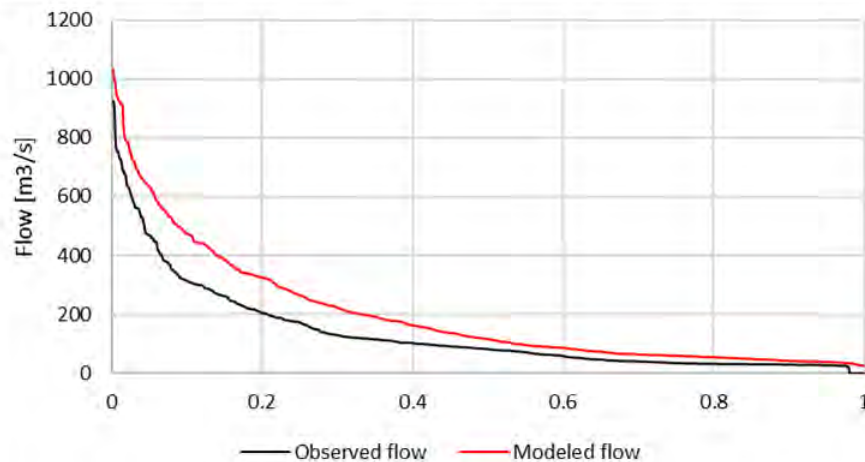
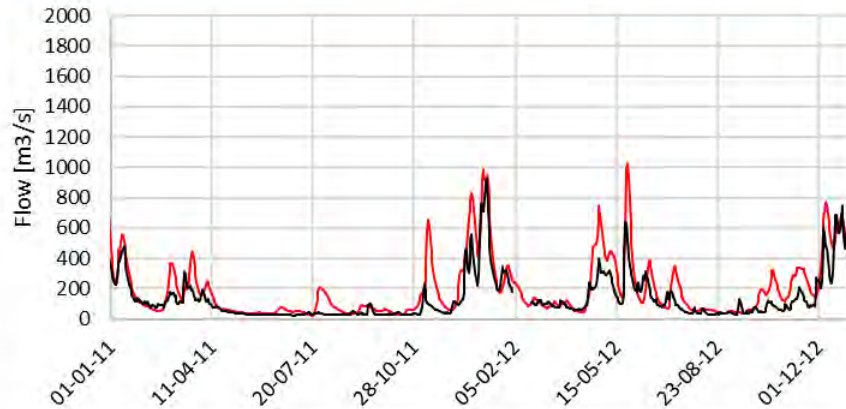
- Precipitation
- Wind speed and direction
- Air temperature
- Cloud cover
- Relative humidity



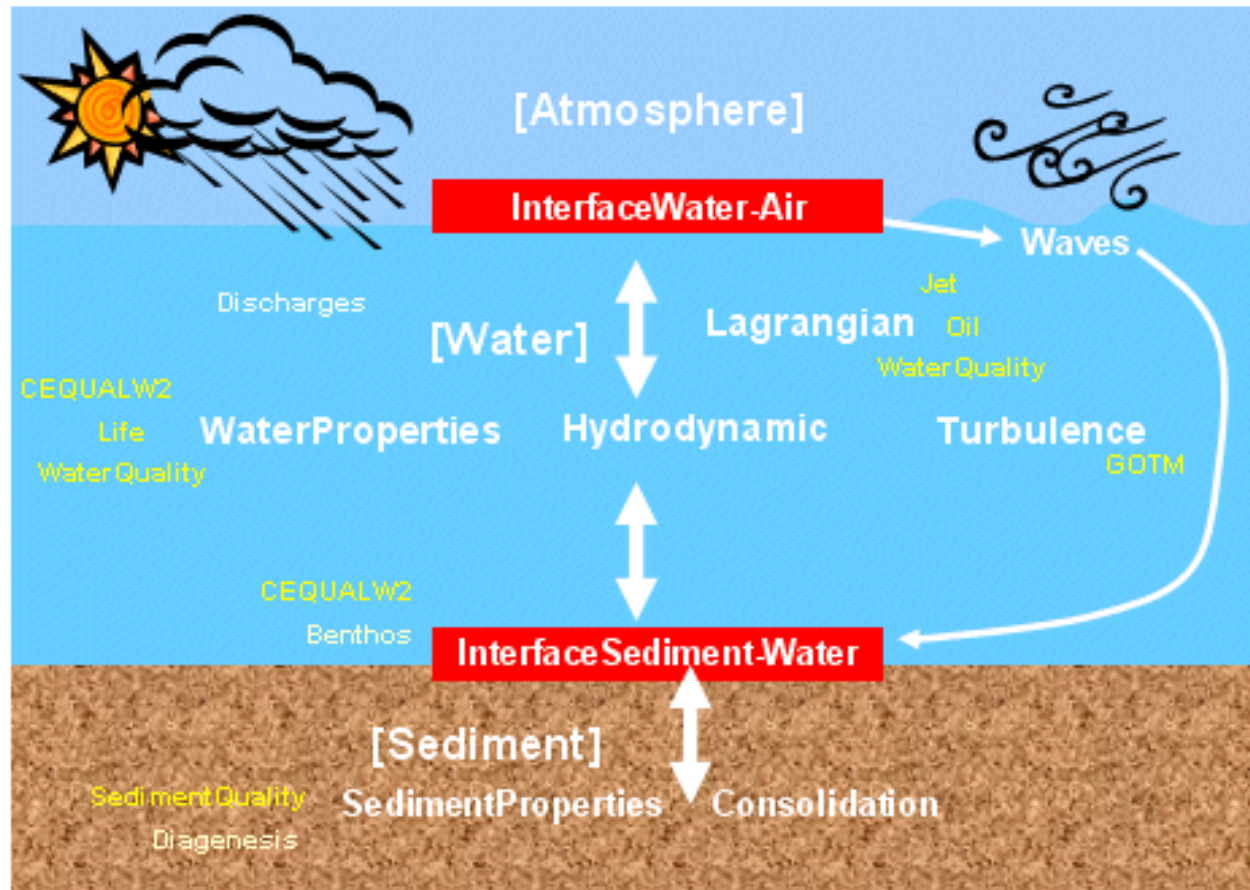
Source: NOAA

MOHID Land – output data

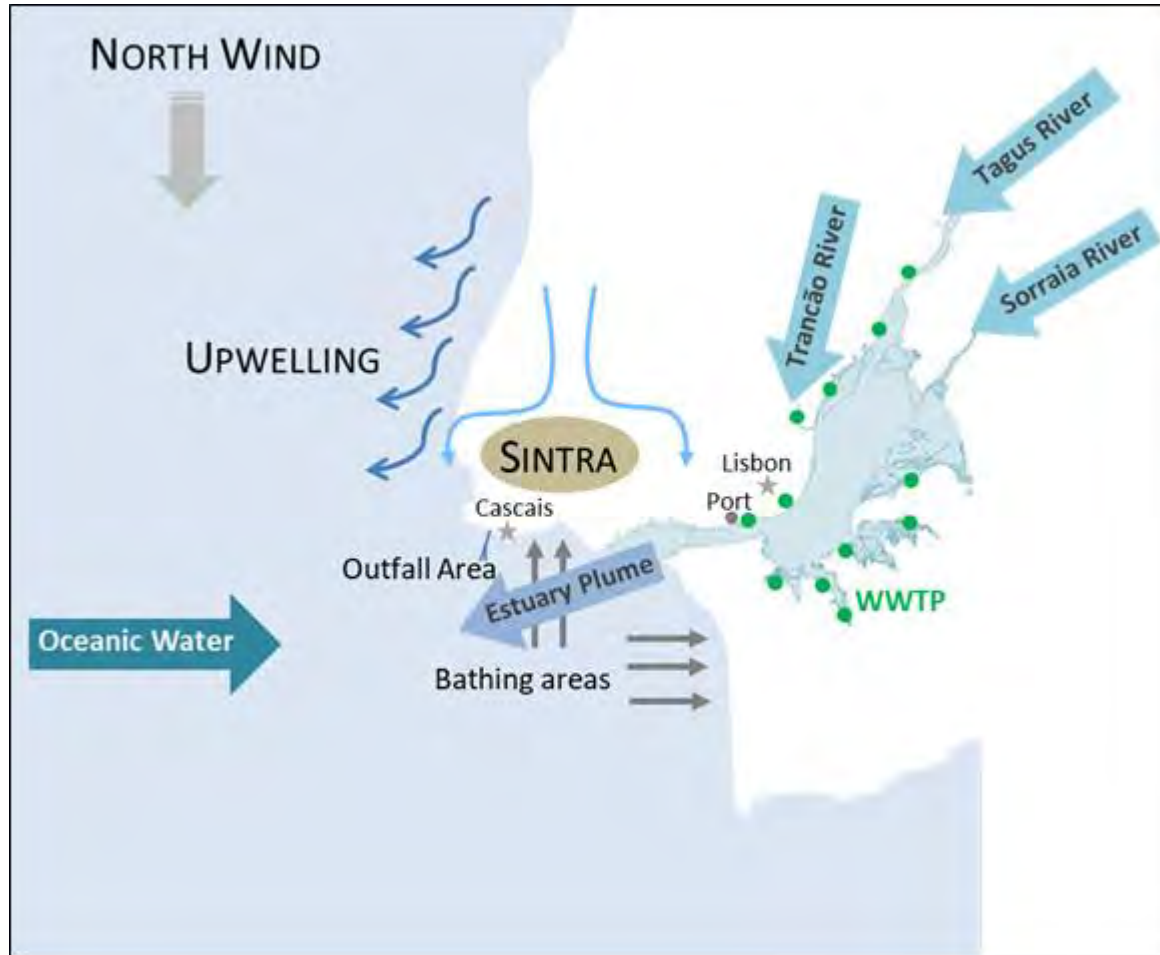
La Loire à Nevers station – Loire river



MOHID Water Model – estuary model



Study area characterization – Tagus estuary



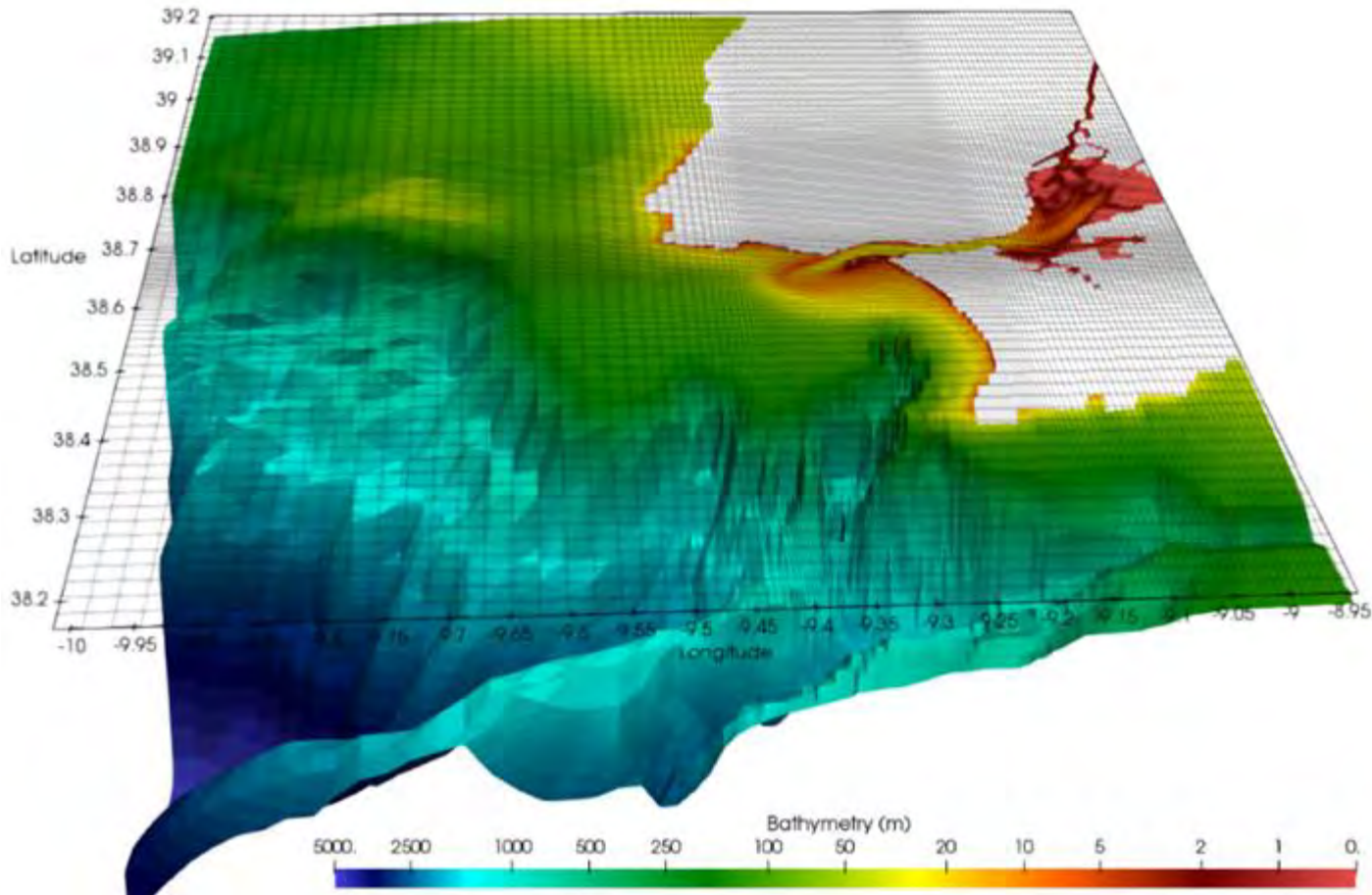
For each study area first identify the important forcings

MOHID Water – input data



- Grid
- Bathymetric points
- Coastal line

MOHID Water – input data



- Vertical discretization for 3D model

MOHID Water – input data

Boundary conditions

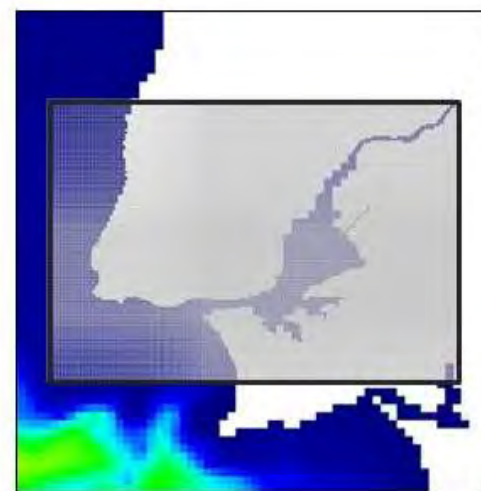
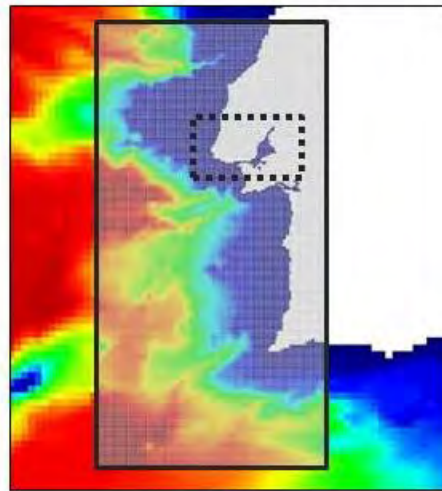
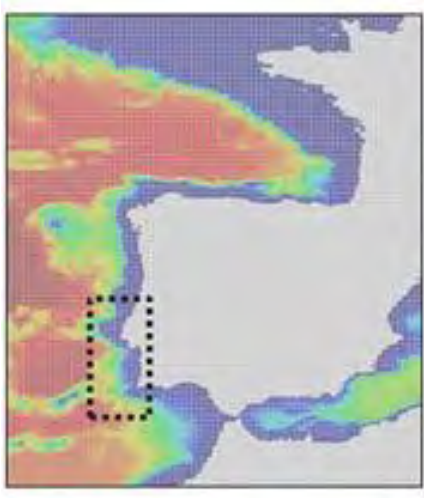
- Ocean:
 - Water level from FES2014 model
 - Velocity, temperature and salinity from copernicus
- River:
 - Flow and water temperature from MOHID land model output
- Atmospheric:
 - WRF model – wind speed, wind direction, air temperature, precipitation, solar radiation, long wave radiation, mean sea level pressure, albedo, relative humidity

Model main outputs

- **Mohid water – estuary model:**
 - Water temperature and salinity
 - Water velocity
- **Mohid land – watershed model:**
 - River flow
 - Water temperature
- **WRF – atmospheric model:**
 - Wind speed and direction
 - Air temperature
 - precipitation

MOHID Water – nested domains

- Tagus river case



Model results exploitation - HazRunoff platform



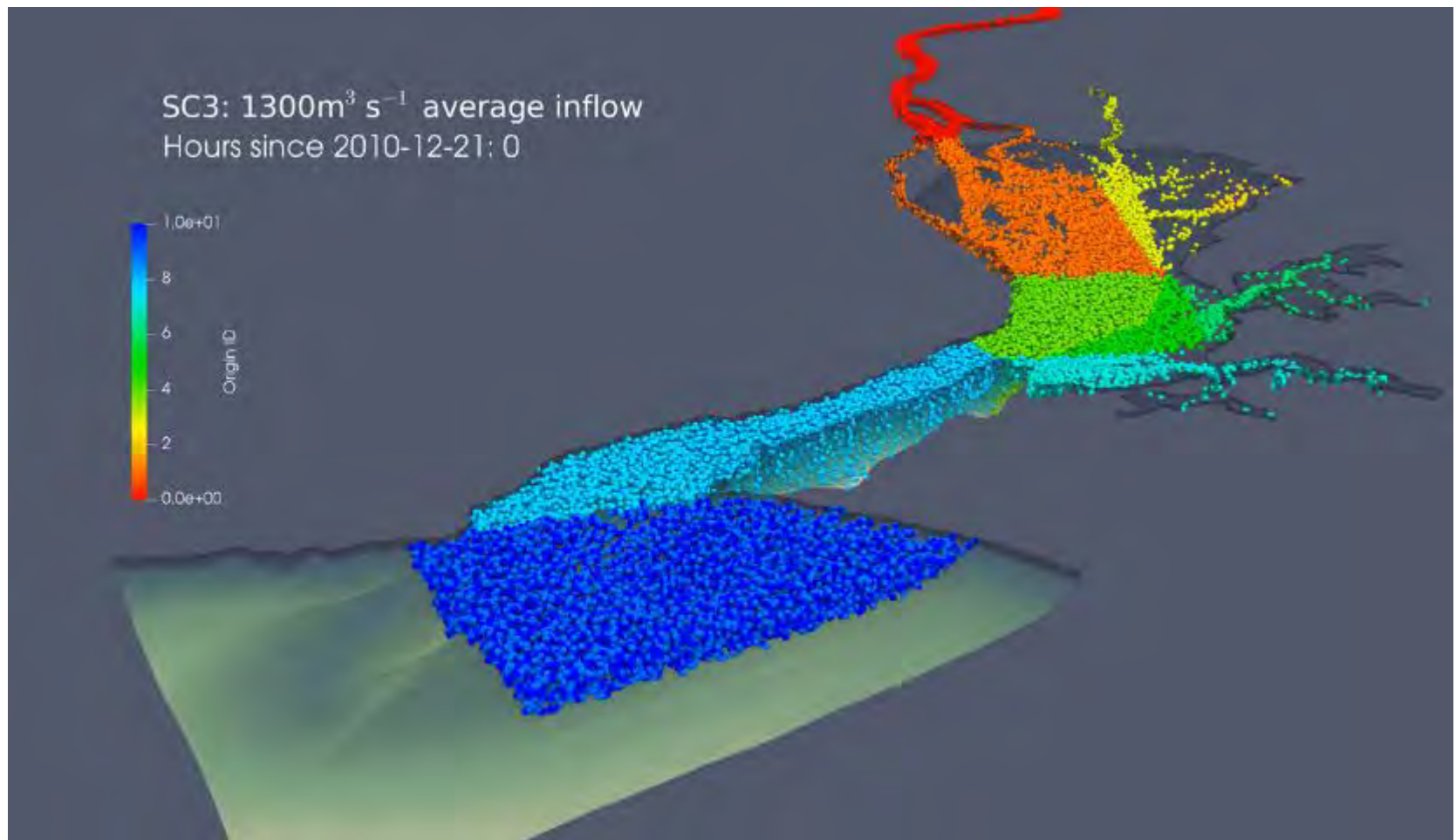
Water pollutant and debris dispersion model

- Lagrangian transport models are very useful to simulate localized processes with sharp gradients (e.g. submarine outfalls, sediment erosion due to dredging works, oil dispersion).
- MOHID's Lagrangian module uses the concept of lagrangian tracers, the most important property of a tracer is its position (x,y,z) :
 - for a physicist a tracer can be a water mass, for a geologist it can be a sediment particle or a group and for a chemist it can be a molecule or a group of molecules. A biologist can spot phytoplankton cells in a tracer (at the bottom of the food chain) as well as a shark (at the top of the food chain).

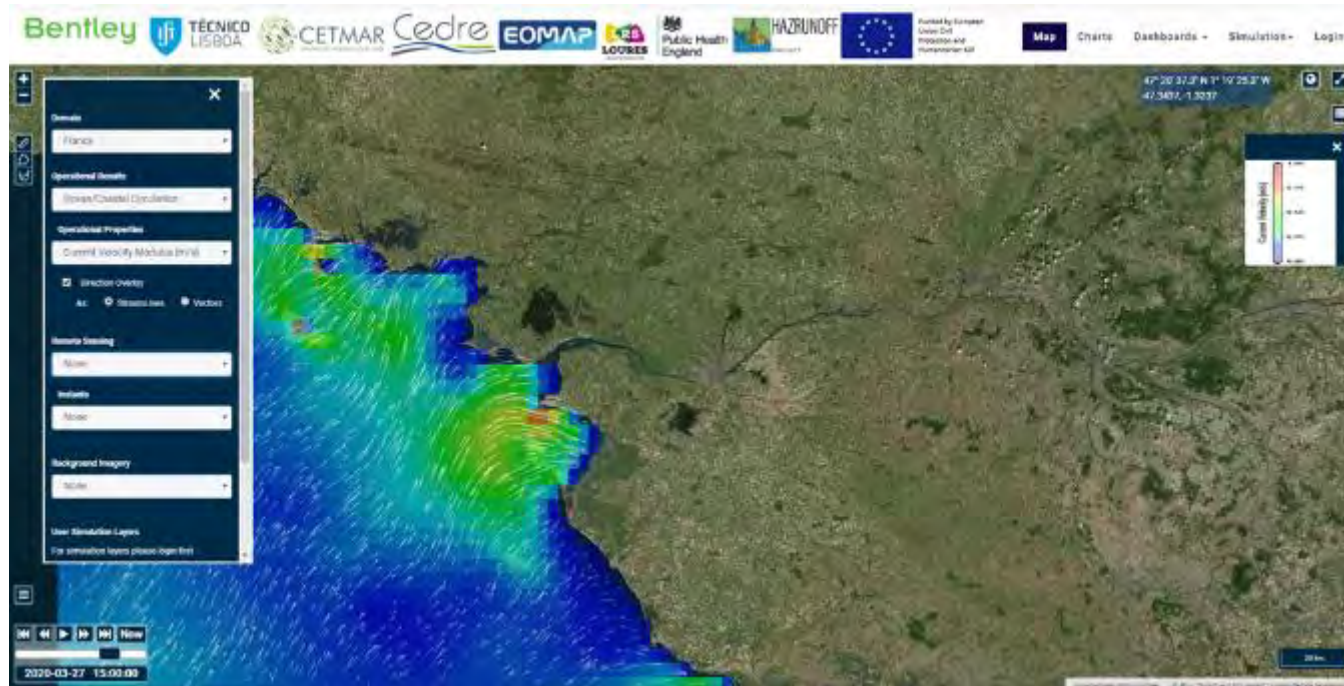
MOHID lagrangian module

- MOHID Lagrangian transport module uses the concept of tracer, assuming that the spilled contaminant can be represented as an amount of several different small tracers / spilletts, and tracked as they move in three-dimensional space over time:
 - this software is used in several different studies, as oil spills, floating containers, dispersion of plumes in submarine outfalls, sediments transport, etc.
- MOHID lagrangian module can be run simultaneously with the hydrodynamic model (currents, water temperature, salinity, etc.), or in “offline” mode. In both modes, this model is able to digest currents, water properties, wave parameters and atmosphere properties from different models.

Tagus estuary – residence time



Lagrangian simulation - HazRunoff platform



- The system is able to handle on-demand transport simulations of multiple types, namely: oil spills in water, HNS (chemical) spills in water, human body (search and rescue purposes), passive tracers (water mass transport like ballast waters), floating objects (e.g. container or vessel adrift) and airborne HNS emissions.

User friendly platform- simulation in 4 steps

1. What?

Incident Name

Simulation Name

Substance Type

Oil Spill

Oil Spill

HNS Spill

Human Body

Passive Tracer (e.g. Ballast water)

Floating Object (e.g. Container)

Airborne HNS Emission

2. Where?

Domain

France

Pick Incident Locations Interactively



3. When?

Incident Type

☐ Continuous ☒ Instantaneous

Incident Instant/Simulation Start

2017-12-26 00:00

Simulation End

2017-12-26 06:00

Volume (m3)

100

4. Run

Simulation Resume

Name : Simulation Name

Substance : Oil Spill

Localization : -15.808 28.949

Emission Type : instantaneous

Start Date : 2017-12-26 00:00

End Date : 2017-12-26 06:00

Advanced

☐ Ensemble Probabilistic Run 



Spill simulation – HazRunoff platform



Not secure | hazrunoffactionmodules.com/maps/map1.shtml

Bentley | TÉCNICO LISBOA | CETMAR | Cedre | EOMAP | LOURES | Public Health England | HAZRUNOFF PROJECT | European Union Civil Protection and Humanitarian Aid

Map | Charts | Dashboards | Simulation | Login

Domain: France

Operational Results: Ocean/Coastal Circulation

Operational Properties: None

Direction Overlay: As, StreamLines, Vectors

Remote Sensing: None

Background Imagery: None

User Simulation Layers: For simulation layers please login first

47° 15' 22.2" N 1° 16' 47.1" W
47.2562, -1.2798

Let's go to the platform
www.hazrunoff.eu

2020-03-27 15:00:00

Obrigada
Thank you

Questions?

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Quality of results: data and models

Instituto Superior Técnico

Lígia Pinto



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Outline

The main topics of this session will be :

- Data providers and sources in EU: Copernicus Marine service, EMODNet, local providers
- Statistical metrics to compare data and model results
- Model results versus data: examples
- Early warning pollution indicators and sentinels in monitoring stations



Data providers and sources in EU

www.marine.copernicus.eu

The screenshot shows the homepage of the Copernicus Marine Environment Monitoring Service. At the top, there is a navigation bar with the European Commission logo, the service name, and a search bar. Below this is a horizontal menu with links: ABOUT US, USE CASES & MARKETS, NEWS, SCIENCE & MONITORING, TRAINING & EDUCATION, and SERVICES PORTFOLIO. The main content area features a large banner with the text "ACCESS YOUR OCEAN INFORMATION" and a central image of Earth from space. Below the banner are three main sections: "OCEAN PRODUCTS" (with a "DATA" button), "OCEAN MONITORING INDICATORS" (with a "TRENDS" button), and "OCEAN STATE REPORT" (with an "EXPERTISE" button). To the right of these sections is a "SHORT-CUT TO SERVICES" sidebar with links: REGISTER NOW!, SCIENTIFIC QUALITY, ONLINE TUTORIALS, COLLABORATIVE FORUM, and LATEST NEWS FLASH INFORMATION. At the bottom, there is a section titled "COPERNICUS MARINE SERVICE TO DELIVER HIGH-RESOLUTION OCEAN COLOUR PRODUCTS USING SENTINEL-2" with a "READ MORE" button and an image of a satellite. The footer contains the text "SITE MAP - ALL RIGHTS RESERVED" and a navigation bar with links: ABOUT US, PARTNERS & STAKEHOLDERS, MARKETS, FEEDBACK SURVEY, and ANY QUESTIONS? Ask the Service Desk.

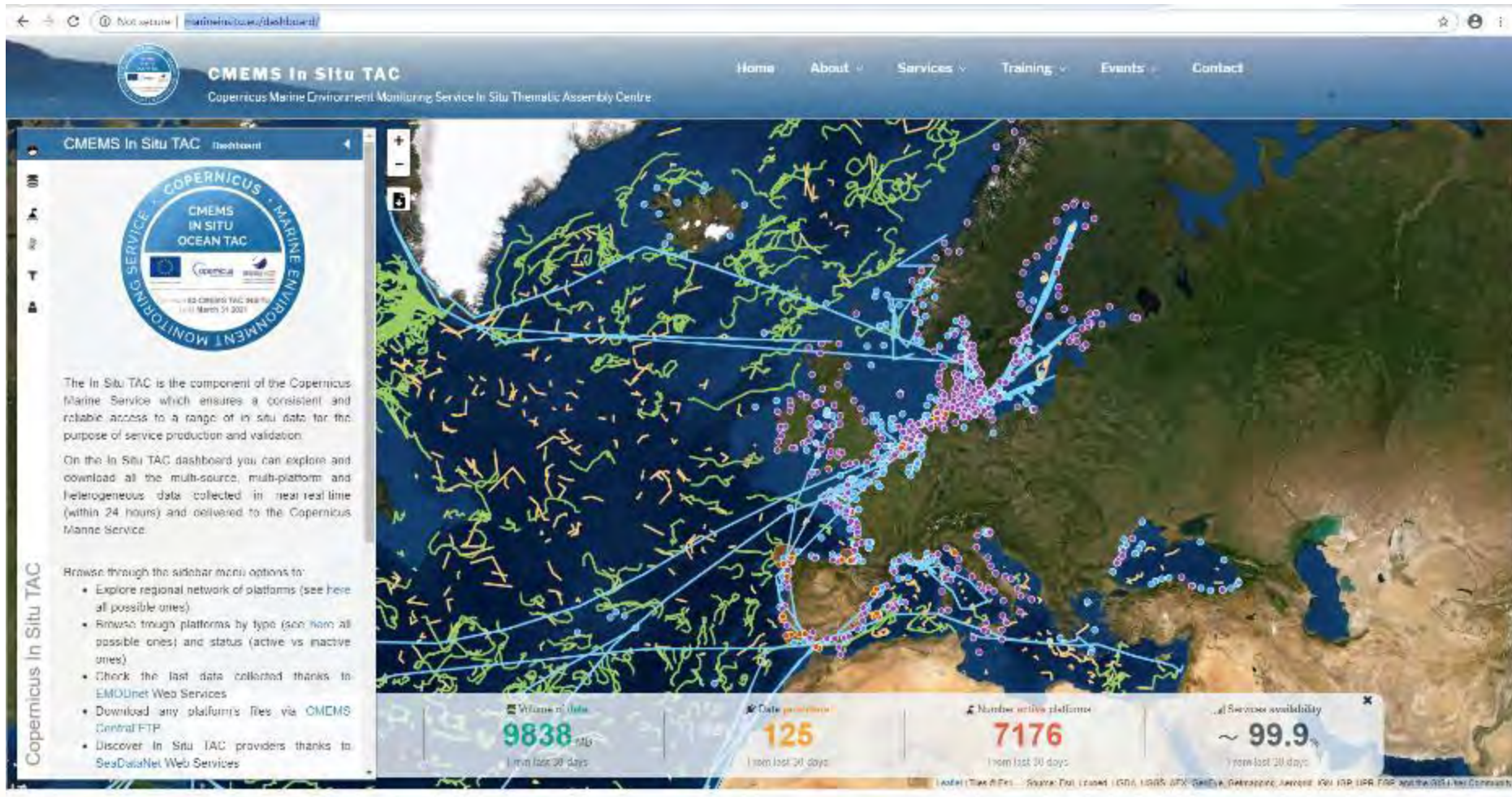
- TO ACCESS DATA USERS MUST REGISTER
- IN-SITU DATA AND MODEL RESULTS

NOFF



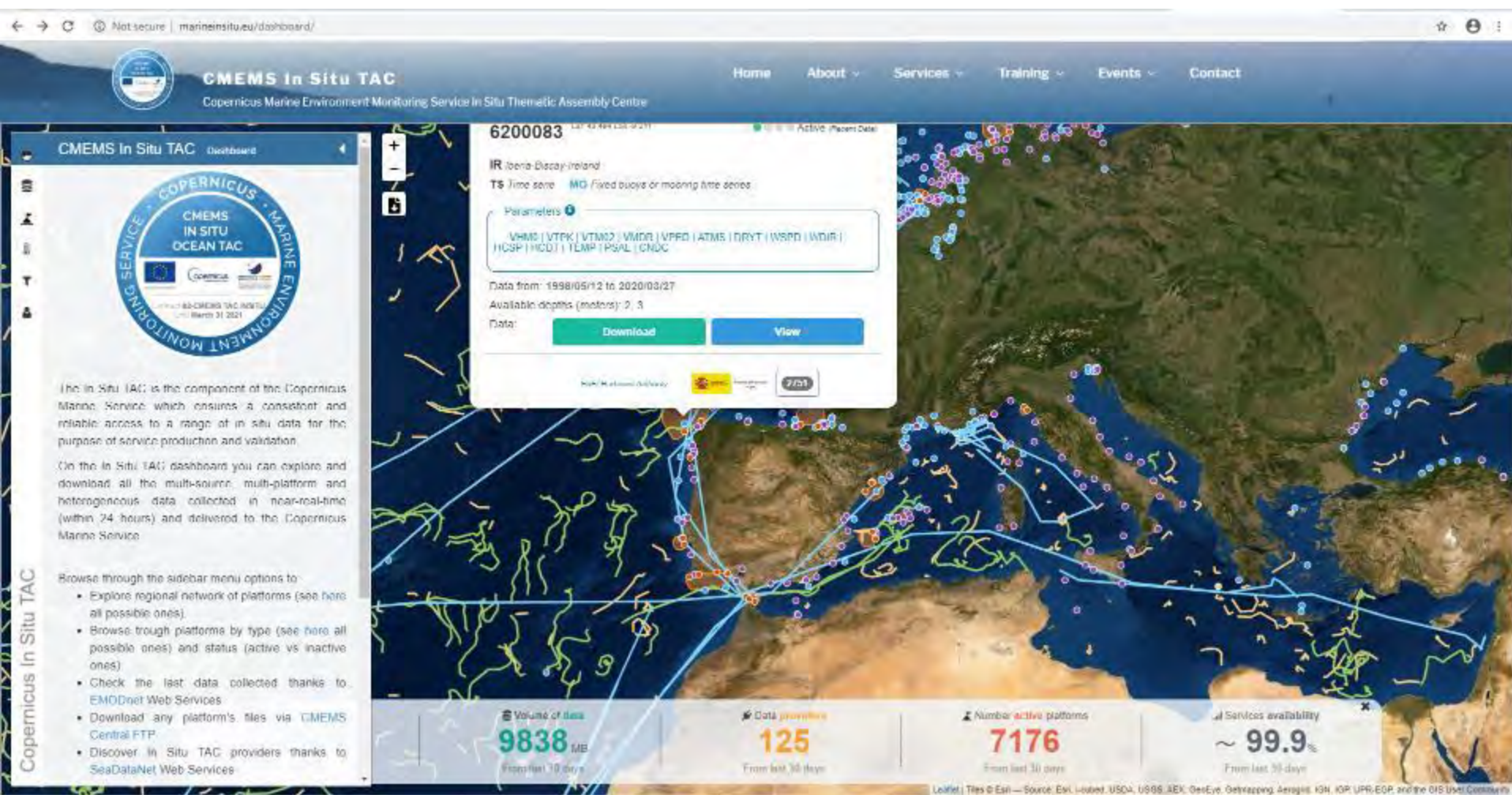
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<http://www.marineinsitu.eu/dashboard/>

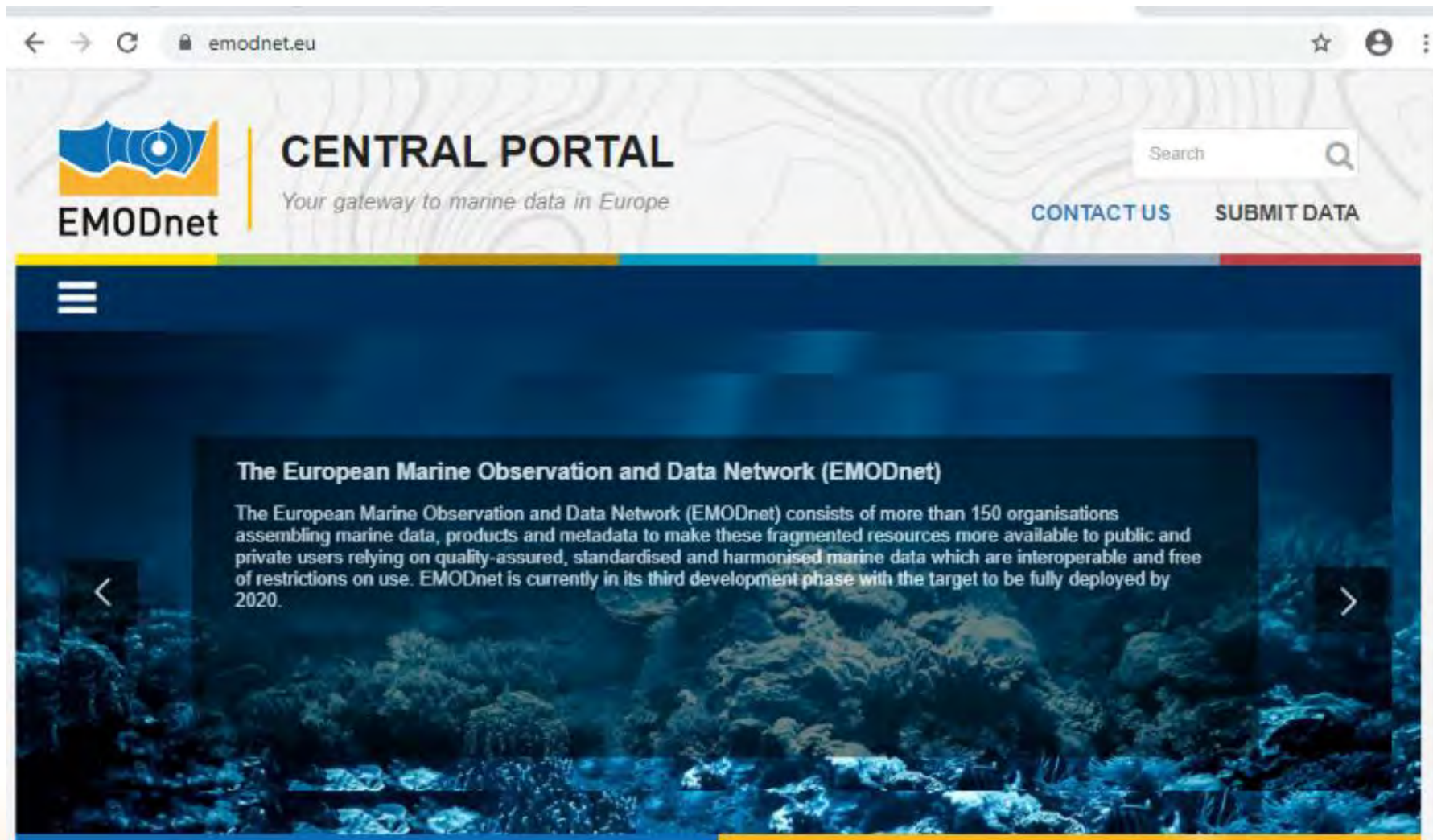


02/06/2020

CMEMS In Situ TAC



<https://www.emodnet.eu/>



ACCESS THEMATIC PORTALS

DATA INGESTION PORTAL

The EMODnet Data Ingestion portal seeks to identify and to reach out to other potential providers in order to make their data sets also part of the total offer. It aims at:

[READ MORE](#)

BATHYMETRY

Data on bathymetry, water depth, seafloor, and geographical location of underwater structures, vessels.



USE CASES



INFO



ACCESS

BIOLOGY

Data on temporal and spatial distribution of species abundance and biomass from several taxa.



USE CASES



INFO



ACCESS

CHEMISTRY

Data on marine litter and the concentration of nutrients, organic matter, pesticides, heavy metals, radionuclides and anthropogenic in water, sediment and biota.



USE CASES



INFO



ACCESS

GEOLOGY

Data on seabed substrate, sea-floor geology, coastal behaviour, geological events and minerals.



USE CASES



INFO



ACCESS

HUMAN ACTIVITIES

Data on hydrography and environmental or human activities areas.



USE CASES



INFO



ACCESS

PHYSICS

Data on salinity, temperature, waves, currents, sea-level, light attenuation and FerryBoxes.



USE CASES



INFO



ACCESS

SEABED HABITATS

Data on modelled seabed habitats based on seabed substrate, energy, biological zone, and salinity.



USE CASES



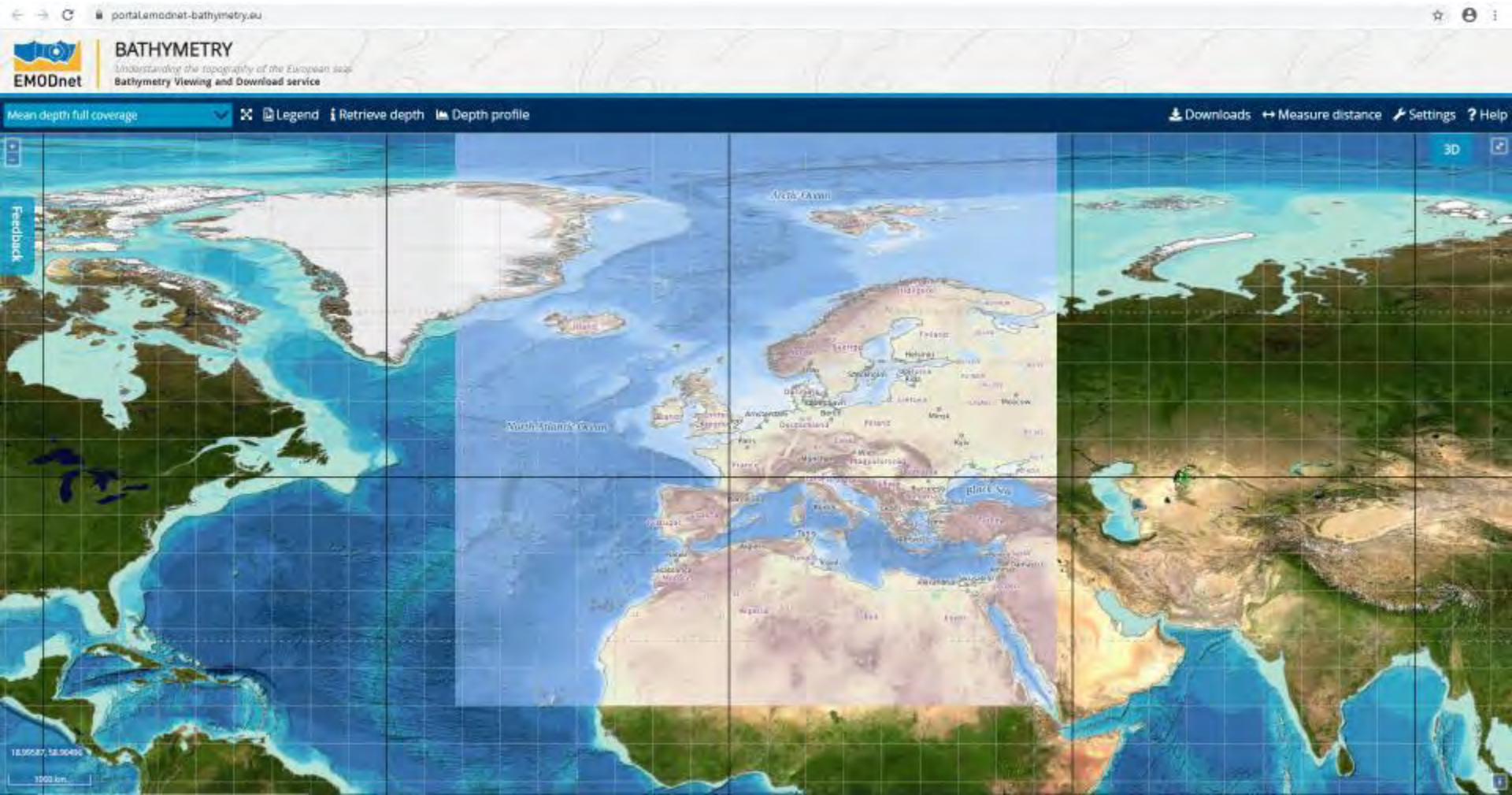
INFO



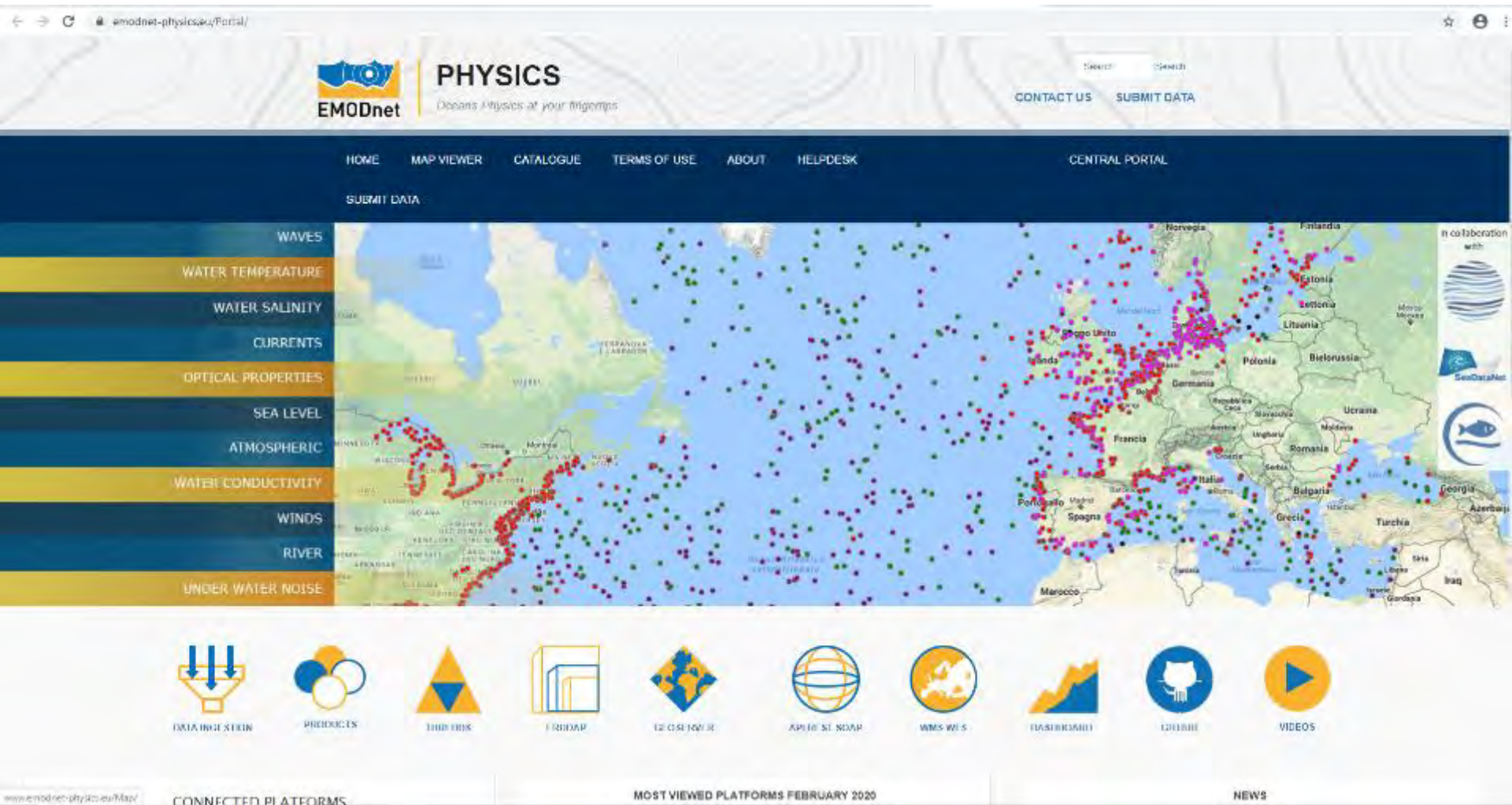
ACCESS

ACCESS THEMATIC PORTALS

EMODnet – Bathymetry portal



EMODnet - Physics portal



02/06/2020

In Situ data – local providers

- National or regional information systems:
 - France:
 - IFREMER (<http://data.ifremer.fr/>);
 - Meteo France (<http://www.meteofrance.com>);
 - Portugal:
 - SNIRH (<https://snirh.apambiente.pt/>);
 - IPMA (<https://www.ipma.pt/>)
 - Spain:
 - Meteogalicia (<https://www.meteogalicia.gal>);
 - Puertos del estado (<http://www.puertos.es>)
 - UK:
 - MetOffice (<https://www.metoffice.gov.uk>);
 - National River Flow Archive (<https://nrfa.ceh.ac.uk>)
 - UK Hydrographic Office (<https://data.admiralty.co.uk>)



Model results versus data

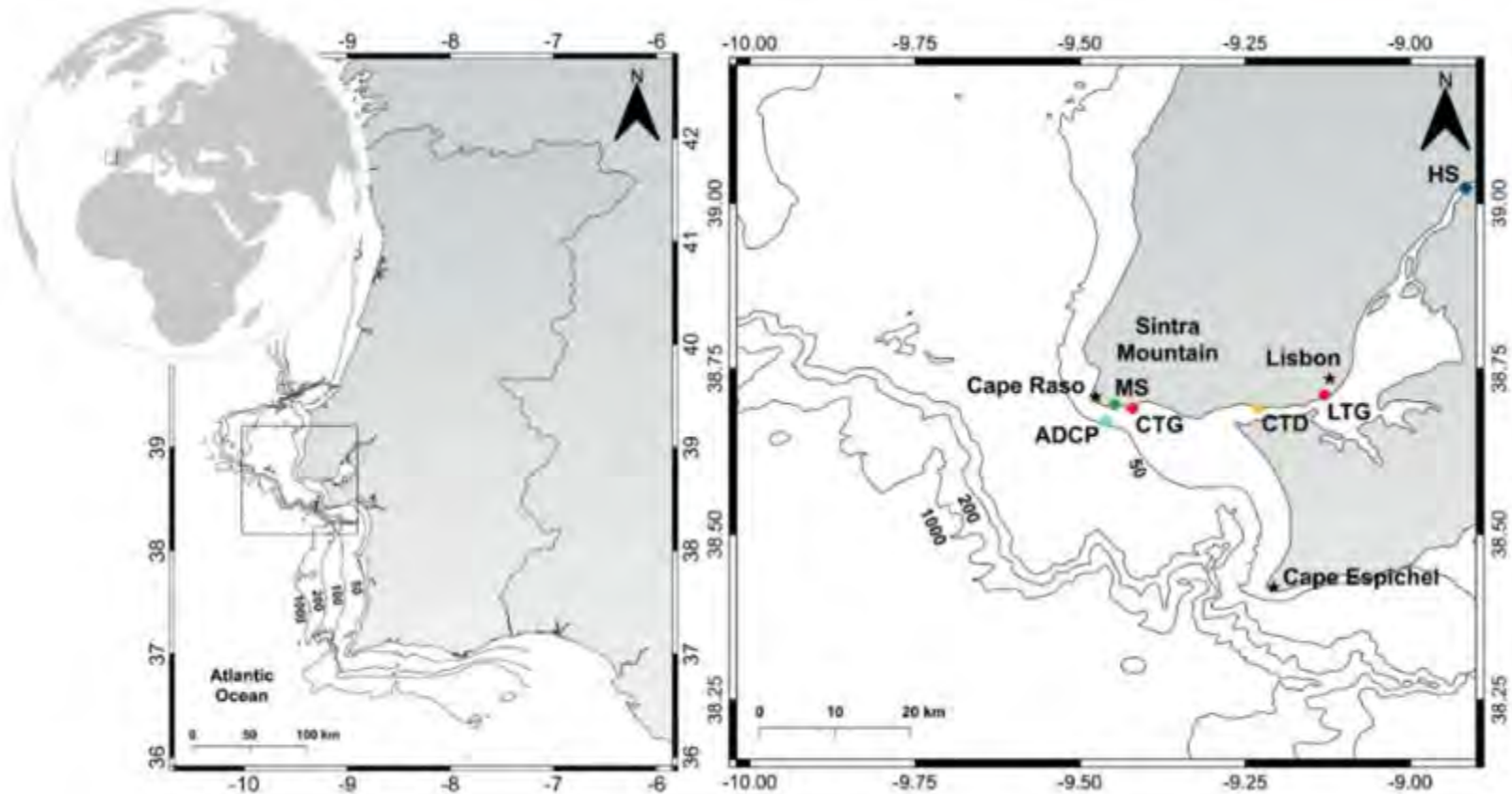
Statistical metrics – model vs data

Statistical metrics used to compare two data sets $x=\{x_1, x_2 \dots x_N\}$ and $y=\{y_1, y_2 \dots y_N\}$ include the mean (\bar{x}), model mean error (bias), root mean squared error (RMSE) and scalar correlation (CORR):

- $\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i$
- $bias = \frac{1}{N} \sum_{i=1}^N (x_i - y_i)$
- $RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - y_i)^2}$
- $CORR = \frac{1}{N-1} \sum_{i=1}^N \left(\frac{x_i - \bar{x}}{\sigma_x} \right) \left(\frac{y_i - \bar{y}}{\sigma_y} \right)$

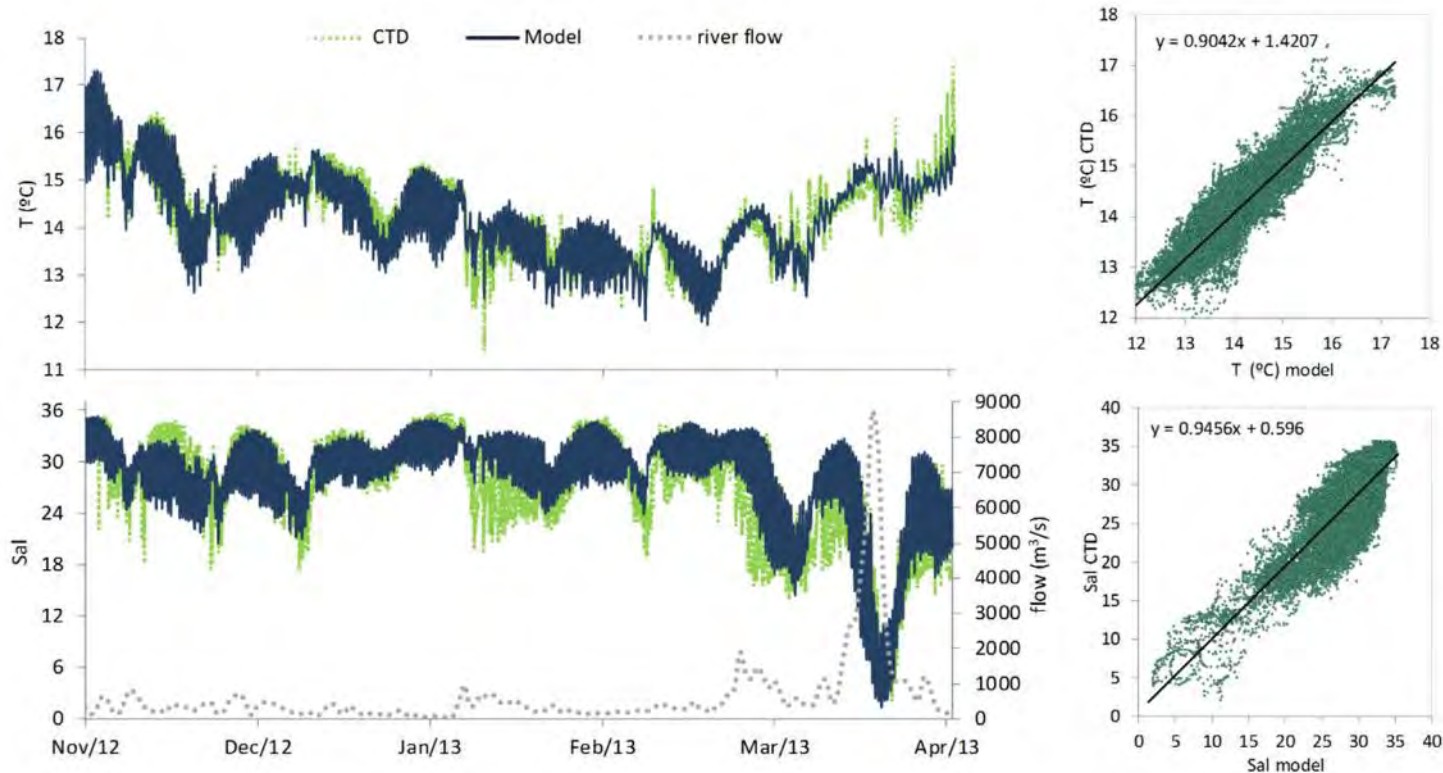
where σ_x and σ_y are the standard deviation of x and y

Case study - Tagus estuary



De Pablo et al (2019). *Water*, 11(8), 1713.

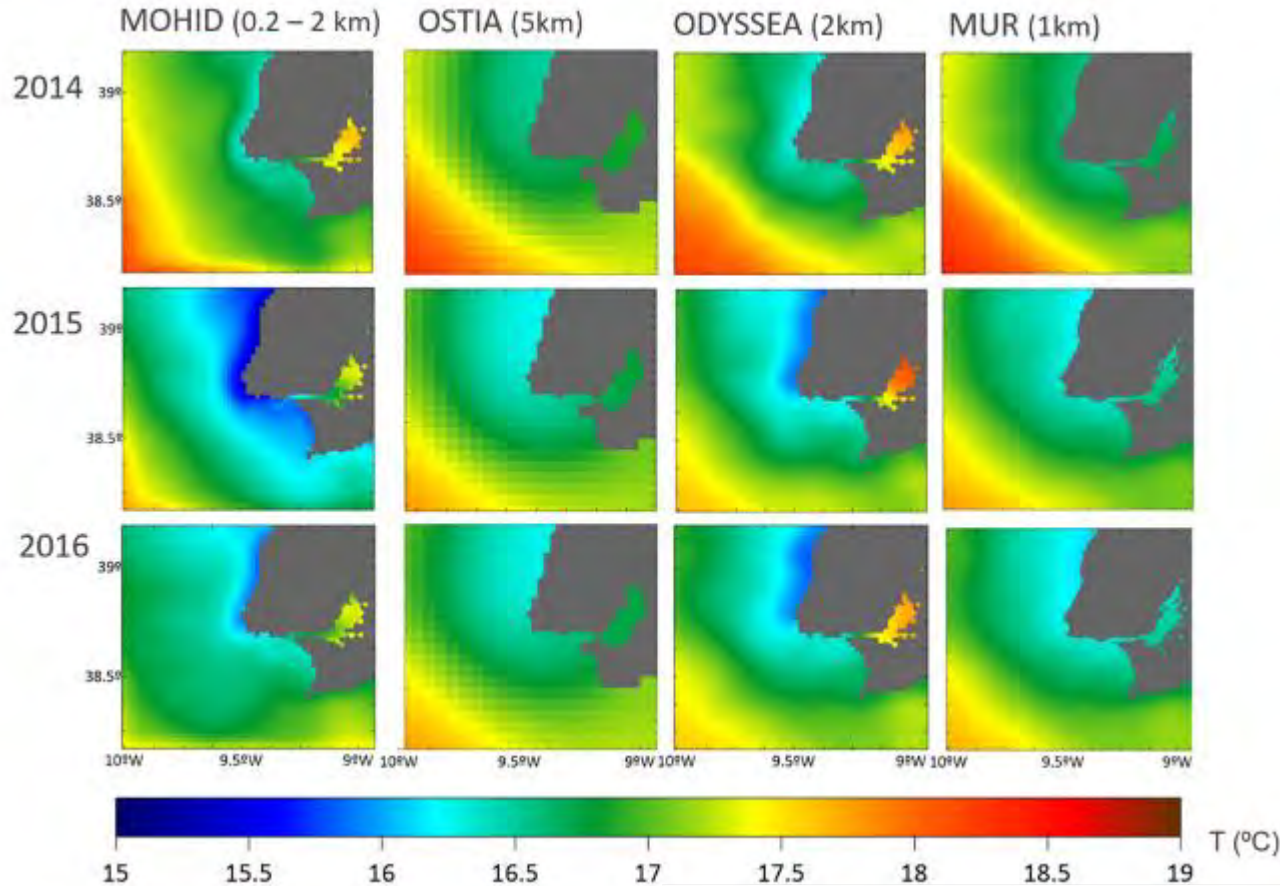
Model results vs time series



Parameter	Average (min-max) MOHID	Average (min-max) CTD	n	Pearson (r)	BIAS	RMSE
Temperature	14.2 (11.4–17.4)	14.3 (11.9–17.3)	21436	0.91	0.1	0.4
Salinity	28.0 (2.1–35.6)	27.4 (1.3–35.3)	21436	0.86	–0.9	2.9

De Pablo et al (2019). *Water*, 11(8), 1713.

Model results vs Satellite

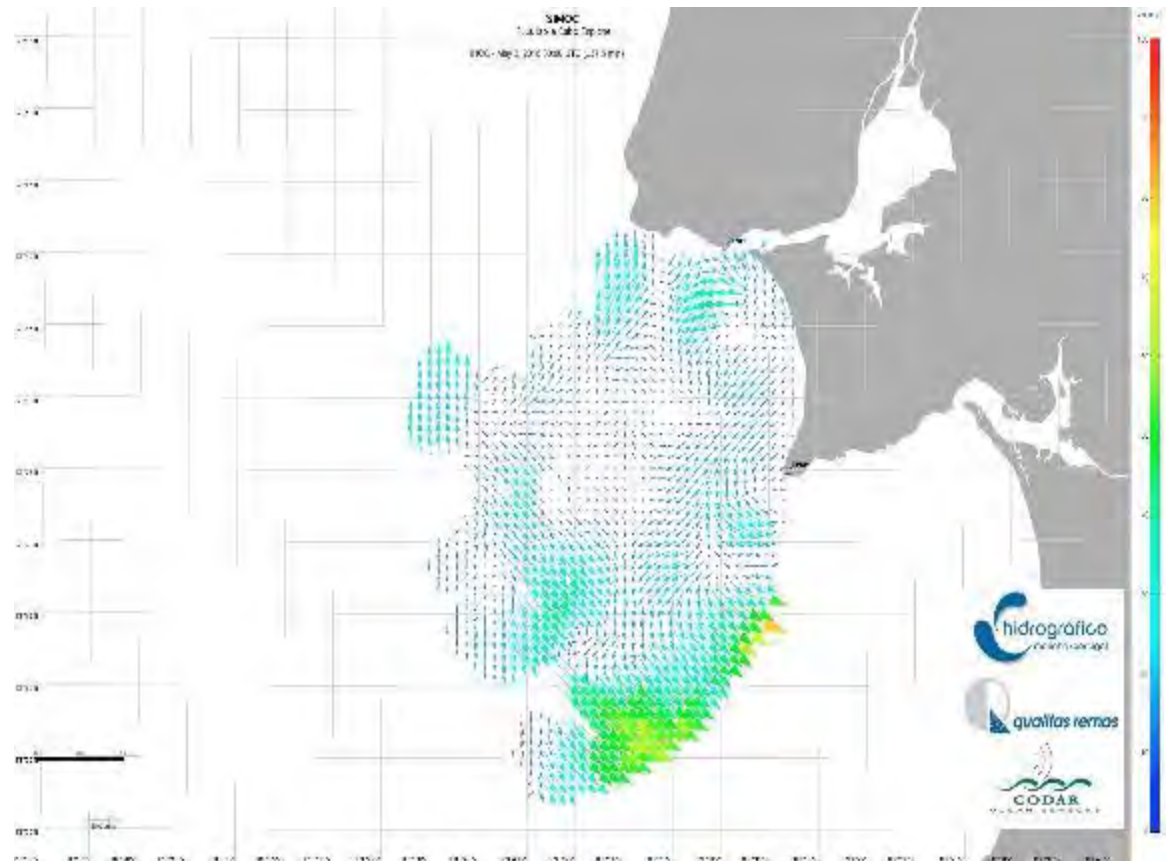


Year	Satellite	Average MOHID	Average L4 products	n (per day)	Pearson (r)	BIAS	RMSE
2014	OSTIA	17.11	17.18	355	0.937	-0.064	0.846
	ODYSSEA	17.11	17.17	2095	0.948	-0.059	0.773
	MUR	17.12	17.20	8356	0.934	-0.078	0.894
2015	OSTIA	16.50	16.91	255	0.919	-0.407	0.946
	ODYSSEA	16.51	16.83	2095	0.924	-0.320	0.889
	MUR	16.56	16.87	8356	0.912	-0.359	0.992
2016	OSTIA	16.74	16.19	355	0.930	-0.176	0.866
	ODYSSEA	16.71	16.83	2095	0.864	-0.127	0.978
	MUR	16.73	16.83	8356	0.916	-0.102	0.914

De Pablo et al (2019). *Water*, 11(8), 1713.

HF Radar – Tagus mouth

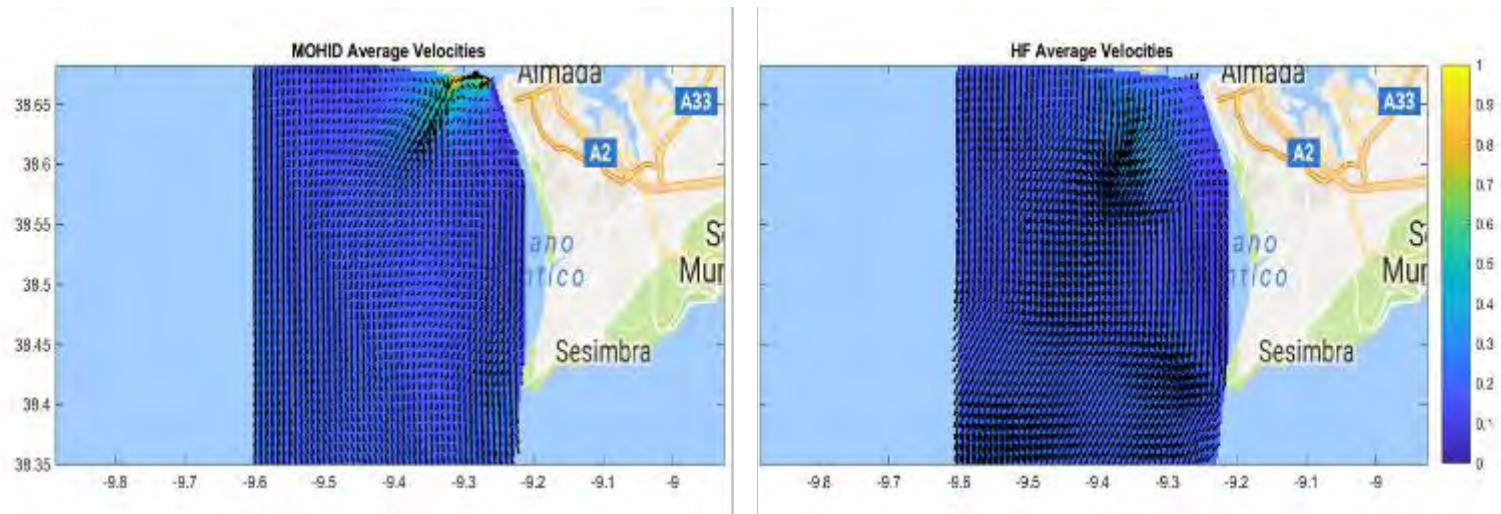
- Resource: Hidrografico
- Grid Spacing: ~1.4 Km
- Frequency: every hour
- Format .tuv (ASCII file)
- The output is already pre-processed by SeaDisplay 6.7.8
- Averaging Radius: 4.000 km
- DistanceAngularLimit: 20.0
- CurrentVelocityLimit: 100.0 cm/s



HF Data source: <http://www.hidrografico.pt/simoc.php>

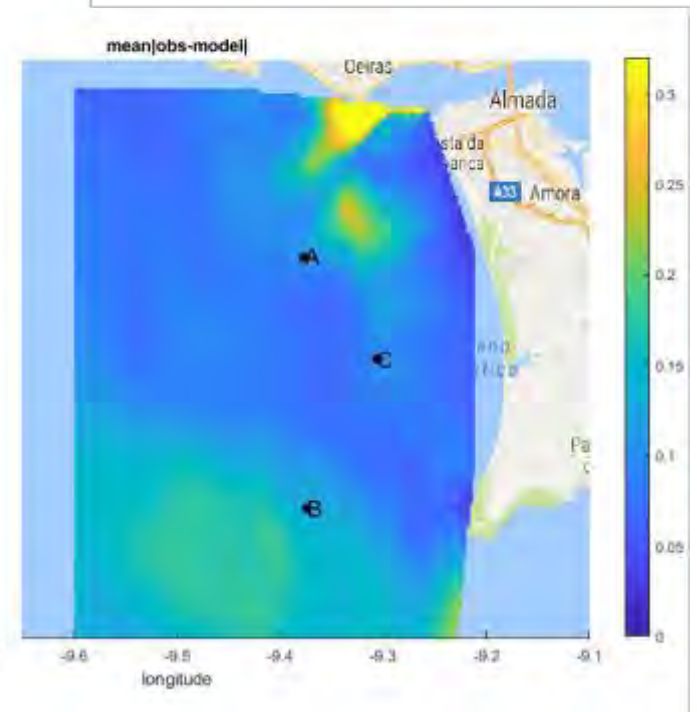
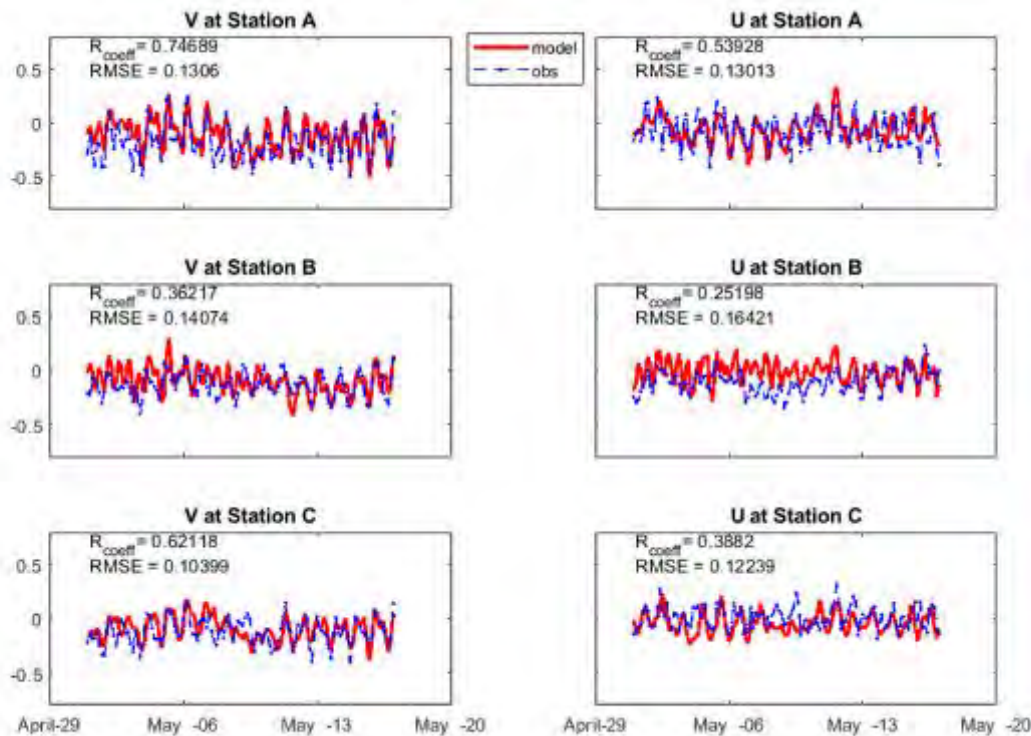
Model vs HF Radar

- Average velocities over time (17 days)



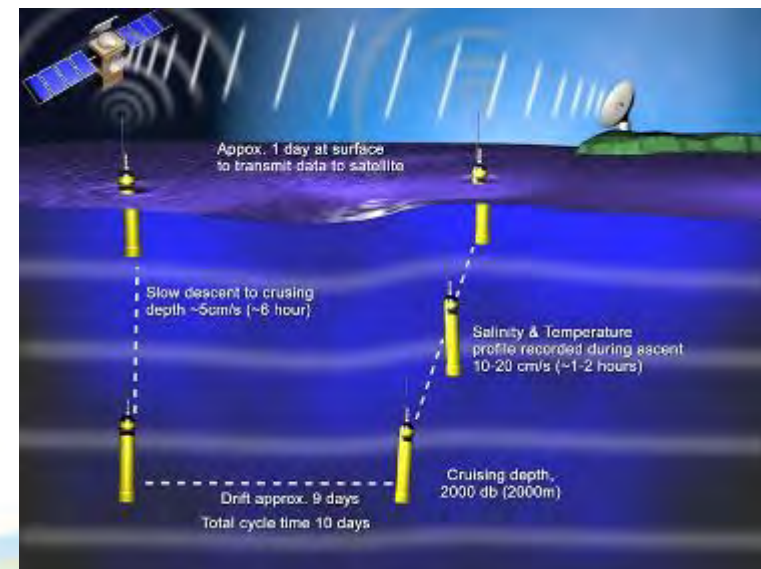
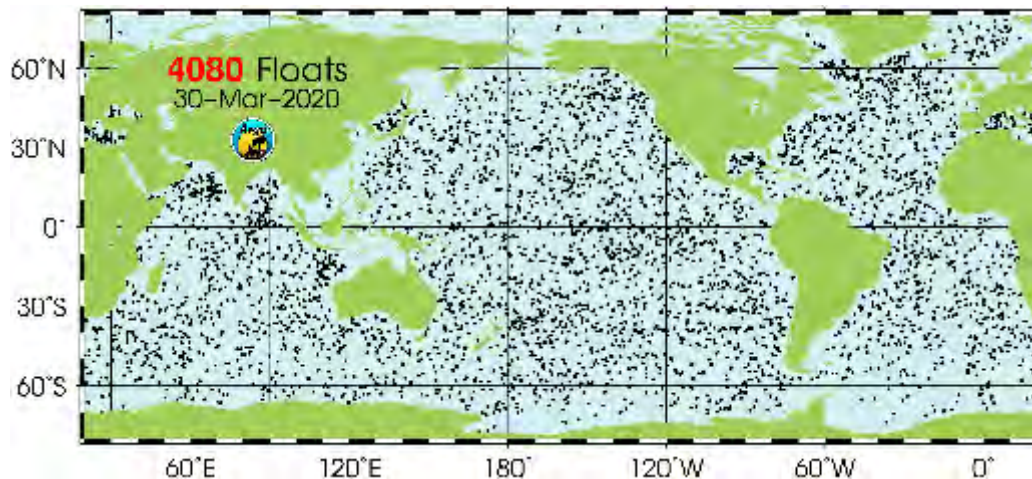
Model vs HF Radar

- 17 days time series analysis (May 2018)



Argo floats

- Argo is a global array of about 4,000 free-drifting profiling floats that measures the temperature and salinity of the upper 2000 m of the ocean.



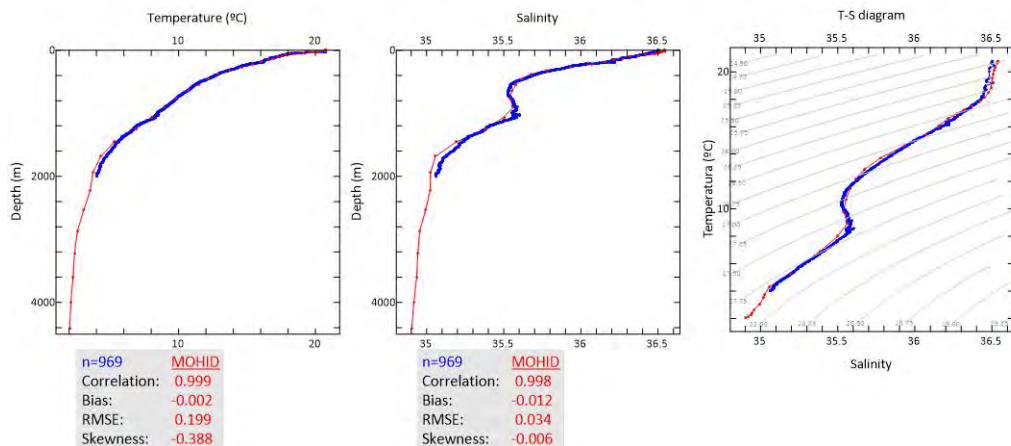
<http://www.argo.ucsd.edu/>

Model vs Argos

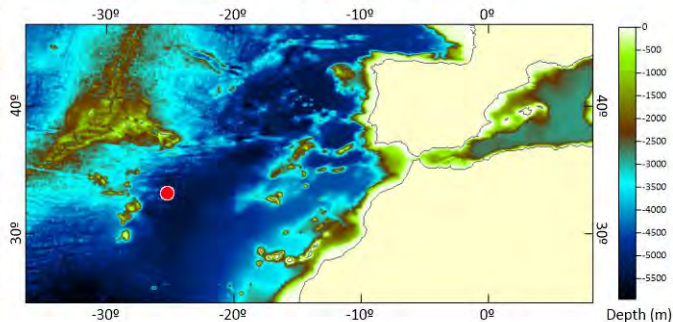
ARGO
MOHID



Time: 28-May-2019 11:20
Location: 33.16°N, 25.238°W
Id: 3901841 Cycle No. 104(A)



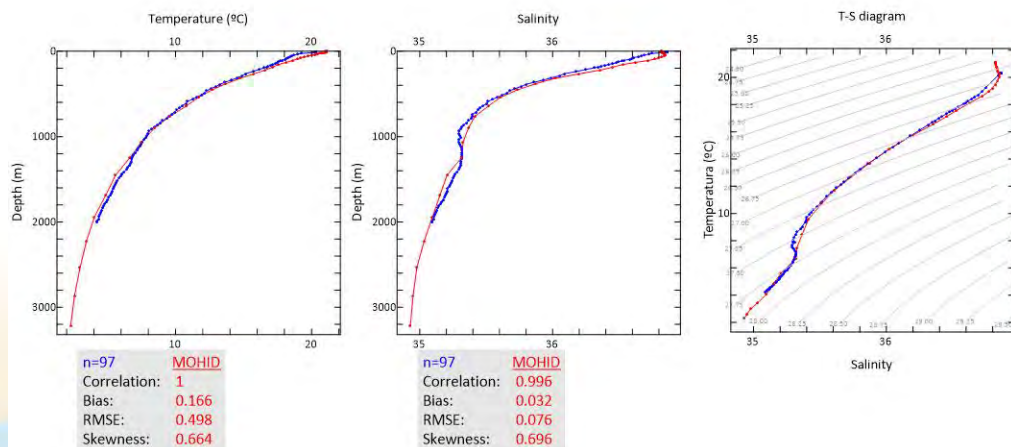
Argo Float(*) Location



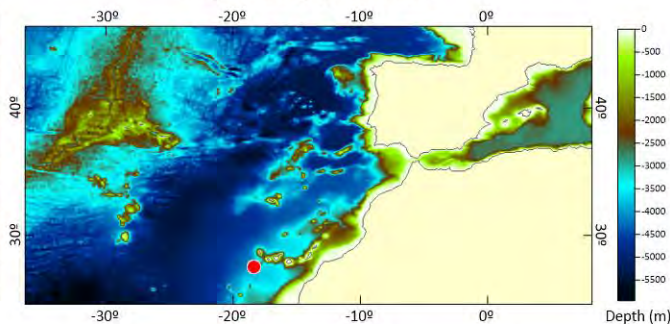
ARGO
MOHID



Time: 28-May-2019 5:41
Location: 27.522°N, 18.374°W
Id: 6901271 Cycle No. 29(R)



Argo Float(*) Location

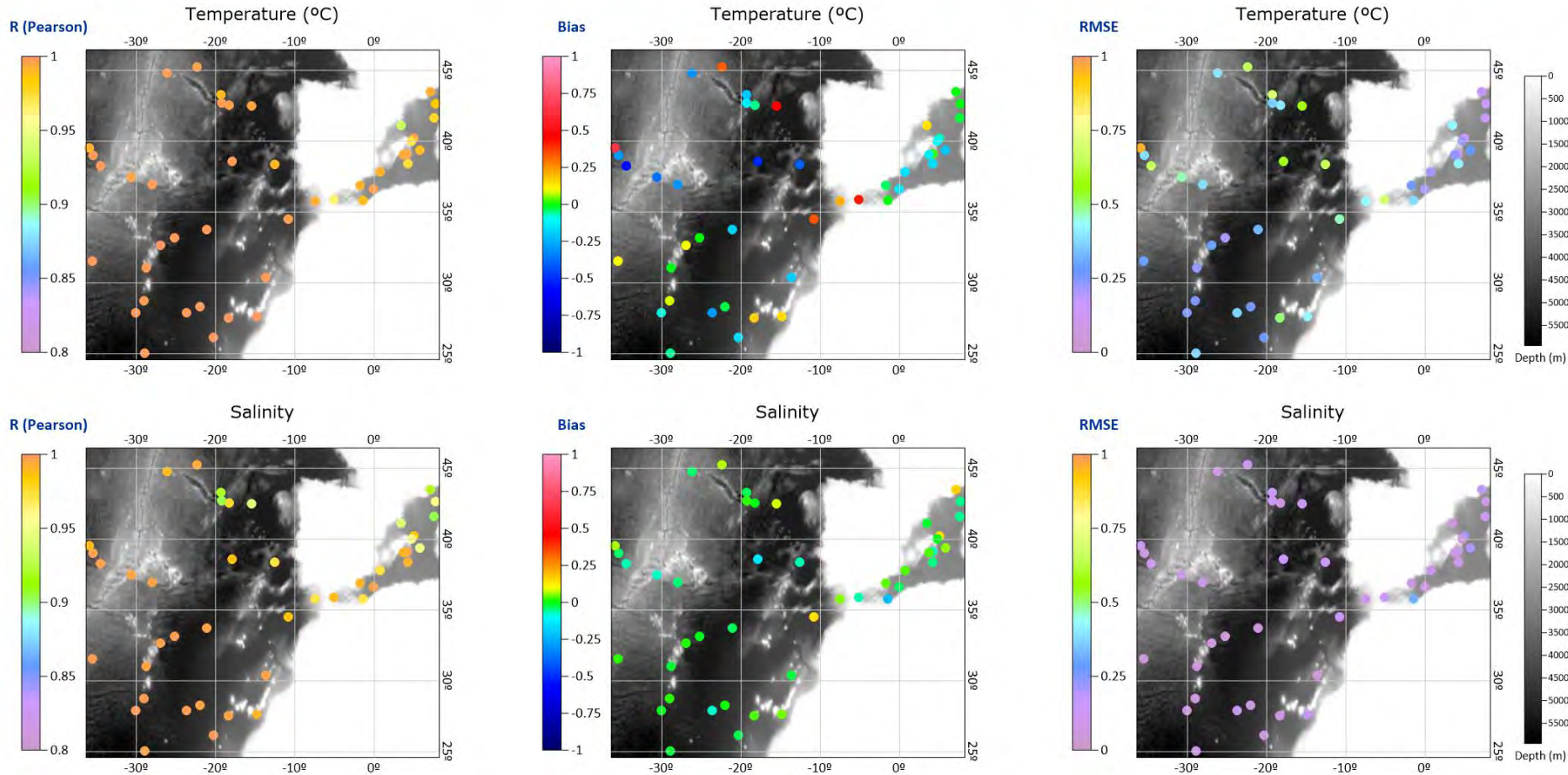


Model vs Argos

MOHID vs Argo floats

Total floats for Temperature: 44
Total floats for Salinity: 44

27-May-2019 to 31-May-2019





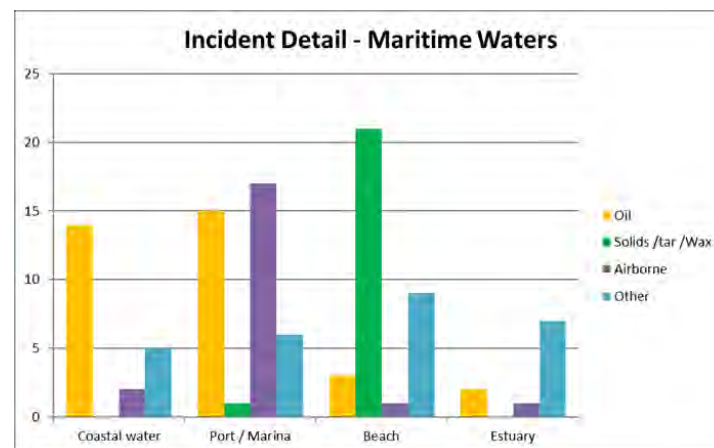
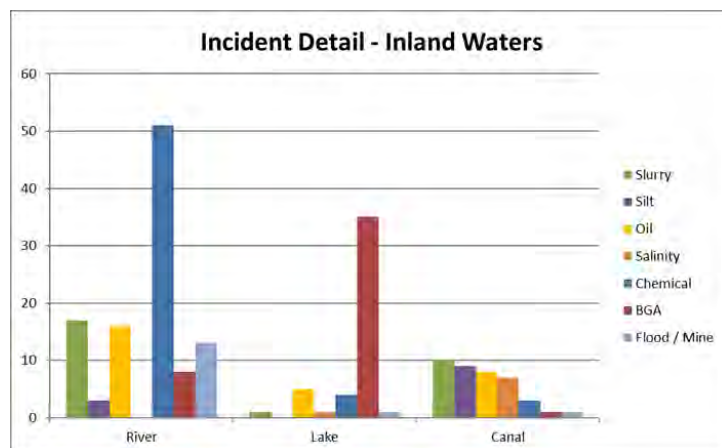
Early warning pollution indicators and sentinels in monitoring stations

Assessment of sentinels and indicators

- During incident response it is important to have knowledge of the chemicals that have been released to aid forecasting and inform the risk assessment
- Likewise it is important to be able to interpret data to assess potential impact on health and the environment
- Real-time (or near real-time) environmental monitoring offers: Rapid; clear characterization; Inform detailed monitoring
- To determine incident scale and impact it may be necessary to monitor the environment at multiple locations utilizing several types of monitoring equipment capable of monitoring a range of parameters

Selection of proxies and indicators

- Reviewed incidents for UK and Wales inland, estuarine and coastal waters (2011 - 2018) and categorised by:
 - pollutant (type and substance),
 - location (river, lake, canal, port, marina, beach and coastal),
 - principal target of impact (human, environment),
 - scale (small, medium, large by estimate of release volume).



Identified key parameters

Pollutant incident type	Pollutant*	Indicators/proxies*
Slurry	Ammonia, TOC	Ammonia, turbidity
Oil Spill	TPH, VOC	BTEX (Benzene)
Chemical	Various including pesticides	pH, PAH, conductivity, DO
BGA	Toxin	Cells, DO
Palm Oil / Wax	VFA, TPH	DO, BTEX, pH
Flooding	TOC, turbidity, salinity, metals	pH, DO, turbidity, conductivity

* (TOC – Total Organic Carbon, BTEX – Benzene, Toluene, Ethylbenzene and Xylene, DO - Dissolved Oxygen, TPH – Total Petroleum Hydrocarbons, VOC – Volatile Organic Compounds, VFA – Volatile Fatty Acids, PAH – Polyaromatic hydrocarbons.)

Water monitoring

- Most frequently occurring substances reported are:
 - slurry/sewage, oil hydrocarbons, blue-green algae, other organic chemicals (largely pesticides) and solid tar/wax
- Potential proxy/indicator substances for these incidents were identified as ammonia, turbidity, BTEX, pH, PAH, conductivity and DO
- The market currently supports real-time monitoring of all the proxy/indicator substances. Monitoring and identification can be achieved through optical, fluorescence, photometric, non-dispersive infrared sensor, mid infrared, electrochemical, microfluidic lab-on-chip and ion selective electrode methods

Water quality standards and guidelines

		BTEX	PAH	Conductivity	pH	Ammonia	Total Pesticides
		µg/l	µg/l	µS/cm at 20°C		mg/l	µg/l
EU Drinking water standard		1*	0.1				0.5
WHO drinking water guideline		10*					
EU Environmental Quality Standards AAs	Inland surface waters	10*					
	Other surface waters	8*					
EU Environmental Quality Standards MACs	Inland surface waters	50*					
	Other surface waters	50*					
UK Private Water Supply Regulations (indicators)	Max	1*		2500	9.5	0.5*	
	Min				6.5		

Obrigada
Thank you

Questions?

Lígia Pinto
ligia.pinto@tecnico.ulisboa.pt





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**HazRunOff platform
- A digital toolkit for situational
awareness & crisis management -**

Rodrigo Fernandes
Bentley Systems

Why?

- Why modelling is important in flood and contamination resilience?
 - Can be integrated as part of multiple mitigation strategies
 - Non-structural measures – direct contribution
 - Structural measures – indirect contribution (informed decision making / optioneering)



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Why?

- Mitigation | Structural measures:

- Reduce runoff, improve runoff retention (e.g. LID, green roofs)
- Optimize drainage systems
- Enhance river capacity
- Create diversion channels (e.g. tunnels)

optioneering

modelling



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Why?

- Mitigation | Non-structural measures:

- Flood risk mapping & zoning
- Disseminate flood risk information
- Flood & pollution forecasting & early warning systems
- Insurance
- Land use planning
- Train emergency teams
- Develop & test emergency management plans
- ...



modelling

Why?

- Sources of incoming water to an urban area?

- Heavy rainfall (pluvial flash flooding)
- Upstream rivers (fluvial flooding)
- Dam break
- Sea-level rise due to storm surge (low atmospheric pressures, high waves, high winds)
- Sea-level rise due to “sunny-day flooding” (unusual high astronomical tides, known as “king tides”)



Compound flooding (combination of flood types)



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Why?

- Why integrated approach is important?
 - multiple factors:
 - Several processes and scales
 - Many flood and pollution sources

System complexity can only be reproduced and understood following an holistic approach



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Integrated modelling = HazRunOff



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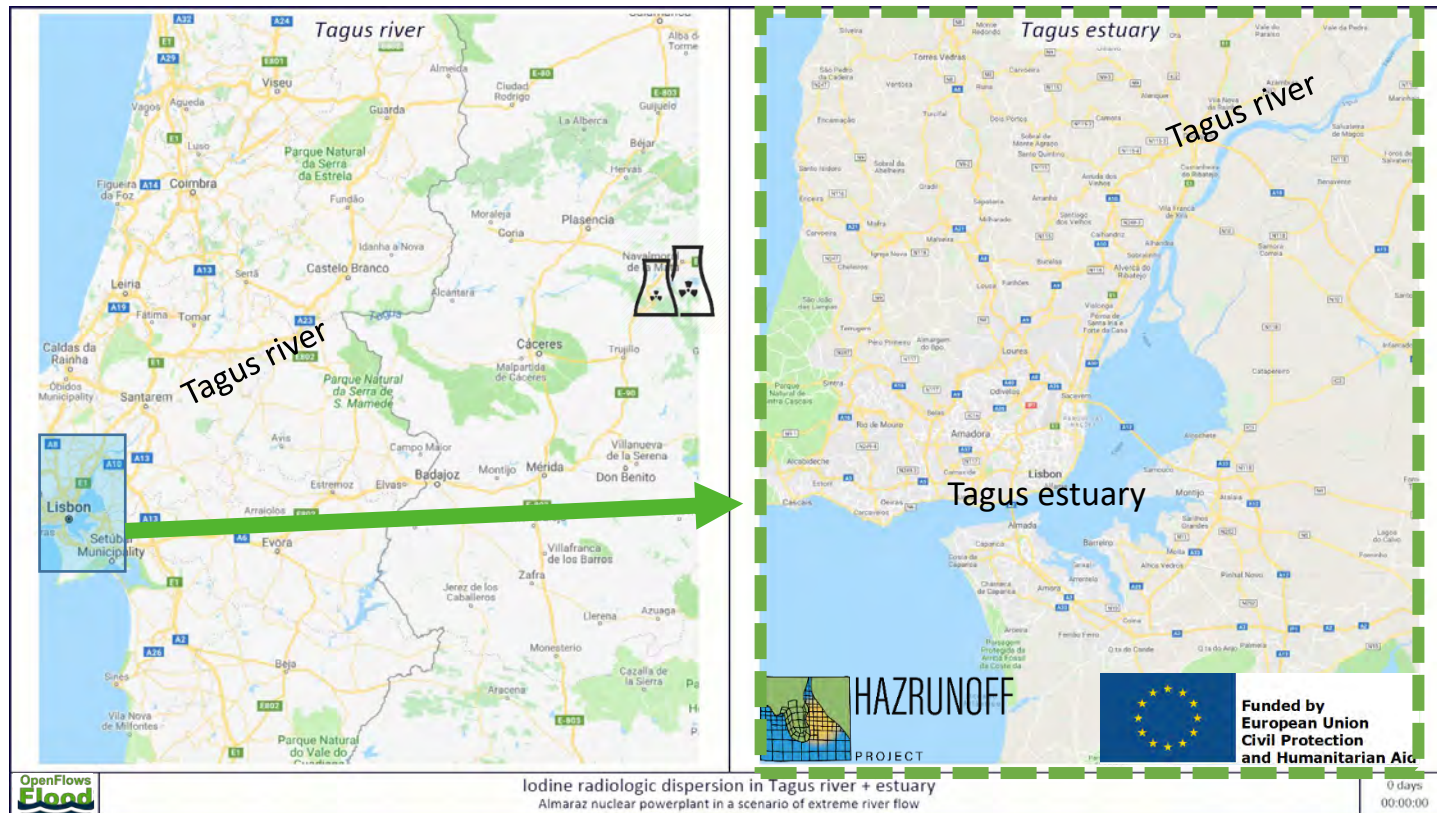


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Floods & Water pollution: mixing scales and processes



Floods & Water pollution: mixing scales and processes



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Floods & Water pollution: mixing scales and processes



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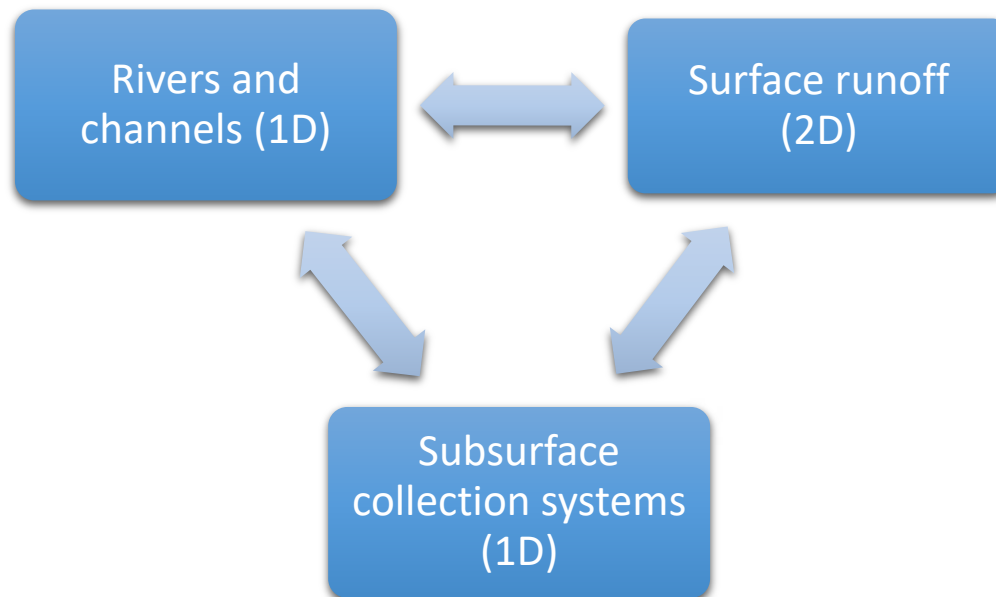
Floods & Water pollution: mixing scales and processes

- Urban drainage and fecal coliform concentration in coastal areas

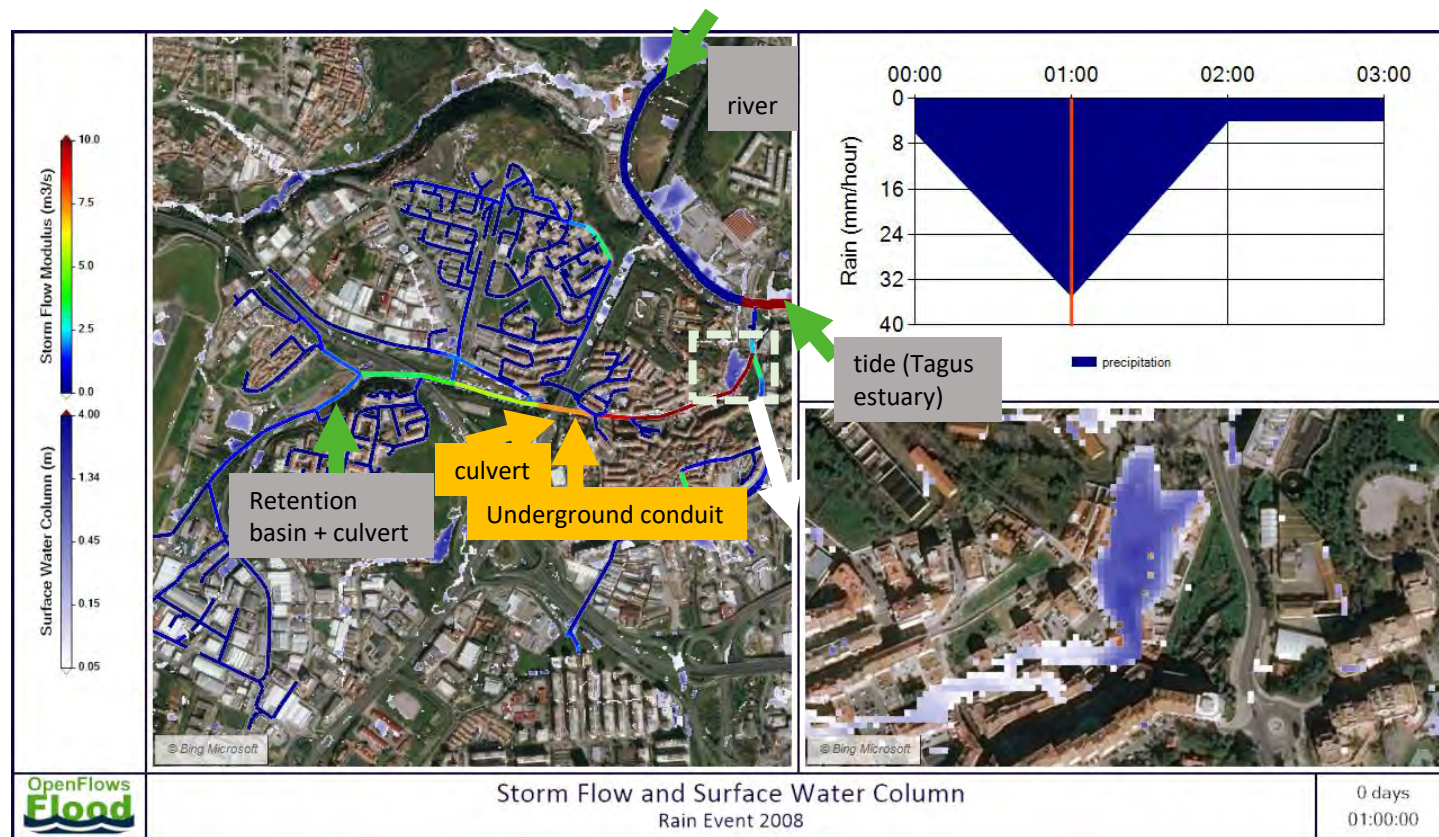


Floods & Water pollution: mixing scales and processes

- 3-way coupled flood modeling (1D-2D)



3-way coupled flood modelling (HazRunOff project)



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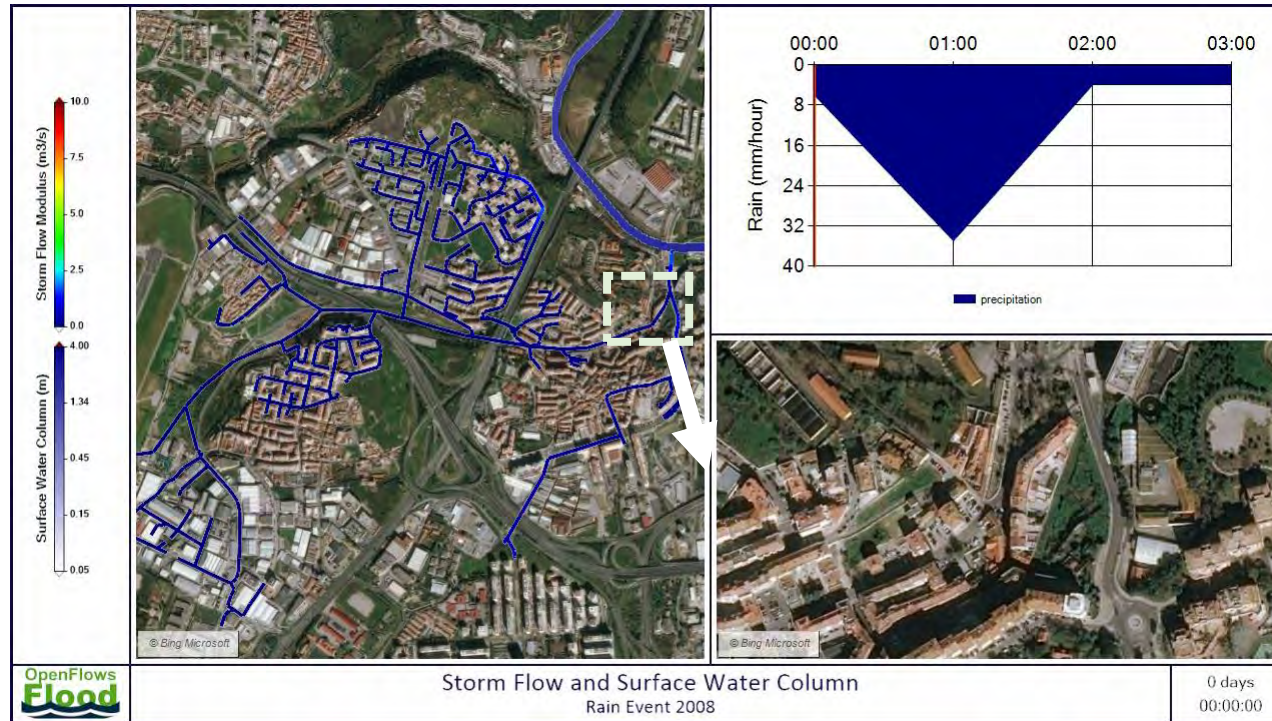
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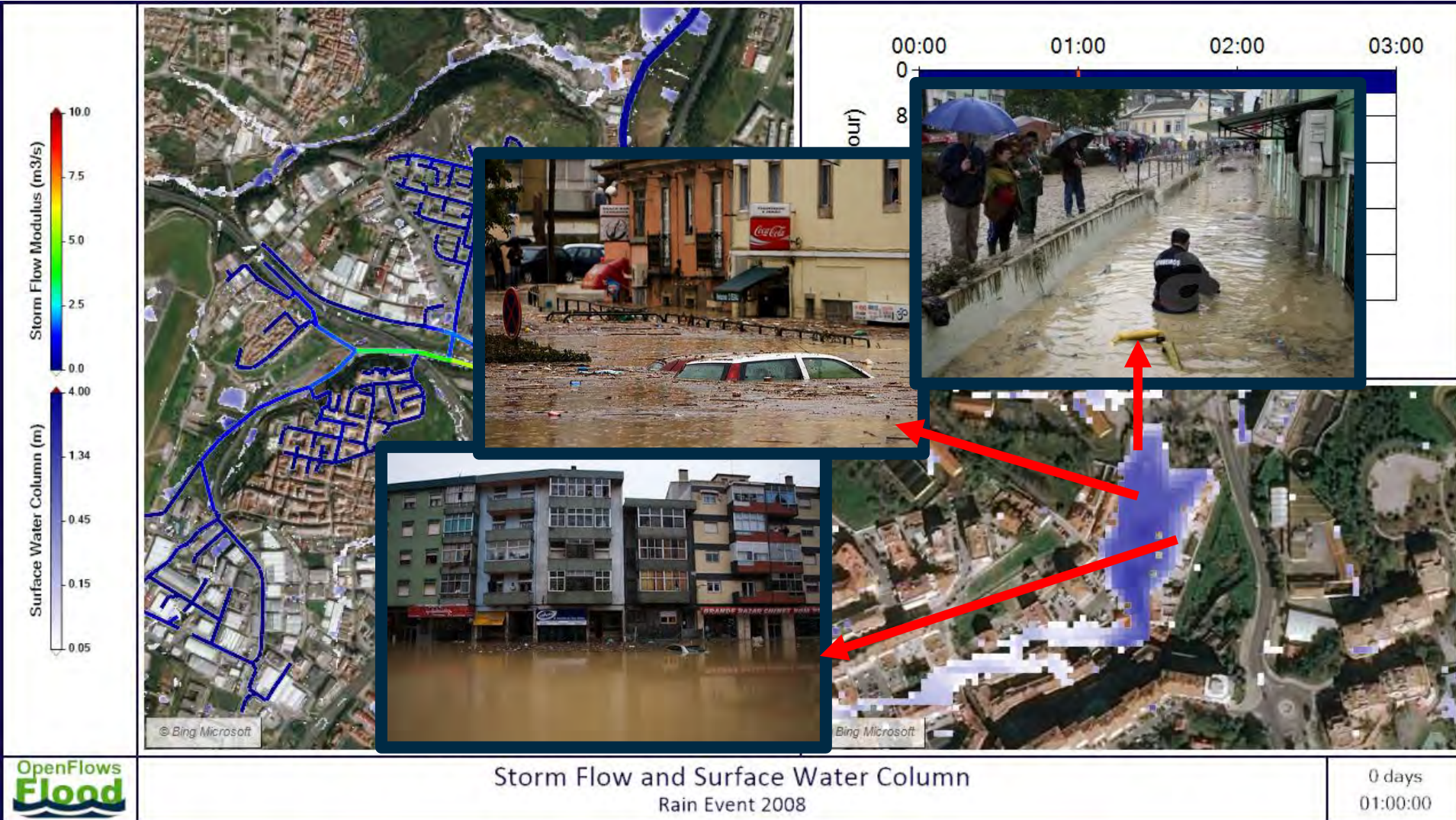


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3-way coupled flood modelling (HazRunOff project)



Integrated flood modelling – Sacavém (Lisbon)



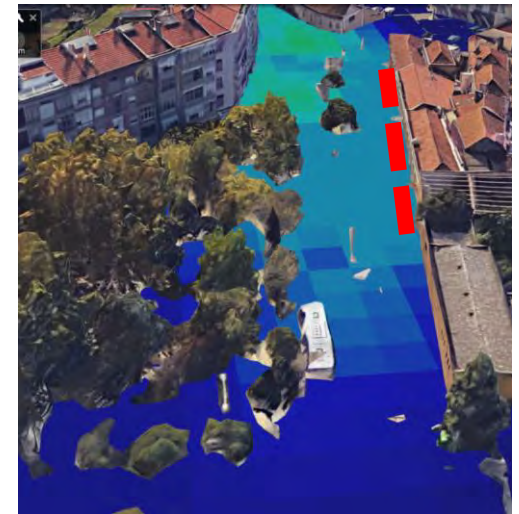
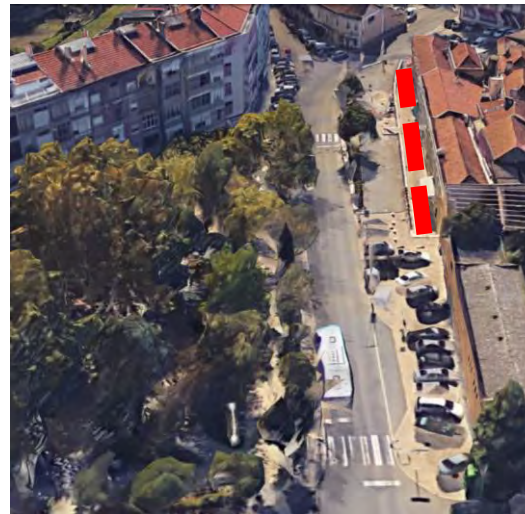
PROJECT



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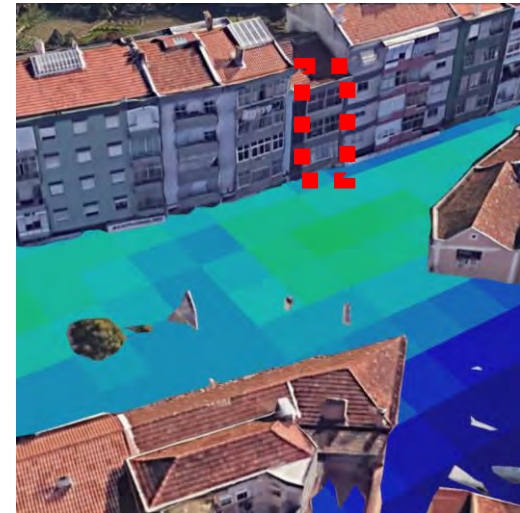
3-way coupled flood modeling (HazRunOff project)

– Results vs. images



3-way coupled flood modeling (HazRunOff project)

– Results vs. images



The ultimate goal of HazRunOff



- To allow realtime and simulated information on rivers, estuaries and coastal areas as a continuum environmental compartment
- Supported with fusion of model and data-oriented holistic view
- Providing smart and actionable information for better decisions in preparedness & response duties.



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Our vision on resilient cities & critical infrastructure
(including seaports, water or power utilities, industry plants, etc.)

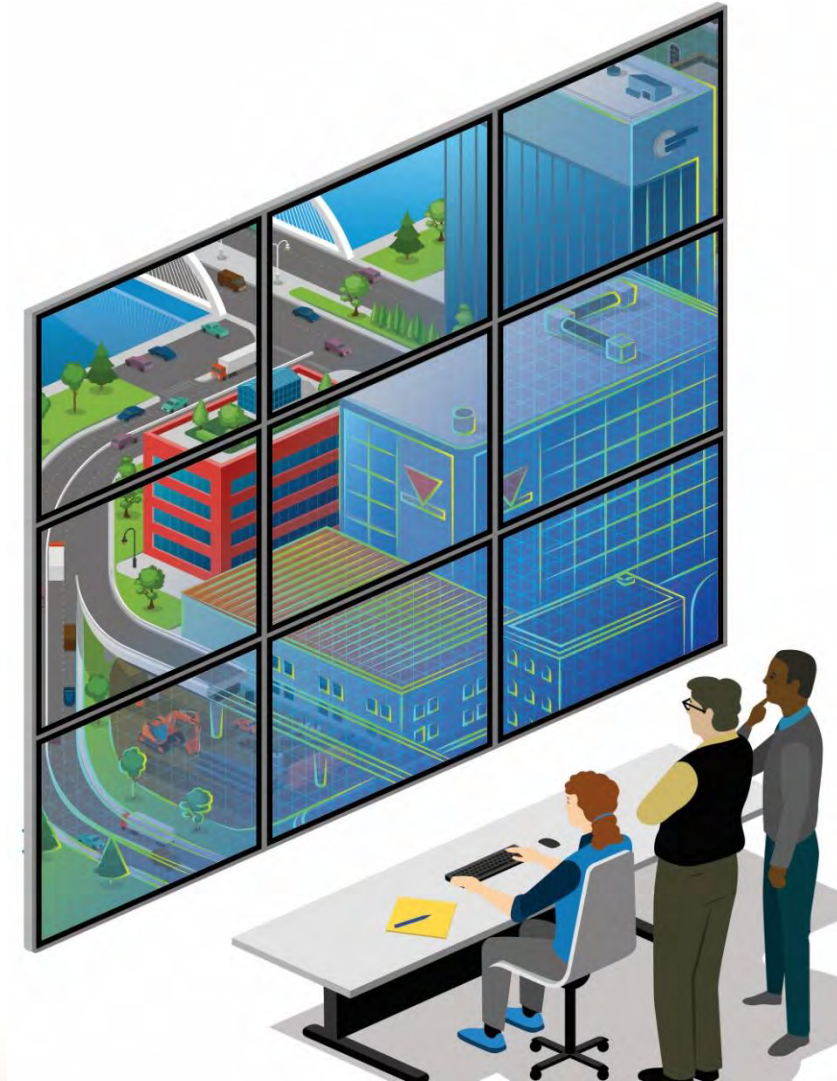
Digital Twin Workflows & Connected Data Environment (CDE)



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Infrastructure Digital Twin

Bridges the physical and virtual

Spans entire asset lifecycle

Is updated continuously

Is a way to visualize assets, check status, perform analysis and generate insights



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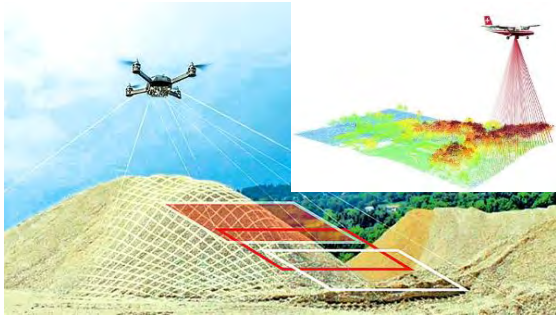
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Digital Twin Workflows & Connected Data Environment



Workflow in a Connected Data Environment

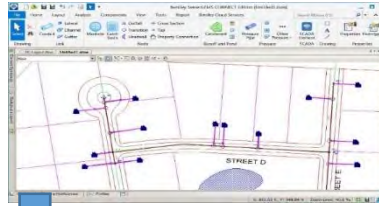
Photos + LiDAR points cloud



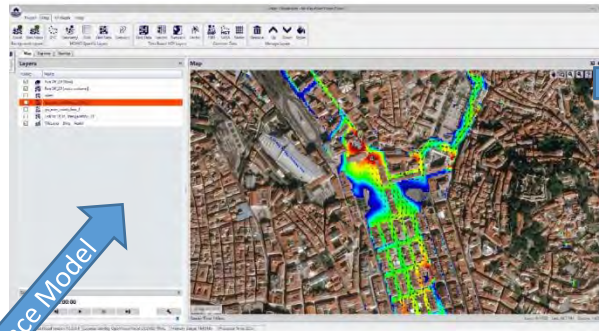
ContextCapture | 3D mesh model



SWMM / SewerGEMS |
Drainage networks



OpenFlows FLOOD | Flood model



Forecast operational systems | HazRunOff



OpenCities Planner | 3D visualization



LumenRT | 3D/4D visualization



Digital Surface Model



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Helsinki: 3D mesh, surface runoff model, 4D visualization



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Digital twin from a flood in a chemical plant (3D Viewpoint 1)

Exaggerated scenario



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Digital twin from a flood in a chemical plant (3D Viewpoint 2)



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What tools and technology support
HazRunOff user interfaces?

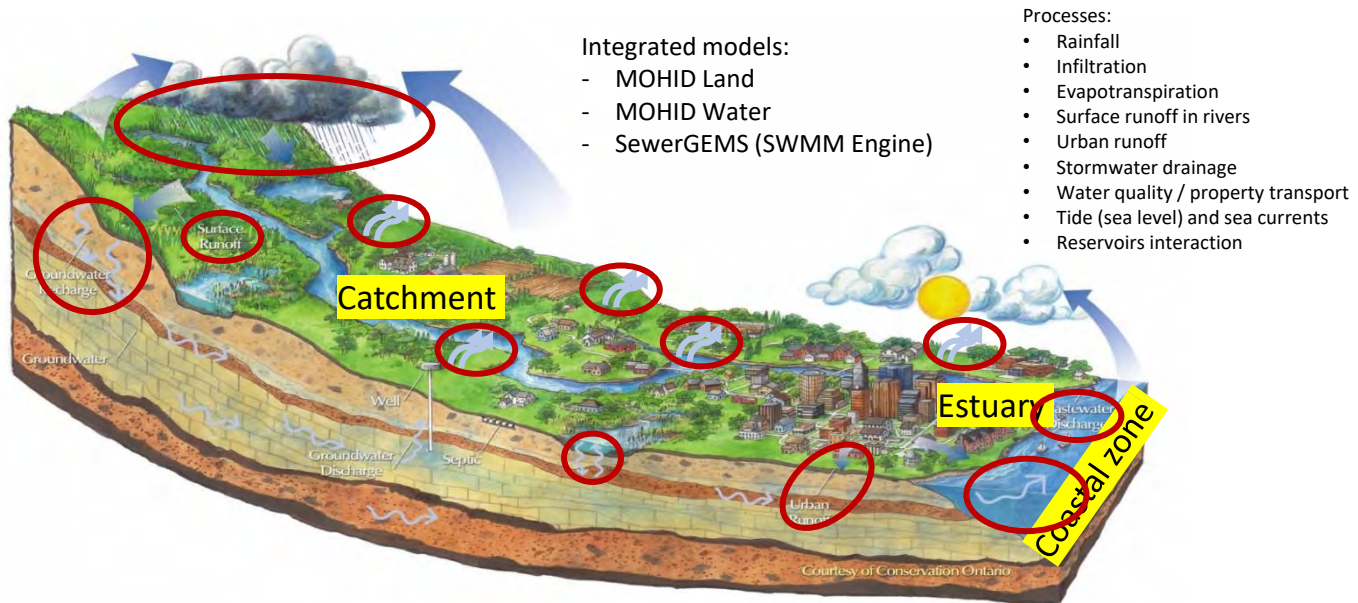


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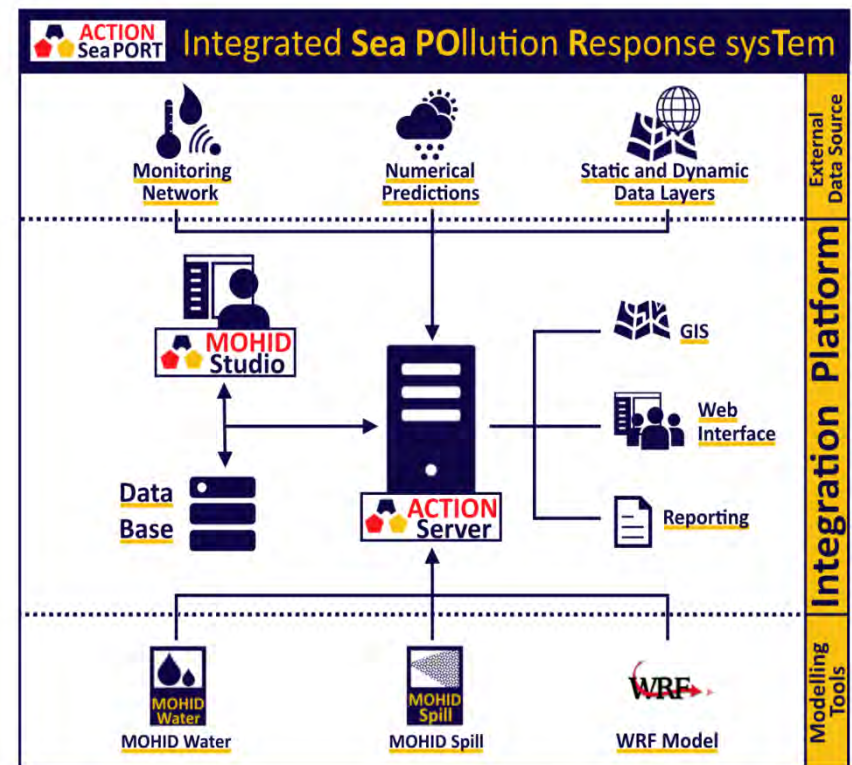
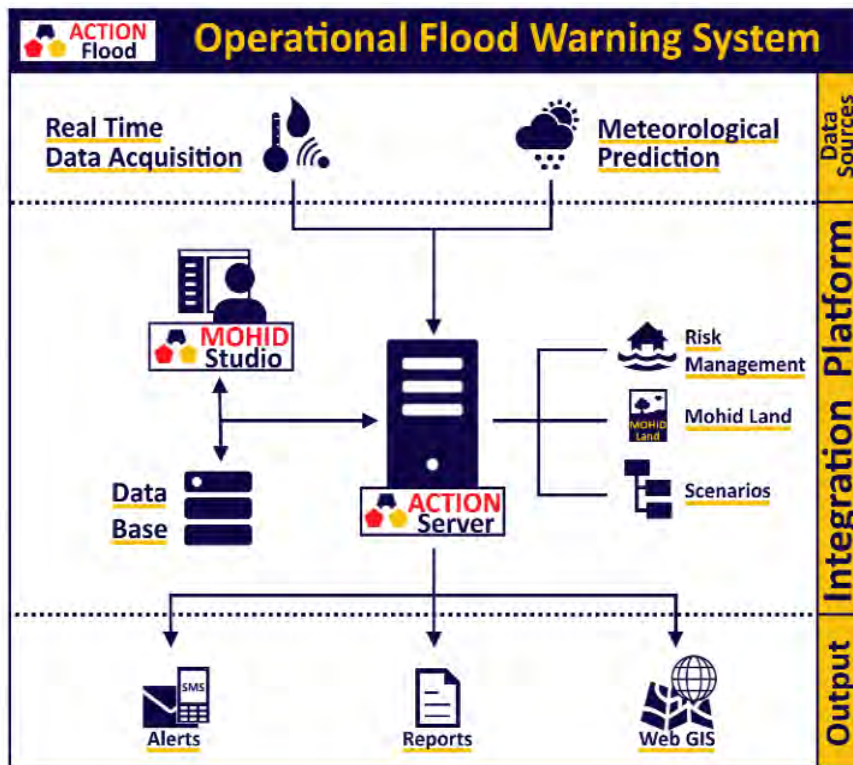
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Model engines



HazRunOff preparedness & response tools

- Predictive operational data analytics
- Based in previously developed technologies ACTION Flood and ACTION Seaport



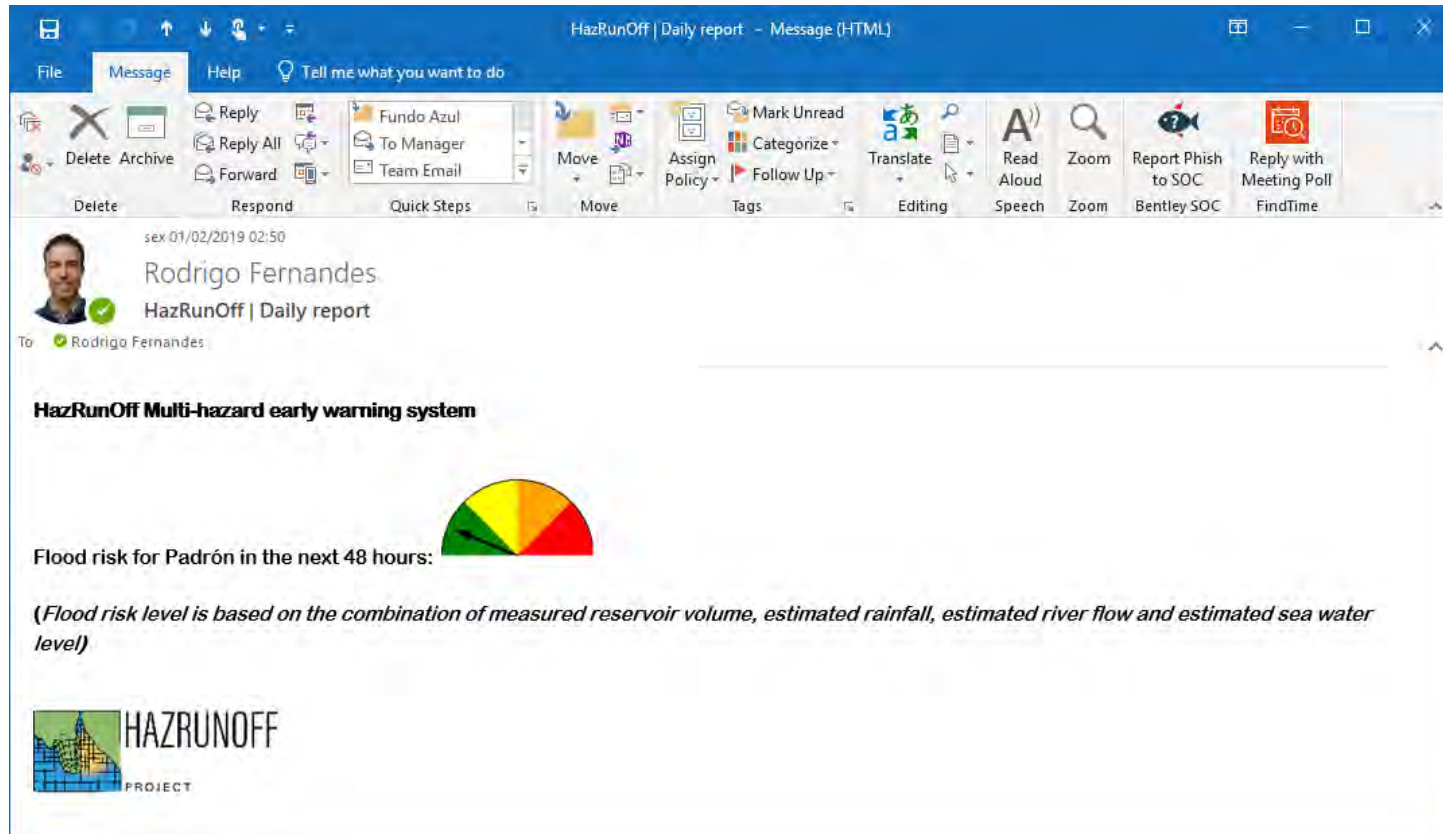
HAZRUNOFF
© 2017 Action Modellers. All rights reserved.
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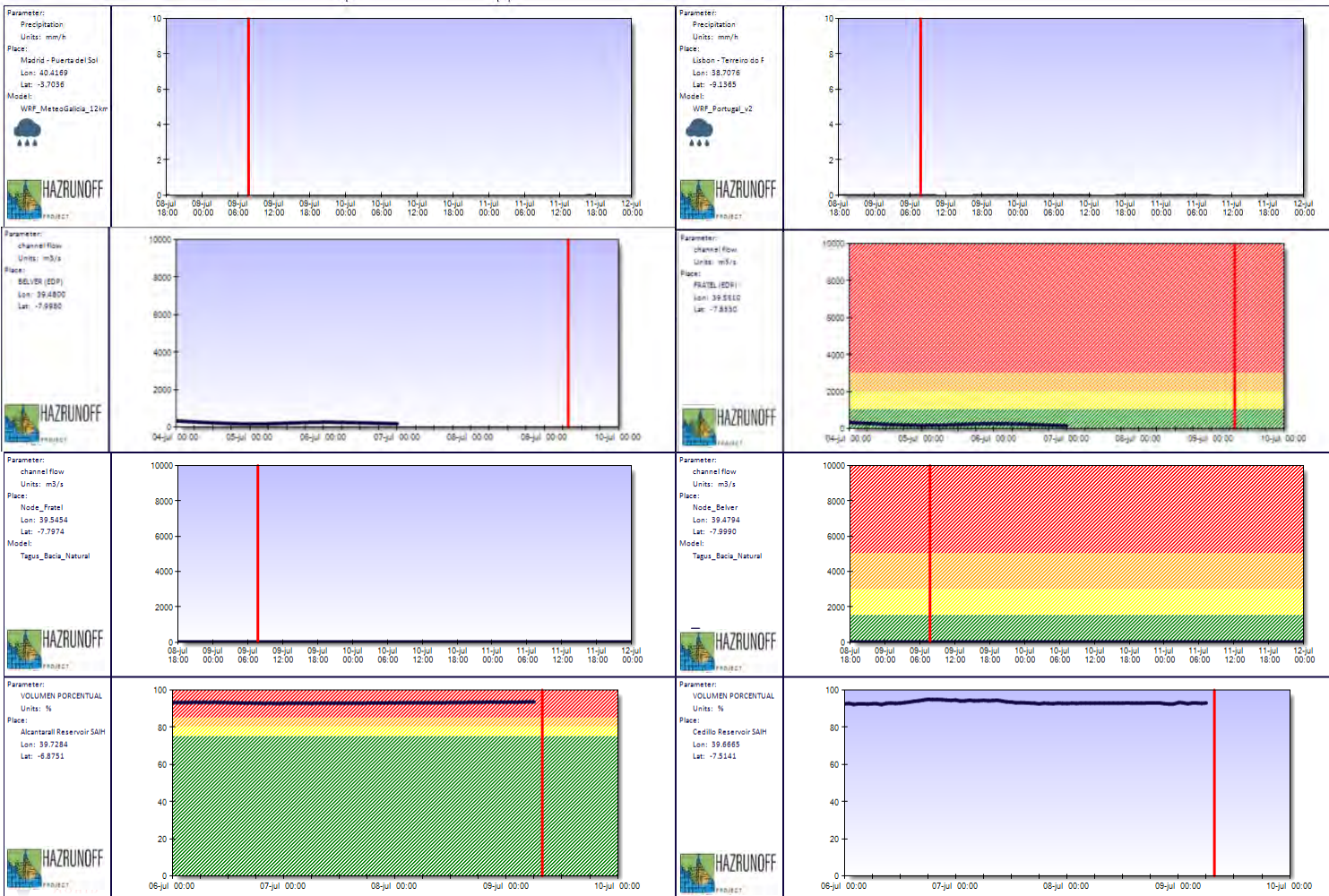
Multi-Hazard early warning system

- Daily reports / Event-triggered early warning notifications



Multi-Hazard early warning system

- Daily reports / Event-triggered early warning notifications



Included parameters:

- River flow
- Water level
- Reservoir percentage
- Rainfall
- Wind speed
- Waves

Web (& mobile-friendly) preparedness & response platform

- Map visualization of properties for integrated view
- Charts & Tables for point analysis
- Realtime dashboards for situational awareness
- On-demand pollutant dispersion system

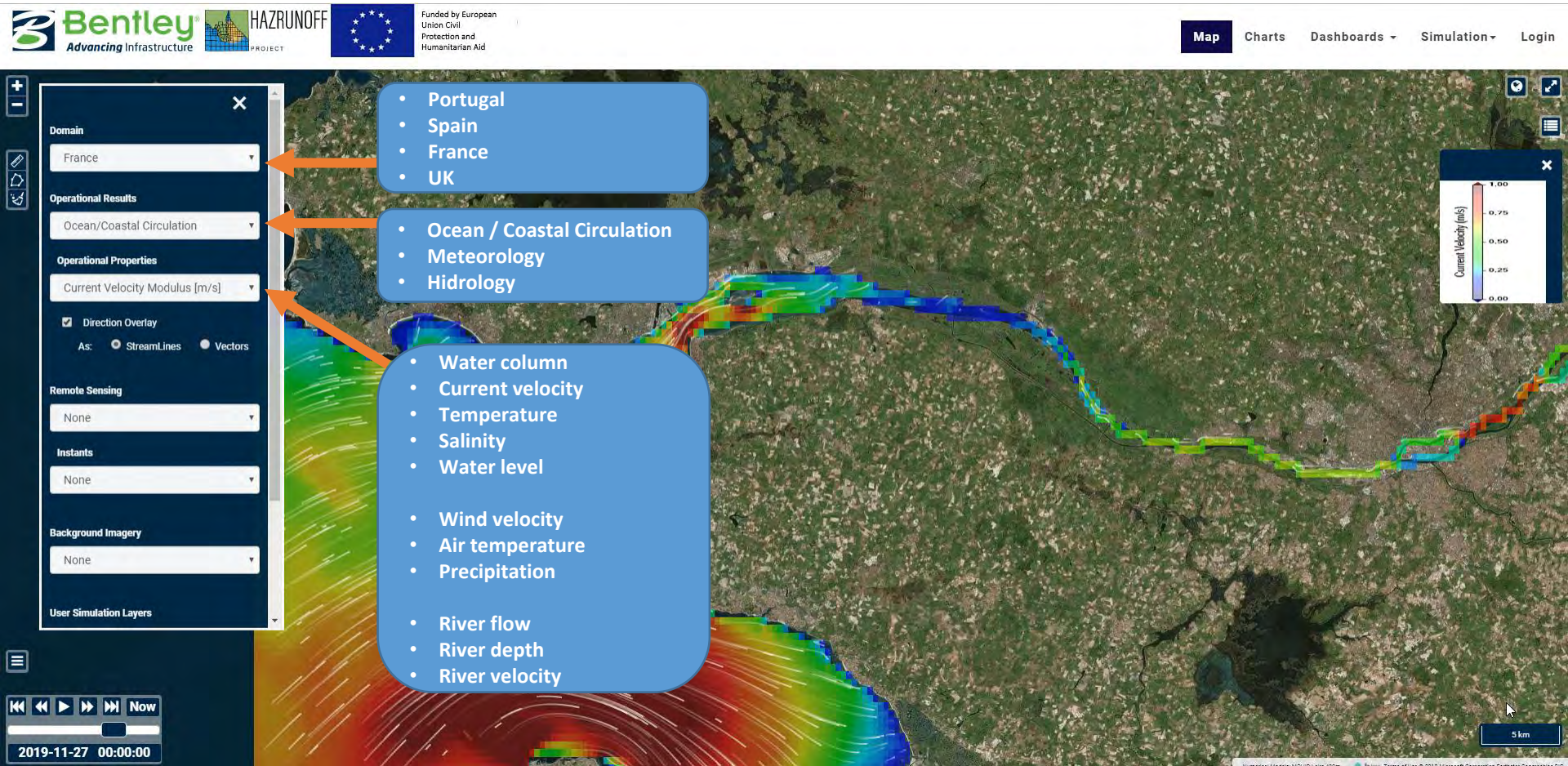


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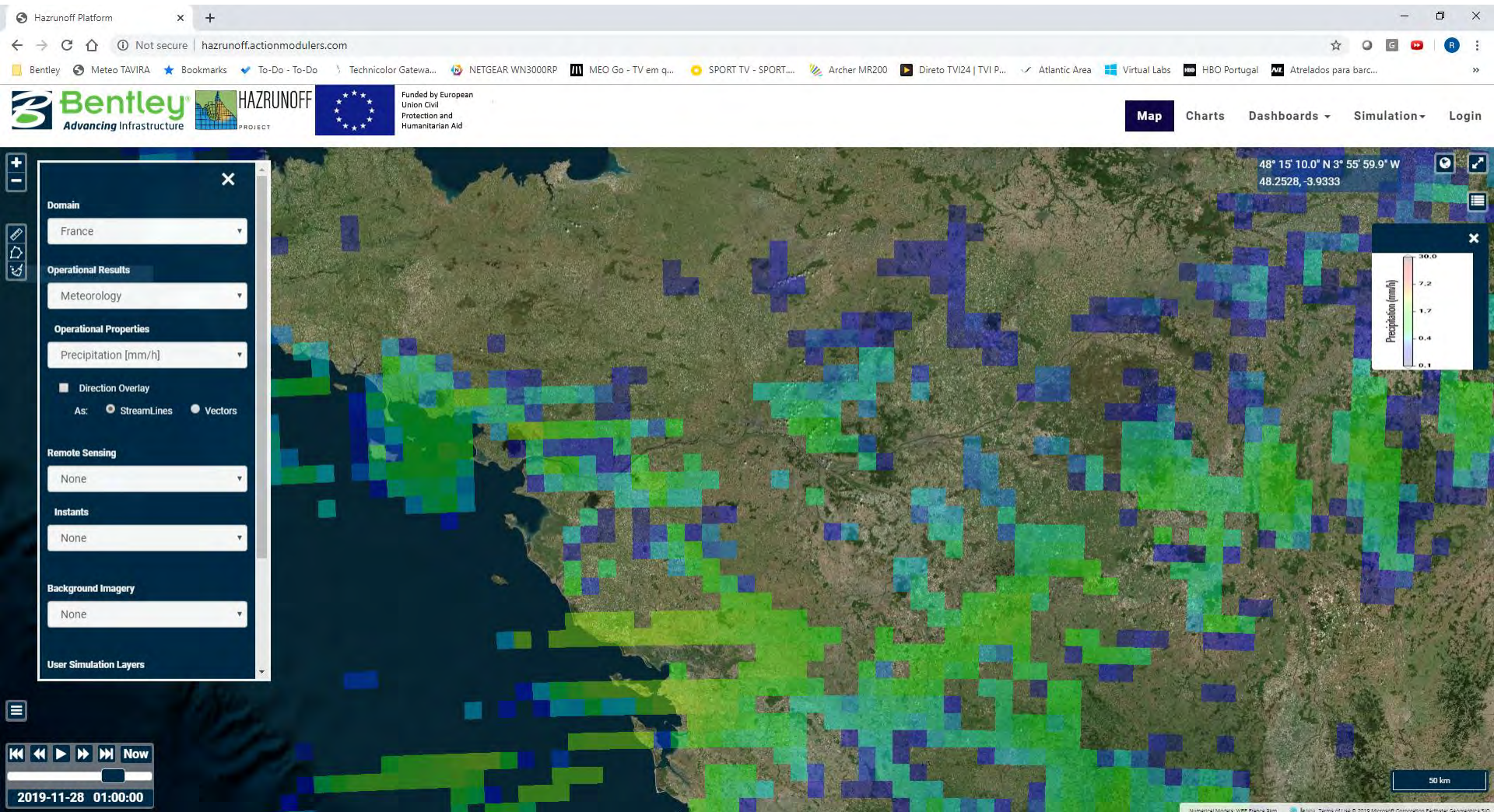


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HazRunOff Platform & coastal current velocity



Meteorology – low resolution

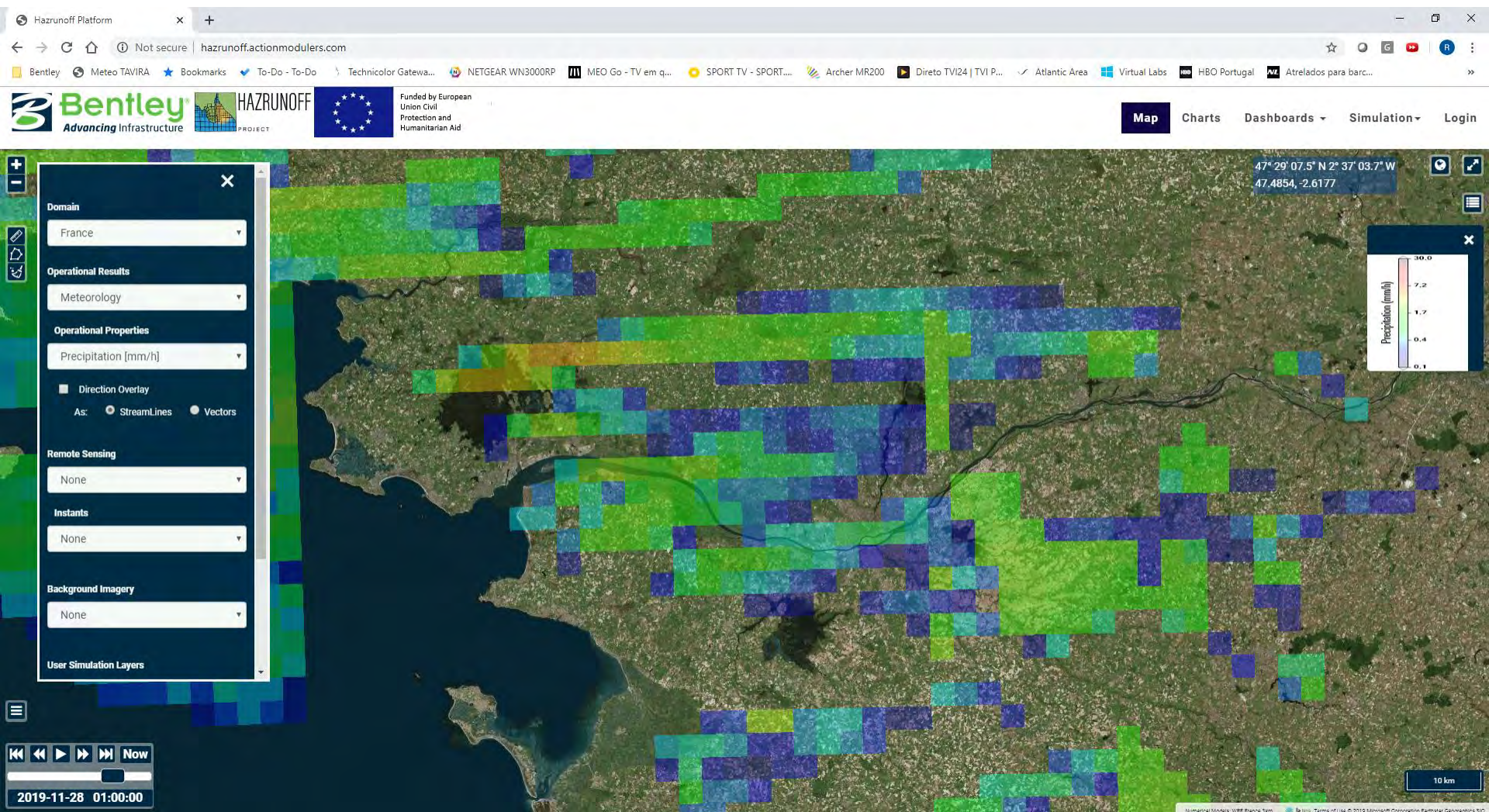


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Meteorology – medium resolution

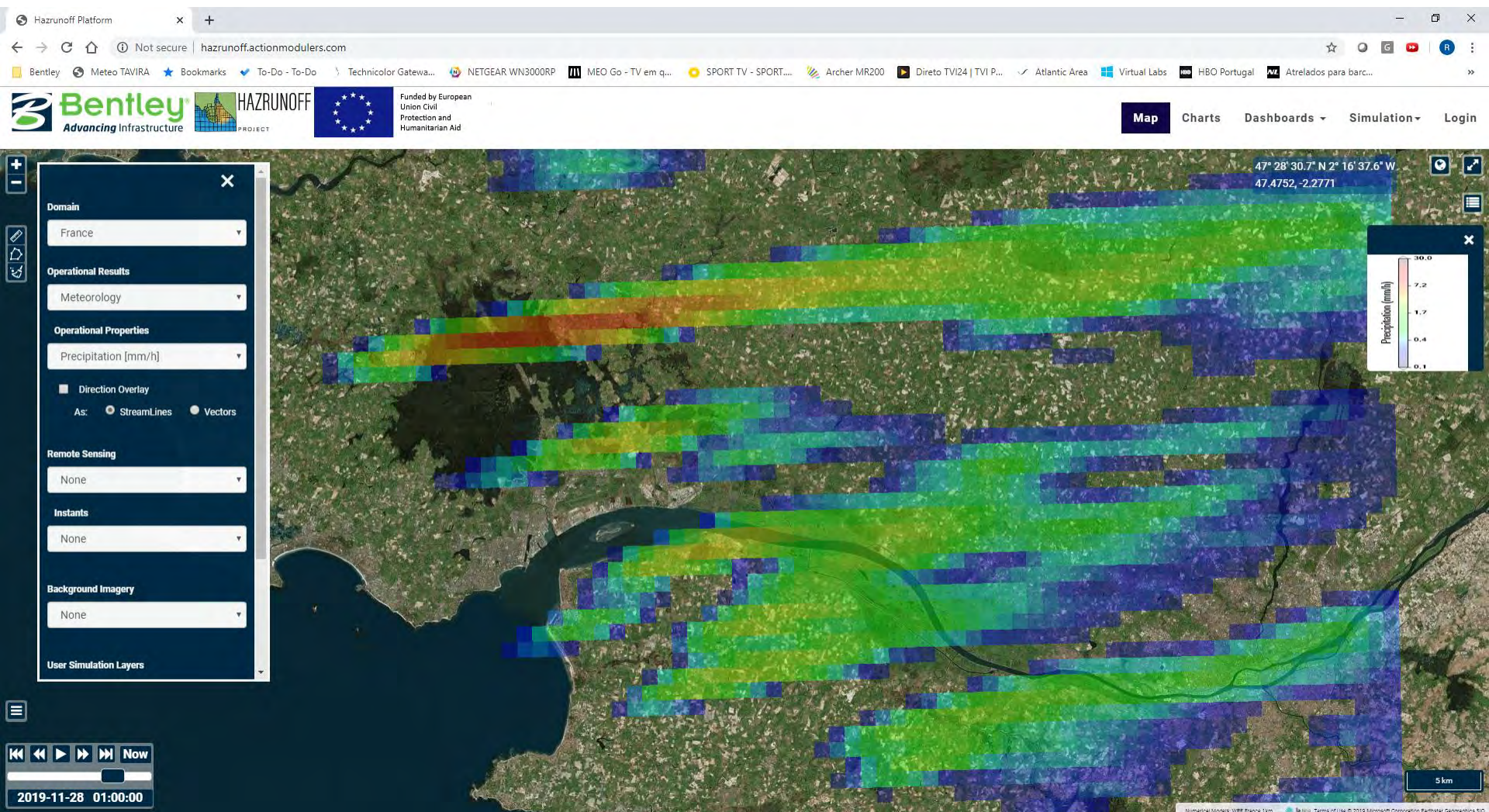


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Meteorology – high resolution

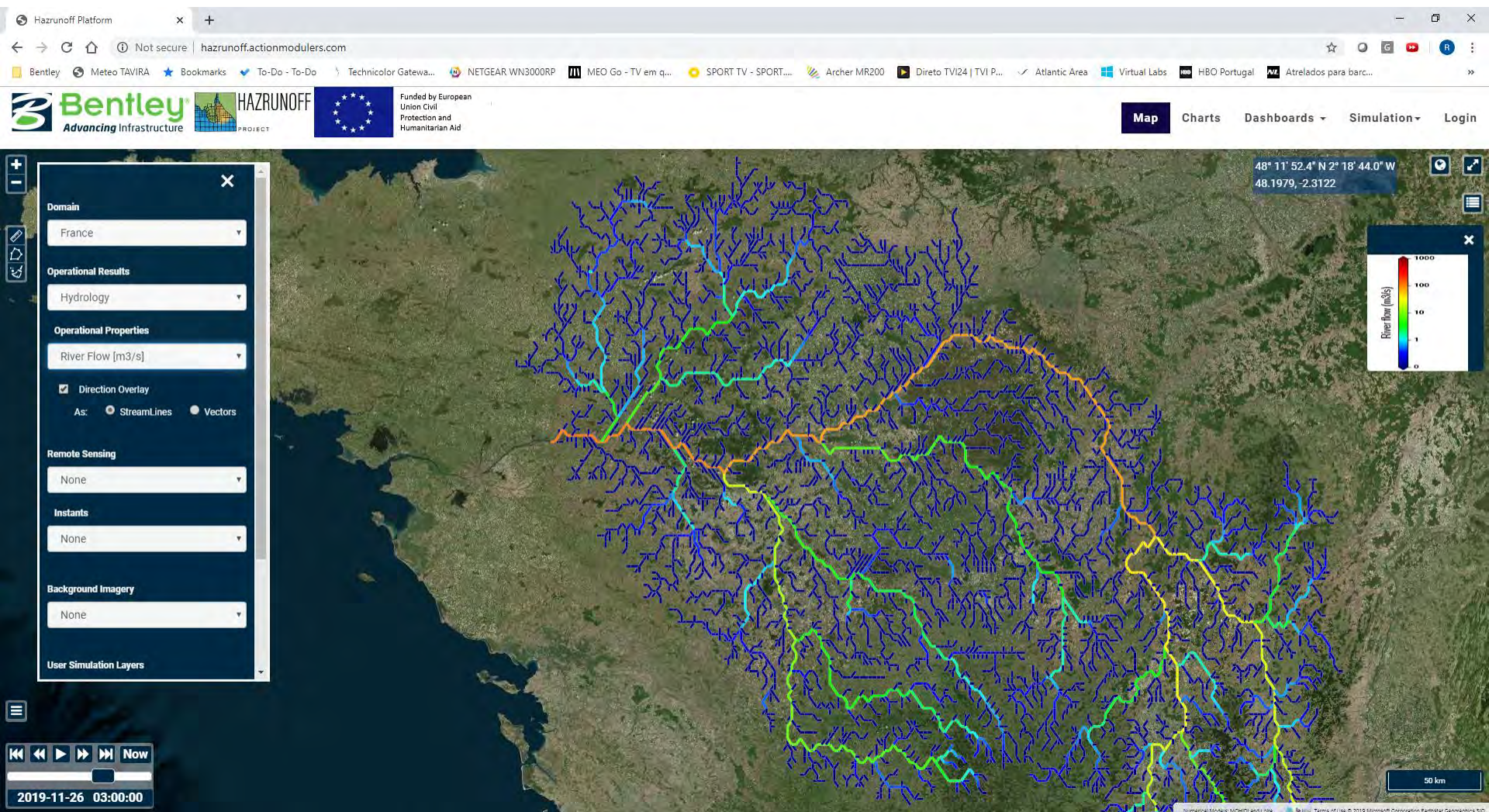


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Hidrology



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Remote sensing

Hazrunoff Platform

Not secure | hazrunoff.actionmodulers.com

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Bentley Advancing Infrastructure | **HAZRUNOFF** PROJECT | Funded by European Union Civil Protection and Humanitarian Aid

Map | Charts | Dashboards | Simulation | Login

47° 18' 45.8" N 2° 36' 34.0" W
47.3127, -2.6095

5 km

2019-11-26 03:00:00

Domain: France

Operational Results: Ocean/Coastal Circulation

Operational Properties: None

Direction Overlay: ☐ As: ☒ StreamLines ☐ Vectors

Remote Sensing: None

Instants: None

Background Imagery: None

User Simulation Layers

- Turbidity
- Aerial Imagery
- Water coverage



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Remote Sensing – aerial photos

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Bentley Advancing Infrastructure | **HAZRUNOFF** PROJECT | Funded by European Union Civil Protection and Humanitarian Aid

Map | Charts | Dashboards | Simulation | Login

Domain
France

Operational Results
Ocean/Coastal Circulation

Operational Properties
None

☐ Direction Overlay
As: ☒ StreamLines ☐ Vectors

Remote Sensing
Aerial

Instants
2019-11-18 11:18

Background Imagery
None

User Simulation Layers

2019-11-18 11:18:00

2km

Remote sensing data from EO1AIP | Terms of Use | © 2019 Microsoft Corporation. Earthstar Geographics SIO.

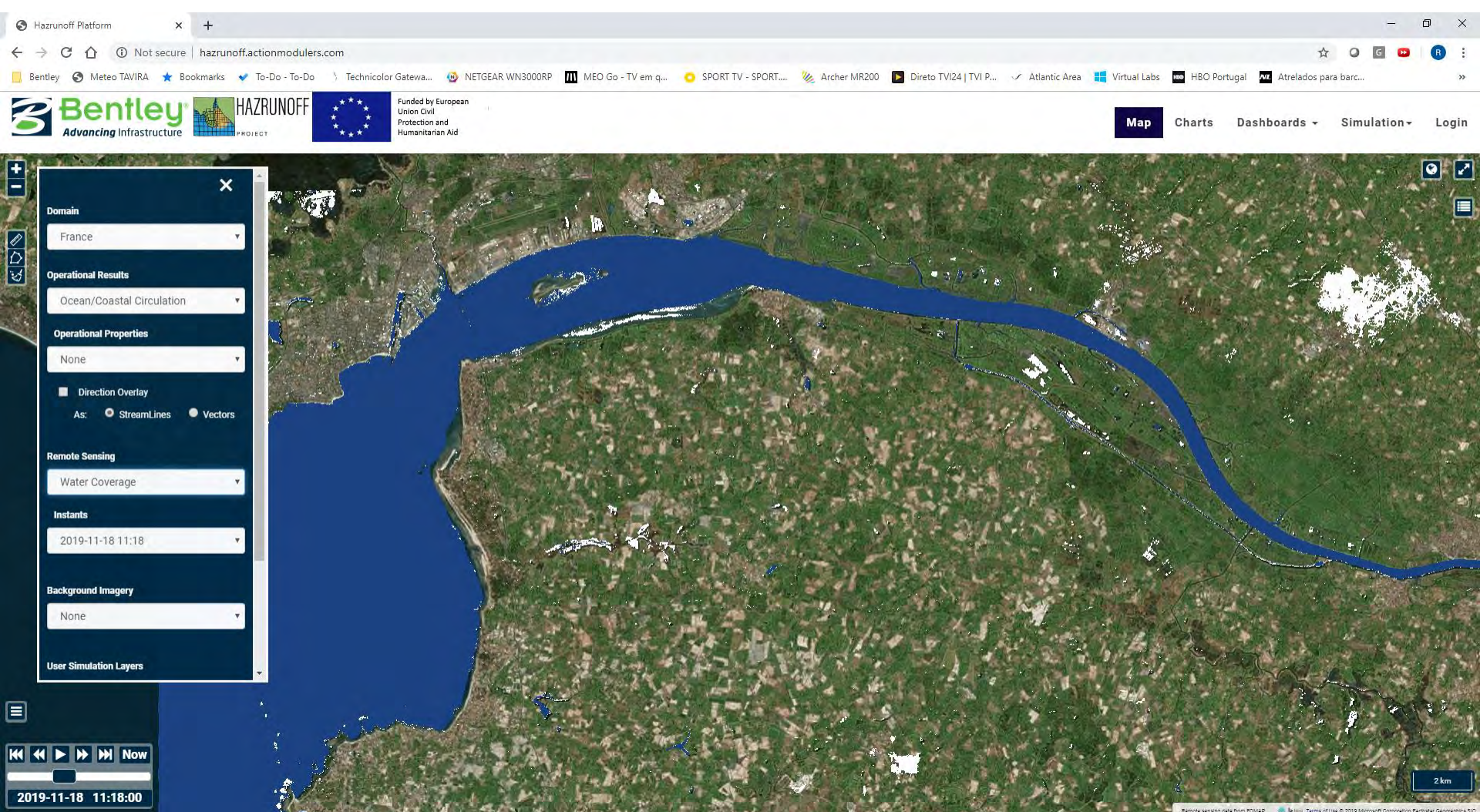


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Remote Sensing – water coverage

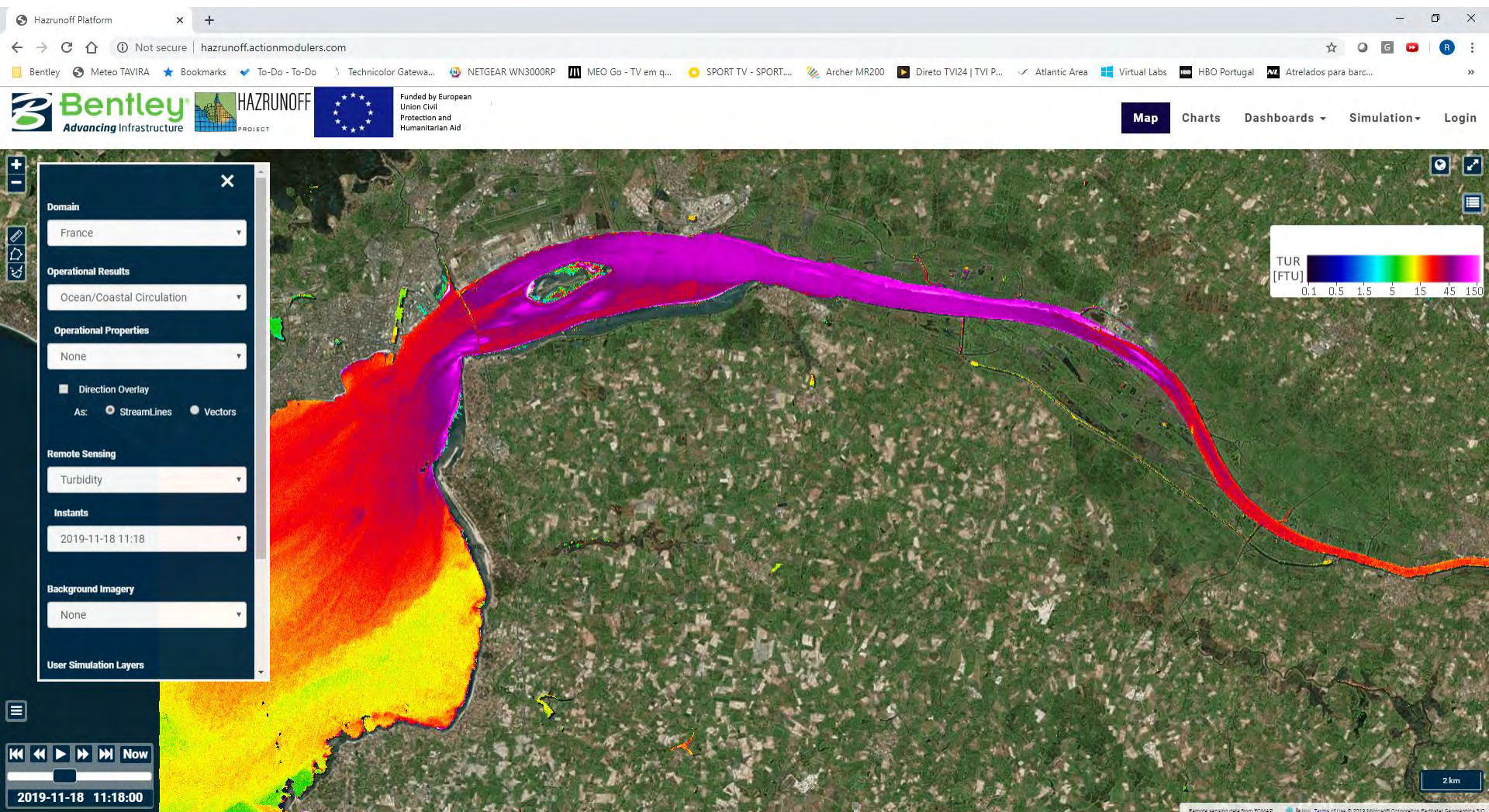


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Remote Sensing – turbidity

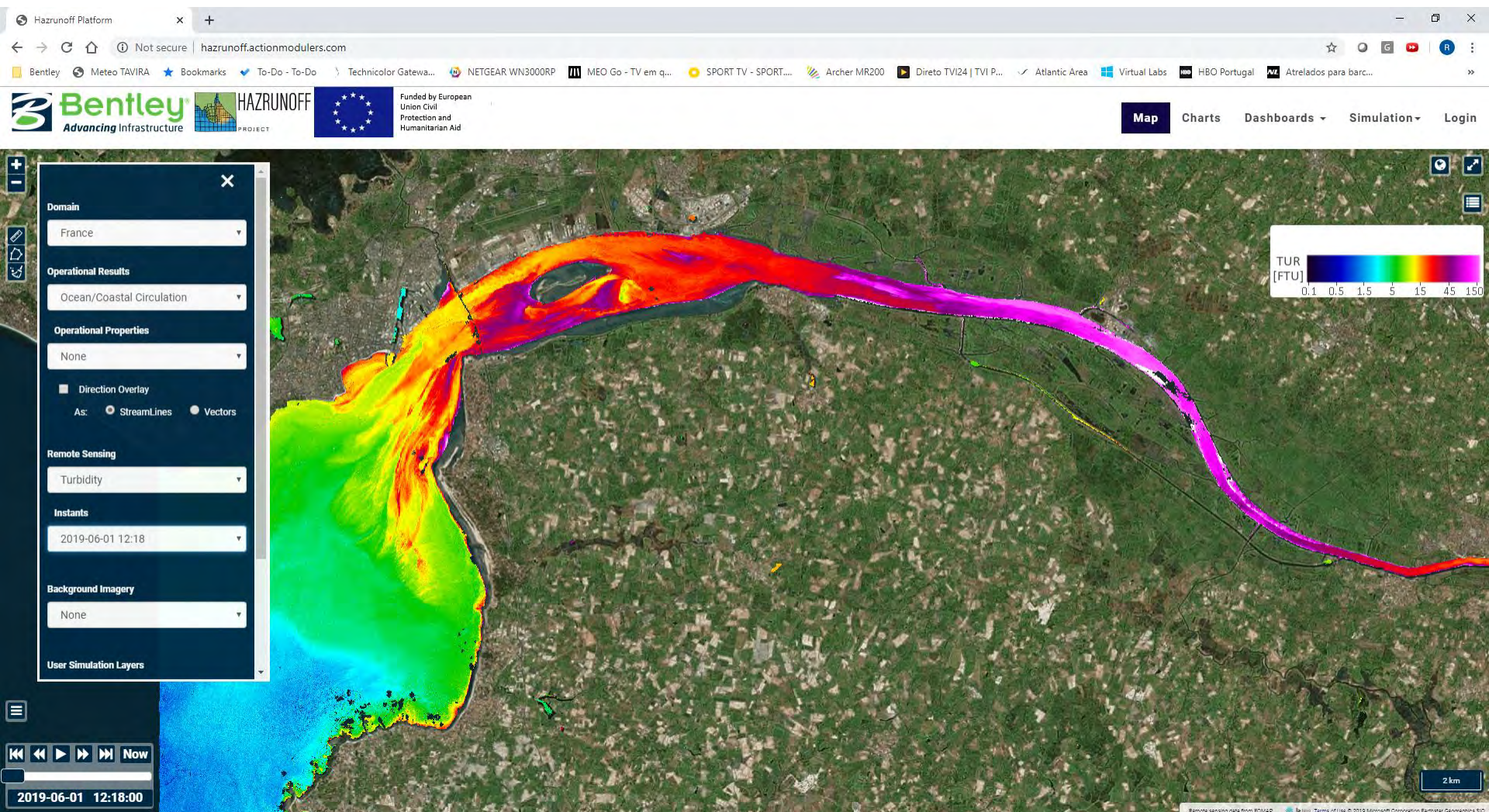


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Remote Sensing – turbidity

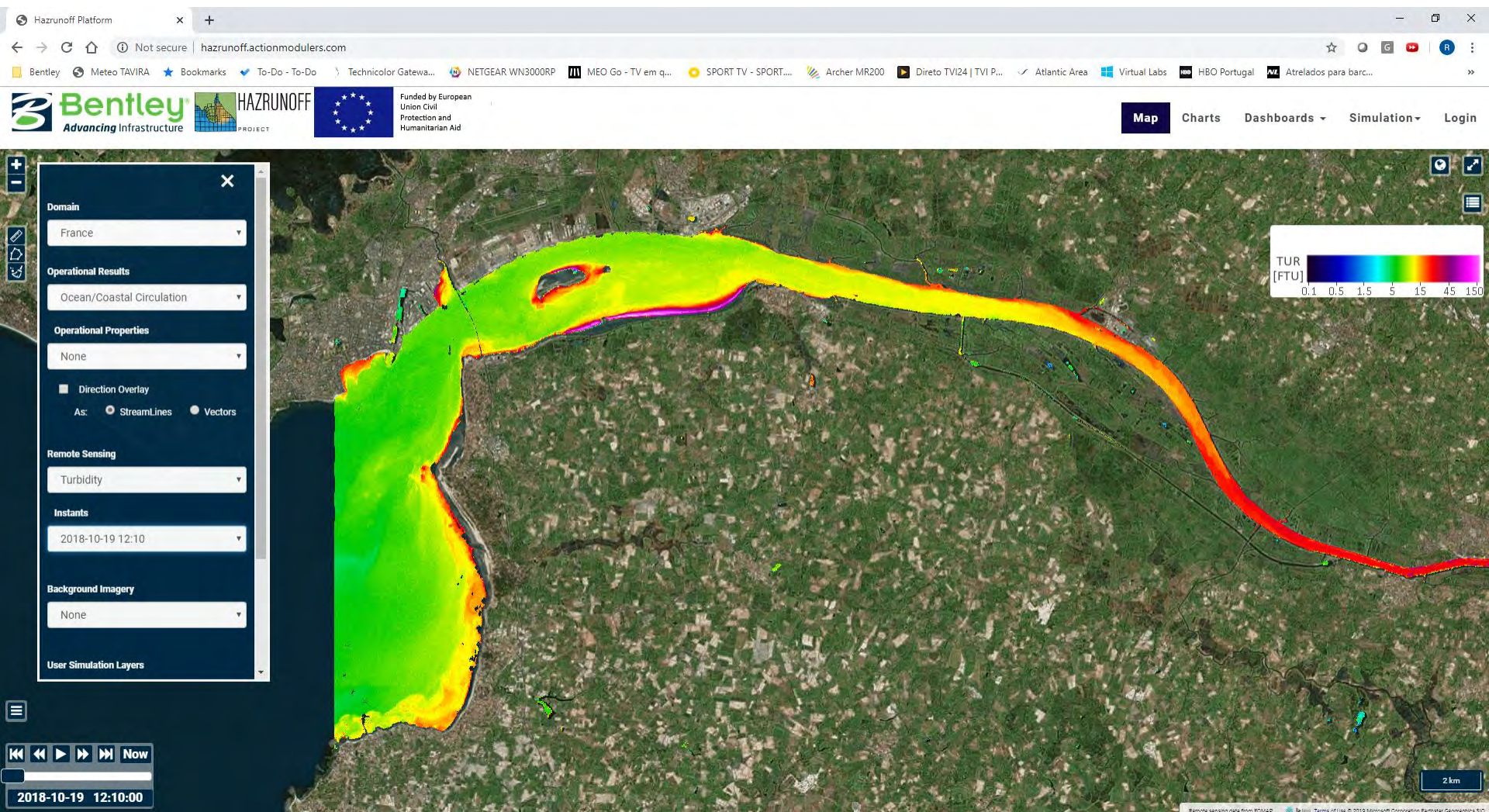


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Remote Sensing – turbidity



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UAV / drone imagery

Hazrunoff Platform

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Bentley Advancing Infrastructure HAZRUNOFF PROJECT

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Map Charts Dashboards Simulation Login

Domain: France

Operational Results: Ocean/Coastal Circulation

Operational Properties: None

Direction Overlay: ☐ As: ☒ StreamLines ☐ Vectors

Remote Sensing: None

Instants: None

Background Imagery: None

User Simulation Layers

47° 18' 45.8" N 2° 36' 34.0" W
47.3127, -2.6095

5 km

2019-11-26 03:00:00

- Latest drone-based images uploaded to FTP



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UAV / drone imagery

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Bentley Advancing Infrastructure | **HAZRUNOFF** PROJECT | Funded by European Union Civil Protection and Humanitarian Aid

Map | Charts | Dashboards | Simulation | Login

48° 34' 26.6" N 4° 40' 23.4" W
48.5741, -4.6732

Domain: France

Operational Results: Ocean/Coastal Circulation

Operational Properties: None

Direction Overlay: ☐ As: ☒ StreamLines ☐ Vectors

Remote Sensing: None

Instants: None

Background Imagery: Latest Image - 2

User Simulation Layers

2019-11-27 00:00:00

100 m

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UAV / drone imagery

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Bentley Advancing Infrastructure | **HAZRUNOFF** PROJECT | Funded by European Union Civil Protection and Humanitarian Aid

Map | Charts | Dashboards | Simulation | Login

Domain
France

Operational Results
Ocean/Coastal Circulation

Operational Properties
None

☐ Direction Overlay
As: ☒ StreamLines ☐ Vectors

Remote Sensing
None

Instants
None

Background Imagery
Latest Image - 2

User Simulation Layers

2019-11-27 00:00:00

5m

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UAV / drone imagery

Hazrunoff Platform

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Bentley | Meteo TAVIRA | Bookmarks | To-Do - To-Do | Technicolor Gatewa... | NETGEAR WN3000RP | MEO Go - TV em q... | SPORT TV - SPORT... | Archer MR200 | Direto TVI24 | TVI P... | Atlantic Area | Virtual Labs | HBO Portugal | Atrélados para barc...

Bentley Advancing Infrastructure | **HAZRUNOFF** PROJECT | Funded by European Union Civil Protection and Humanitarian Aid

Map | Charts | Dashboards | Simulation | Login

Domain
Spain

Operational Results
Hydrology

Operational Properties
None

☐ Direction Overlay
As: ☒ StreamLines ☐ Vectors

Remote Sensing
None

Instants
None

Background Imagery
Latest Image - 2

User Simulation Layers

20 km

2019-11-27 00:00:00

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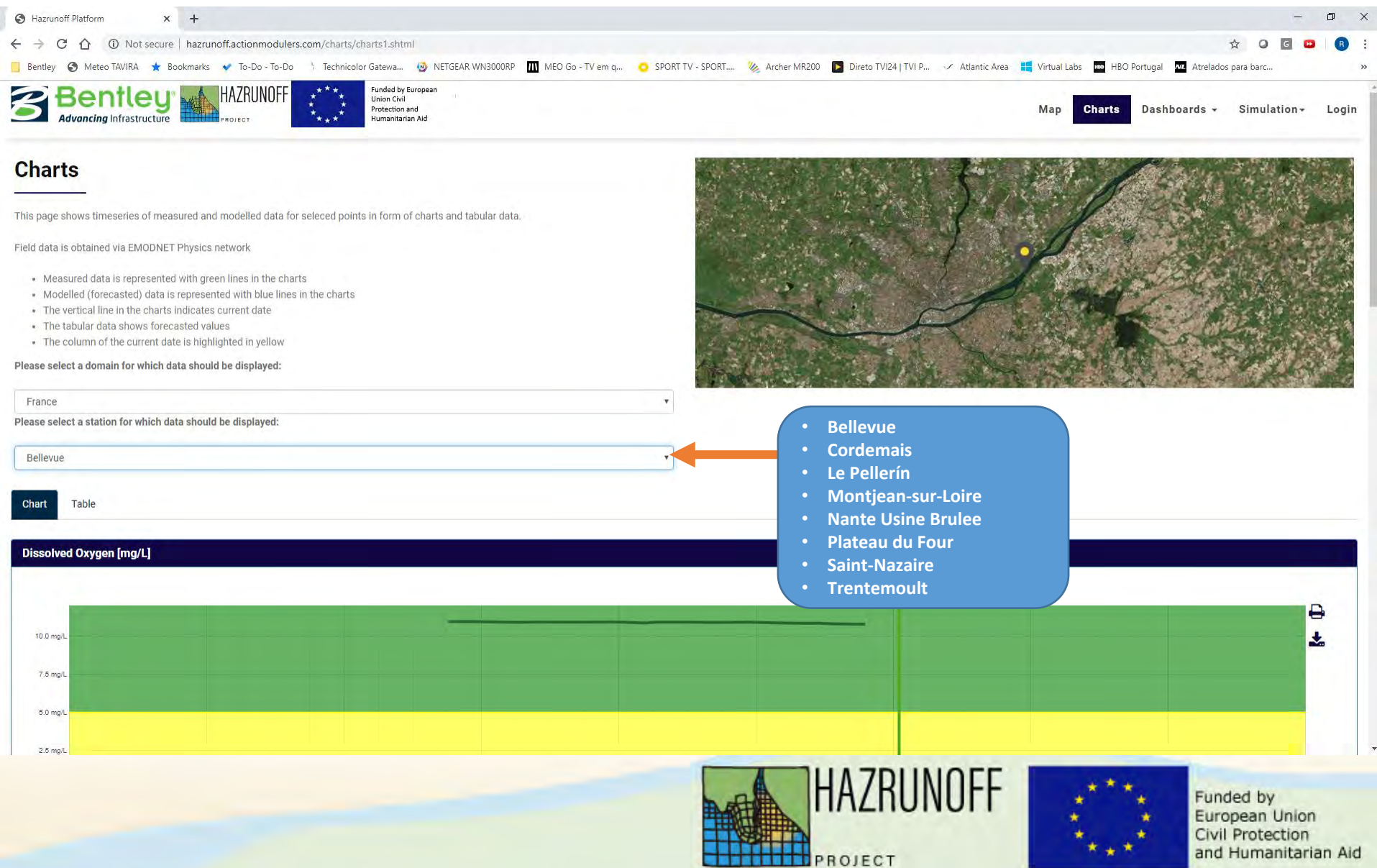


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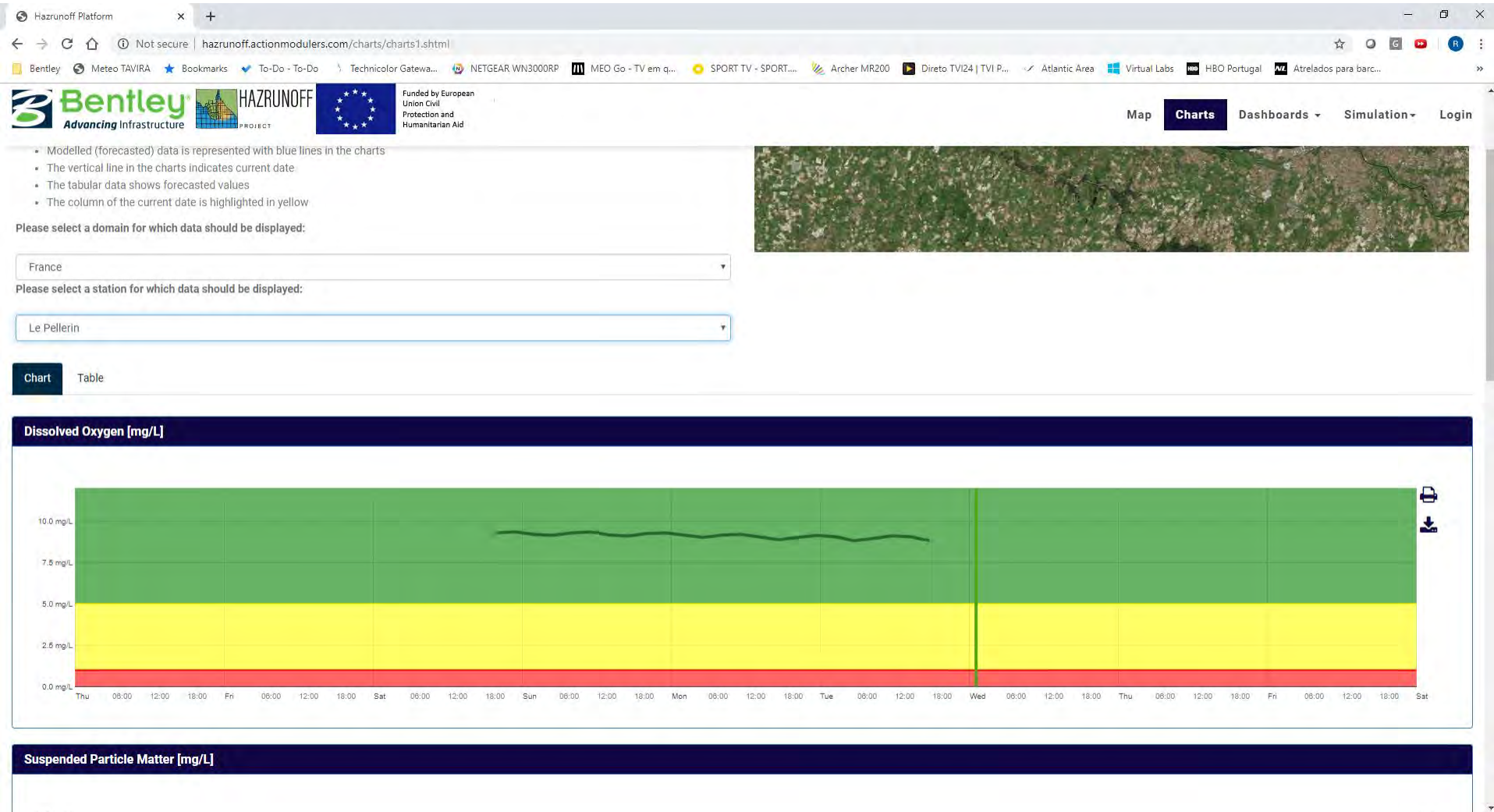


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Charts from stations



Charts from stations

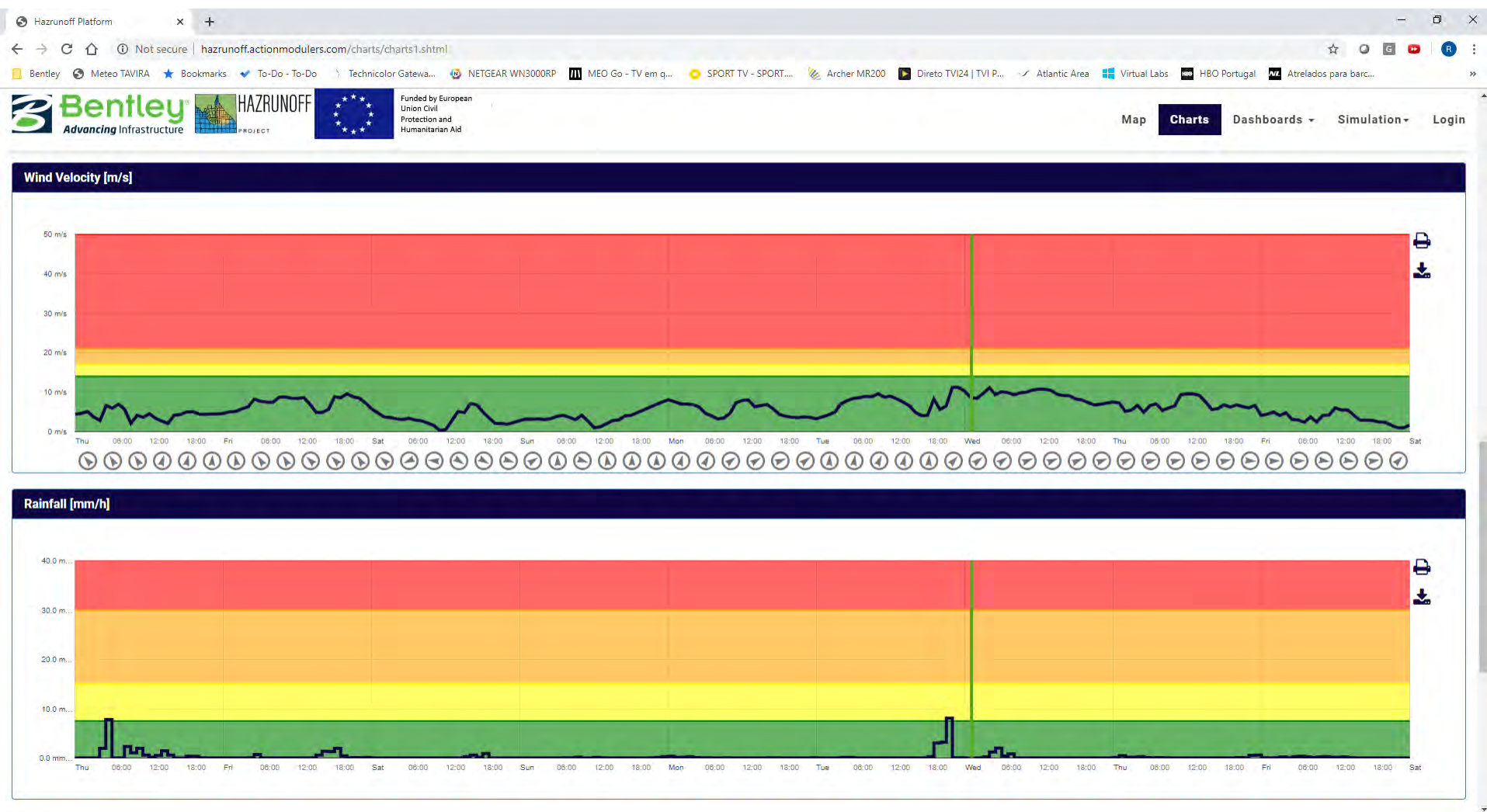


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Charts from stations



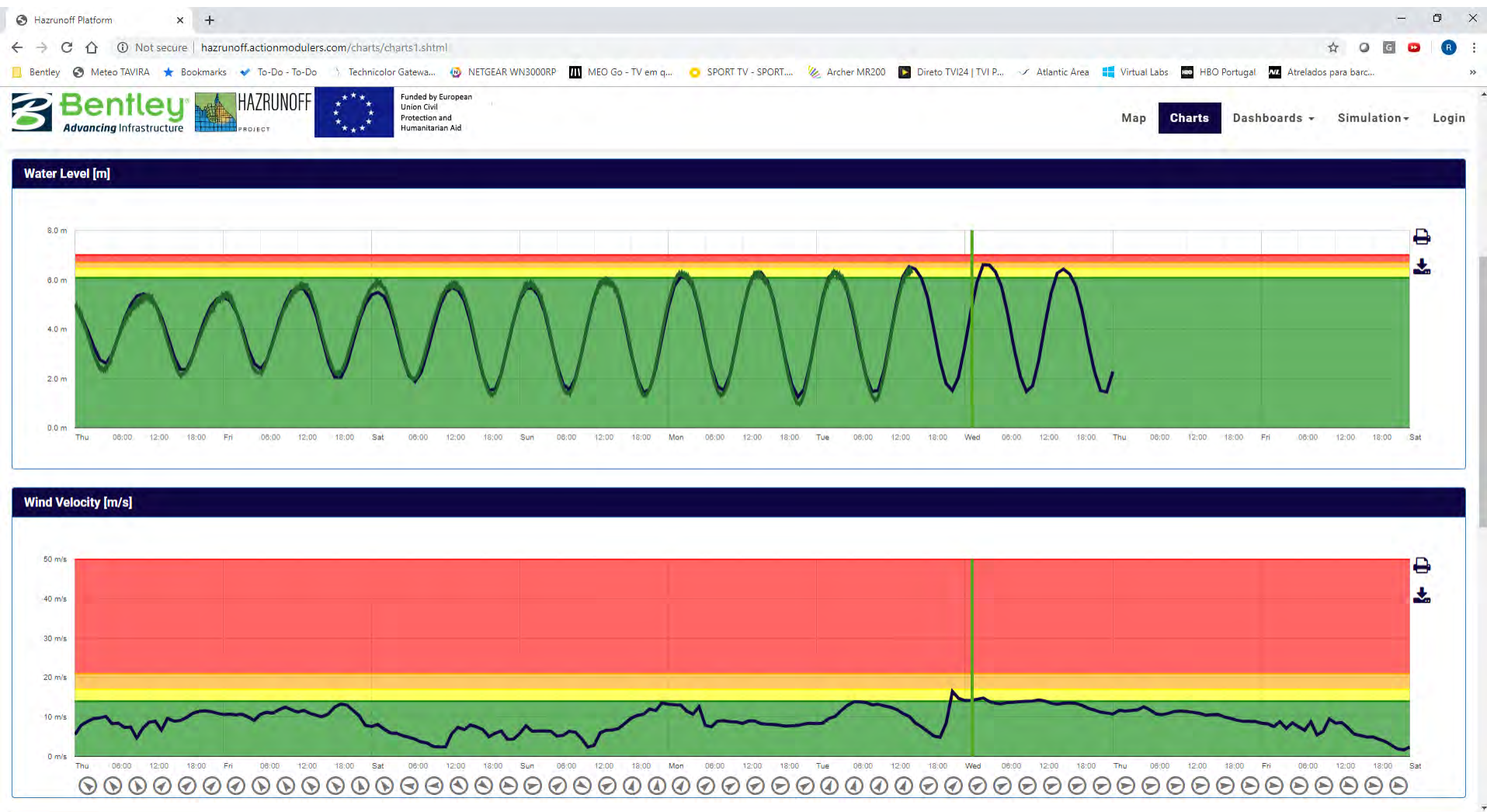
Charts from stations



Charts from stations



Charts from stations

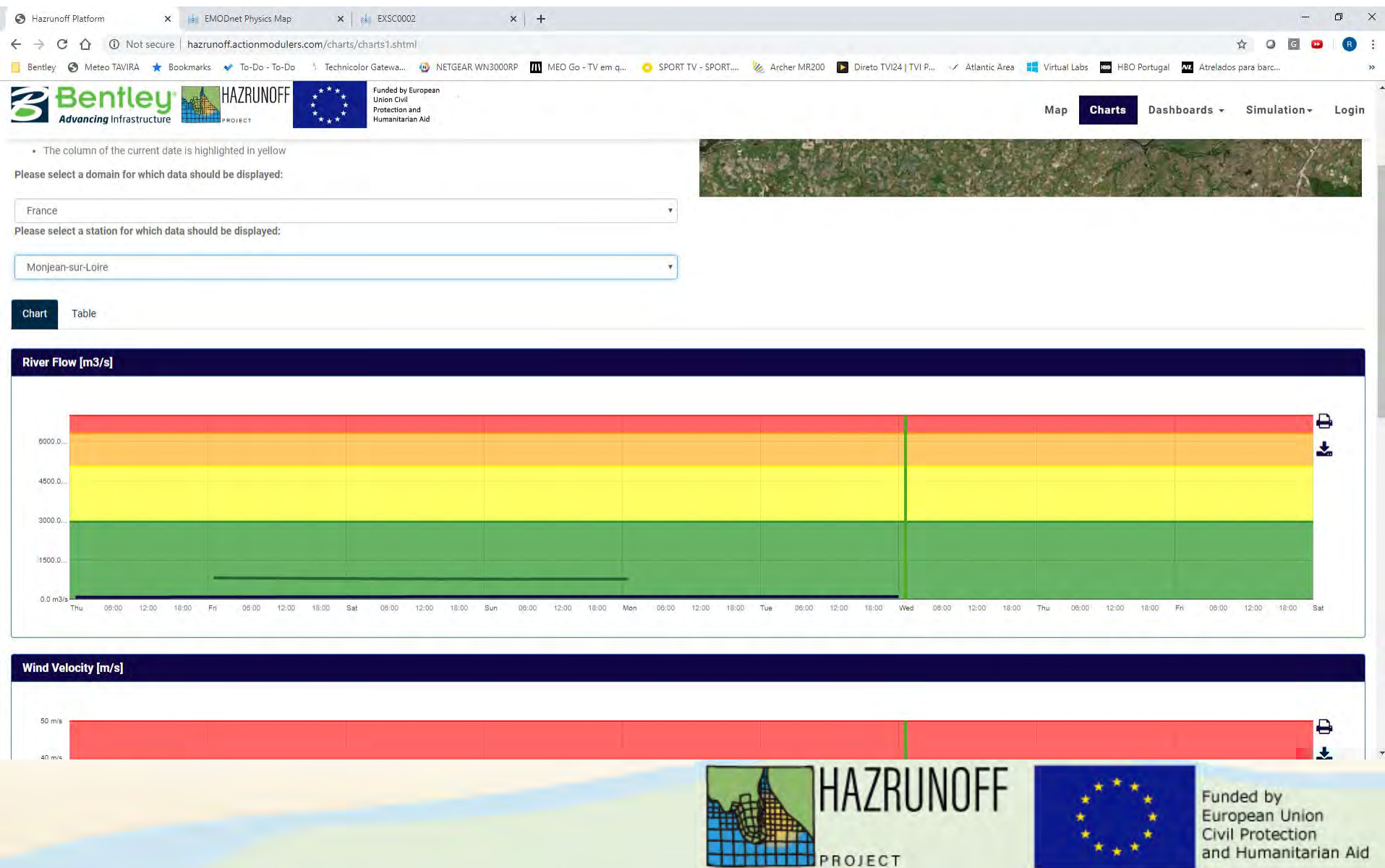


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Charts from stations



Dashboards

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Map | Charts | **Dashboards** | Simulation | Login

Domain: France

Operational Results: Ocean/Coastal Circulation

Operational Properties: None

Direction Overlay: ☐ As: ☒ StreamLines ☐ Vectors

Remote Sensing: None

Instants: None

Background Imagery: None

User Simulation Layers

2019-11-26 03:00:00

5 km

45° 18' 45.8" N 2° 36' 34.0" W
-3127, -2.6095

- Coastal / nearshore
- Inland | Water quality
- Inland | Water quantity

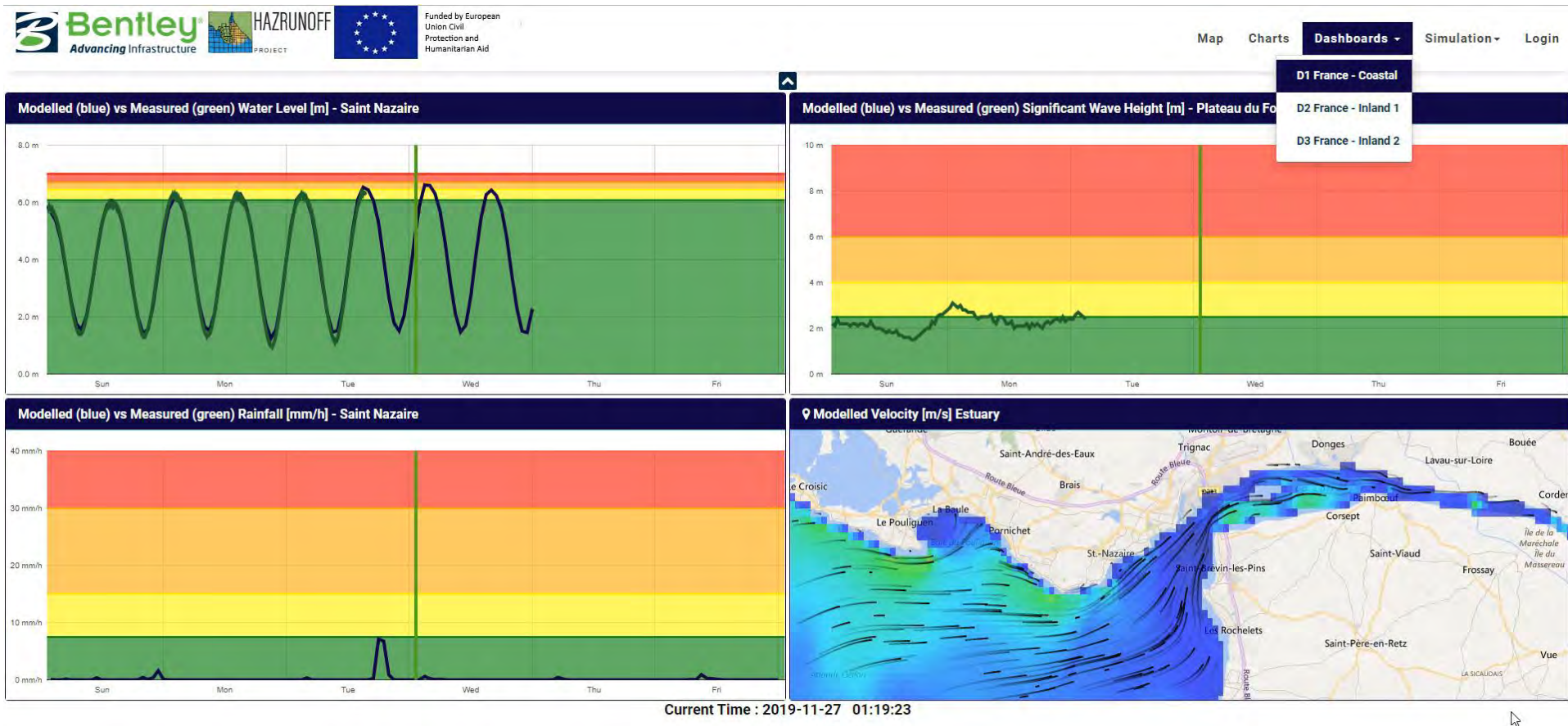


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Dashboard – nearshore data

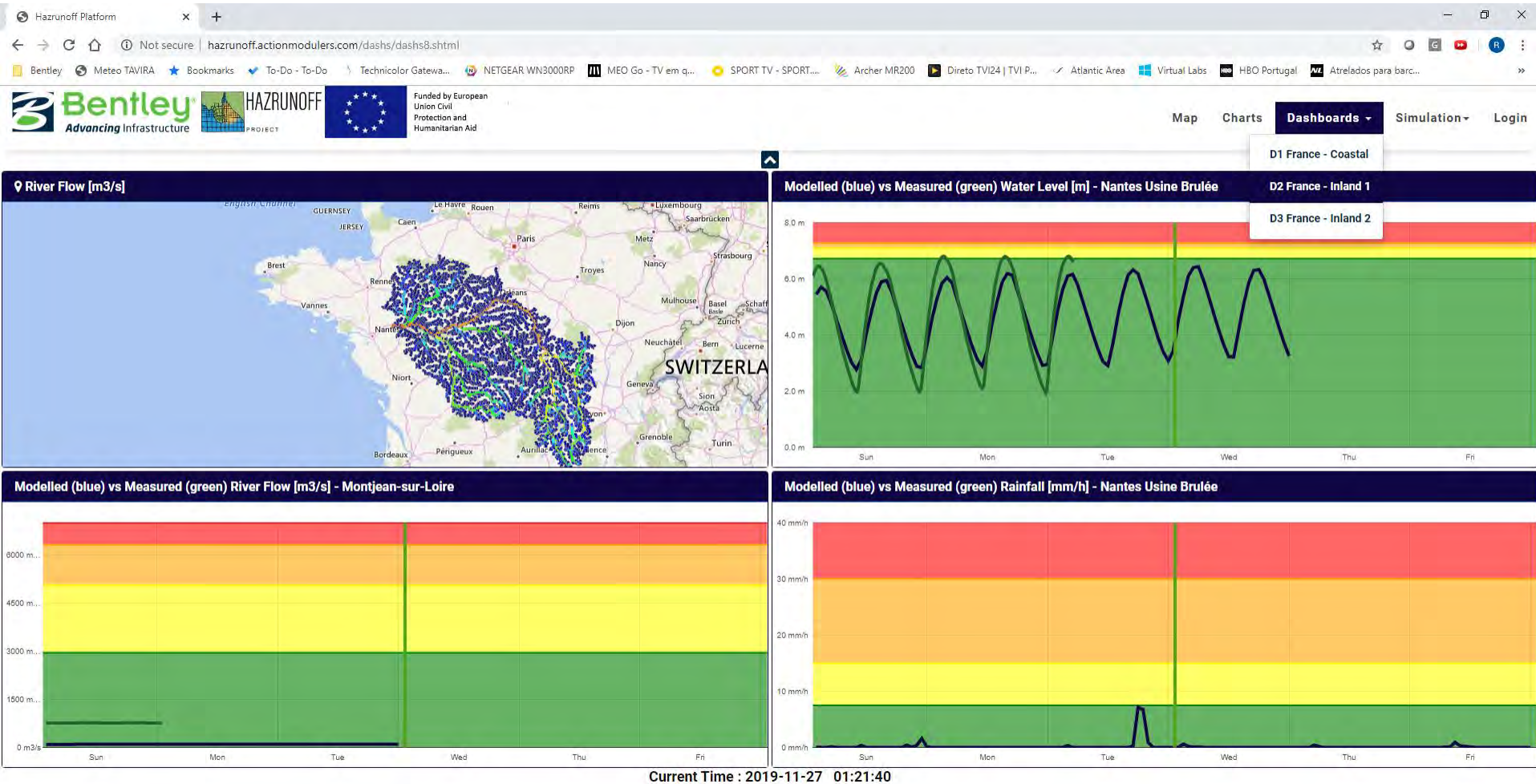


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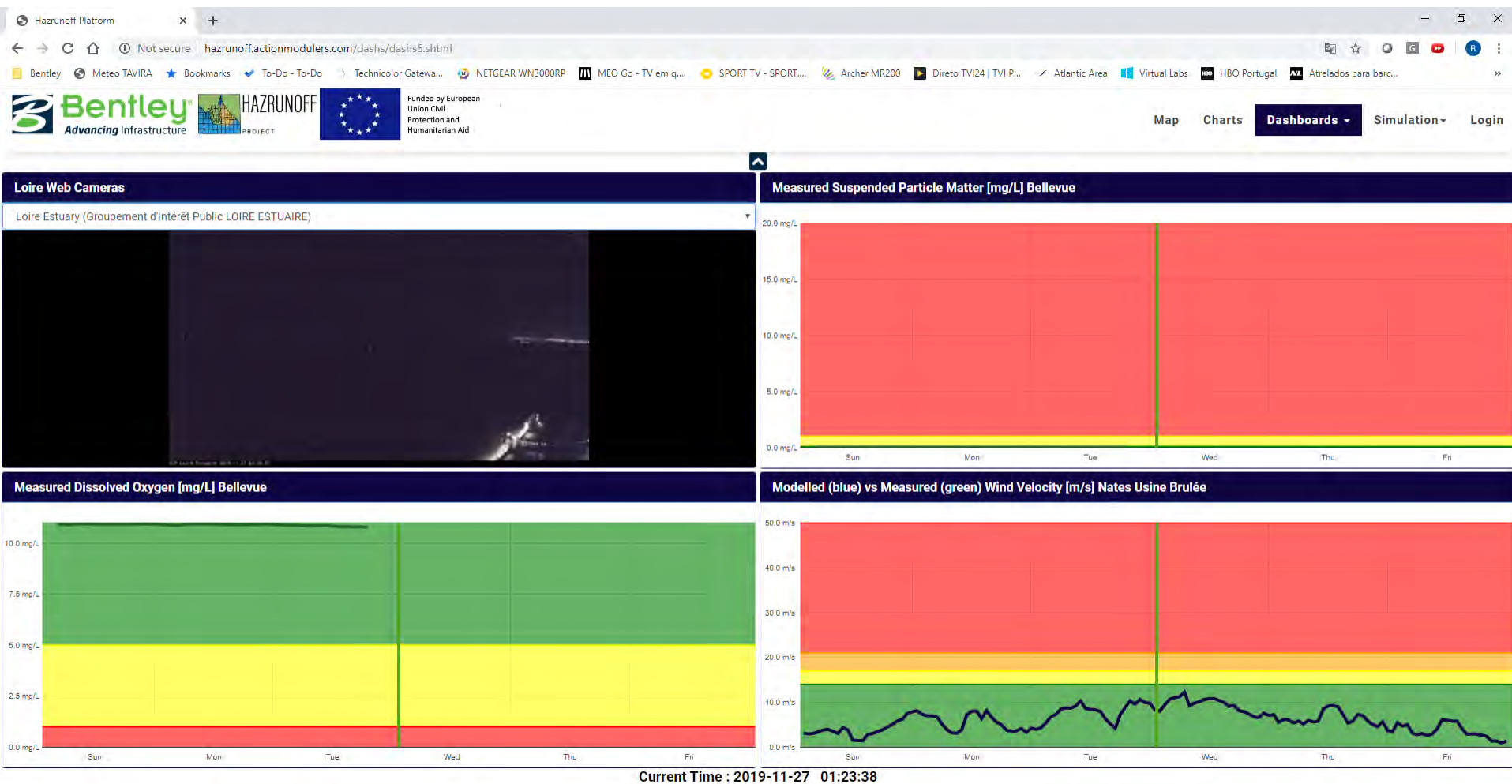


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Dashboard – inland data 1



Dashboard – inland data 2



Spill simulations

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Map | Charts | Dashboards | **Simulation** | Login

Domain: France

Operational Results: Ocean/Coastal Circulation

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Instants: None

Background Imagery: None

User Simulation Layers

47° 18' 45.8" N 2° 36' 34.0" W
47.3127, -2.6095

5 km

2019-11-26 03:00:00

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Map | Charts | Dashboards | Simulation | hazrunoff

1. What? | 2. Where? | 3. When? | 4. Run

Incident Name

2019-11-27 01:31:34 Sim Name

Substance Type

Oil Spill

Oil Spill Options

☒ Oil Classes ☐ NOAA ADIOS Oil Substances DB

Medium Oils (Most Crude Oils)




Previous Next

Spill simulations

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Map Charts Dashboards Simulation hazrunoff

1. What? 2. Where? 3. When? 4. Run

Incident Name

2019-11-27 01:31:34 Sim Name

Substance Type

Oil Spill

Oil Spill Options

☐ Oil Classes ☒ NOAA ADIOS Oil Substances DB

Search:

Name	Density	Viscosity	Pour Point [°C]	Interfacial Tension [dyne/cm]	Resin Content [%]	Wax Content [%]	Saturate Content [%]	Maximum Water Content [%]	Ashphaltene Content [%]	Emulsification Cte.	Is Crude
<input type="checkbox"/> ABOOZAR	26.9 API	0.000037 cSt	-34	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABOOZAR, OIL & GAS	26.9 API	0.00003658 cSt	-34	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABQAIQ	37 API	0.000004293 cSt	-15	-999	0.12	0	0.11	-999	0.05	-999	true
<input type="checkbox"/> ABU AL BU KHOOSH	31.6 API	0.000007 cSt	-12	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABU AL BU KHOOSH, OIL & GAS	31.6 API	0.0000067 cSt	-12	-999	-999	0	-999	-999	-999	-999	true

Showing 1 to 5 of 1,350 entries

Previous 1 2 3 4 5 ... 270 Next



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1. What? 2. Where? 3. When? 4. Run

Incident Name

2019-11-27 01:31:34 Sim Name

Substance Type

Oil Spill

Oil Spill Options

☐ Oil Classes ☒ NOAA ADIOS Oil Substances DB

Search:

Name	Density	Viscosity	Pour Point [°C]	Interfacial Tension [dyne/cm]	Resin Content [%]	Wax Content [%]	Saturate Content [%]	Maximum Water Content [%]	Ashphaltene Content [%]	Emulsification Cte.	Is Crude
<input type="checkbox"/> ABOOZAR	26.9 API	0.000037 cSt	-34	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABOOZAR, OIL & GAS	26.9 API	0.00003658 cSt	-34	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABQAIQ	37 API	0.000004293 cSt	-15	-999	0.12	0	0.11	-999	0.05	-999	true
<input type="checkbox"/> ABU AL BU KHOOSH	31.6 API	0.000007 cSt	-12	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABU AL BU KHOOSH, OIL & GAS	31.6 API	0.0000067 cSt	-12	-999	-999	0	-999	-999	-999	-999	true

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1. What? | 2. Where? | 3. When? | 4. Run

Incident Name
2019-11-27 01:31:34 Sim Name

Substance Type
HNS Spill

Chemical Spill Options
HNS Classes | HNS Online DB's

Search:

Name	Behaviour	CAS	Density [kg/L]	Viscosity [mPa.s]	Solubility [mg/L]	Vapour Pressure [kPa]	Molecular Weight [g/mol]	Log Kow	Source
<input type="checkbox"/> 1,2,3-Trichlorobenzene	Sinker (S)	87-61-6	1453.3	1.69 at 50°C	18 at 25°C	28 at 25°C	181.46	4.05	HNS-MS + MARPOCS
<input type="checkbox"/> 1,2,4-Trimethylbenzene	Floater that evaporates (FE)	95-63-6	880	0.74 at 20°C	60 at 20°C	133.32 at 20°C	120.19	3.78	HNS-MS + MARPOCS
<input type="checkbox"/> 1,2-Propylene Glycol	Dissolves (D)	57-55-6	1040	56.21 at 20°C	1040000 at 20°C	10.67 at 20°C	76.09	-0.92	HNS-MS + MARPOCS
<input type="checkbox"/> 1,3-Cyclopentadiene Dimer	Floater (F)	77-73-6	930.2	0.73 at 21°C	20 at 25°C	1300 at 37.7°C	132.202	2.78	HNS-MS + MARPOCS
<input type="checkbox"/> 1-Butanol	Dissolves (D)	71-36-3	810	3.00 at 20°C	77000 at 20°C	626.5 at 20°C	74.12	0.88	HNS-MS + MARPOCS

Showing 1 to 5 of 74 entries

Previous 1 2 3 4 5 ... 15 Next

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Map

Charts

Dashboards

Simulation

hazrunoff

1. What?

2. Where?

3. When?

4. Run

Incident Name

2019-11-27 01:31:34 Sim Name

Substance Type

Oil Spill

Oil Spill Options

☐ Oil Classes ☒ NOAA ADIOS Oil Substances DB

Search: aboo

Name	Density	Viscosity	Pour Point [°C]	Interfacial Tension [dyne/cm]	Resin Content [%]	Wax Content [%]	Saturate Content [%]	Maximum Water Content [%]	Ashphaltene Content [%]	Emulsification Cte.	Is Crude
<input checked="" type="checkbox"/> ABOOZAR	26.9 API	0.000037 cSt	-34	-999	-999	0	-999	-999	-999	-999	true
<input type="checkbox"/> ABOOZAR, OIL & GAS	26.9 API	0.00003658 cSt	-34	-999	-999	0	-999	-999	-999	-999	true

Showing 1 to 2 of 2 entries (filtered from 1,350 total entries) 1 row selected


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1


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Map Charts Dashboards Simulation hazrunoff

1. What? 2. Where? 3. When? 4. Run

Domain

France

Pick Incident Locations Interactively

Location In DMS

Longitude	2	12	35	W
Latitude	47	12	35	N

47° 14' 40.2" N 2° 30' 36.3" W
47.2445, -2.5101

2 km


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Map | Charts | Dashboards | Simulation | hazrunoff

1. What? | 2. Where? | 3. When? | 4. Run

Incident Type

☐ Continuous ☒ Instantaneous

Incident Instant/Simulation Start

2019-11-27 00:00


Simulation End

2019-11-27 06:00

Volume (m3)

100

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Map Charts Dashboards Simulation hazrunoff

1. What?

2. Where?

3. When?

4. Run

Simulation Resume

Name : 2019-11-27 01:31:34 Sim Name

Substance : Oil Spill

Localization : -2,212 47,210

Emission Type : instantaneous


Start Date : 2019-11-27 00:00

End Date : 2019-11-27 06:00

Expected Run Duration : 3 minutes

Previous

Finish

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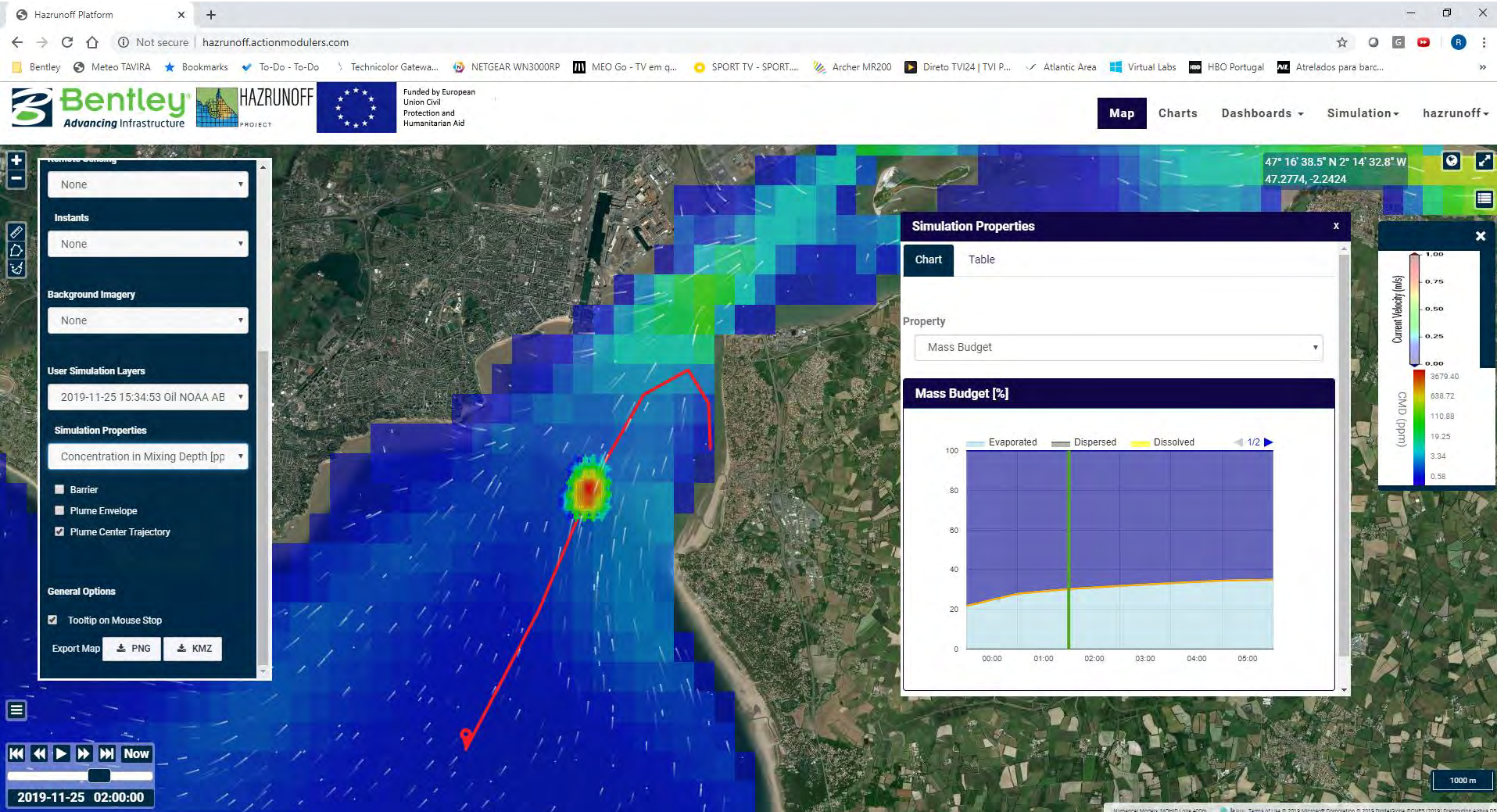


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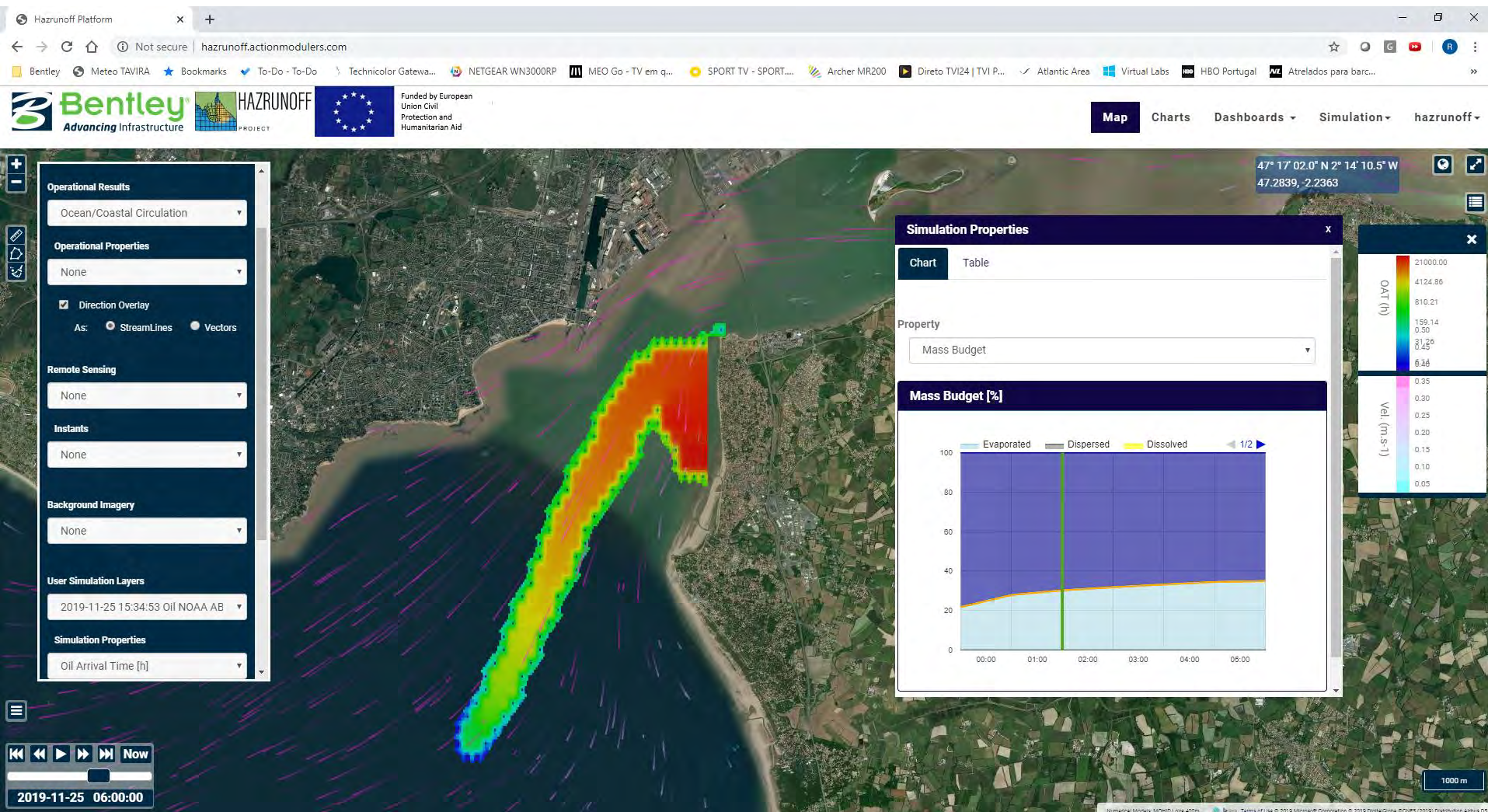


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Spill simulations - oil concentration in the surface



Spill simulations - oil arrival time



Take-home messages

- HazRunOff: Holistic perspective – fully integrated urban flood modeling:
 - only way for reliable simulation of complex and compound flood and contamination hazards
- HazRunOff: Everything is connected
 - Collaborative digital workflows
 - Connectivity
 - Interoperability between project teams, organizations, and different regions.





Thanks!

rodrigo.fernandes@bentley.com