

HAZRUNOFF

PROJECT

**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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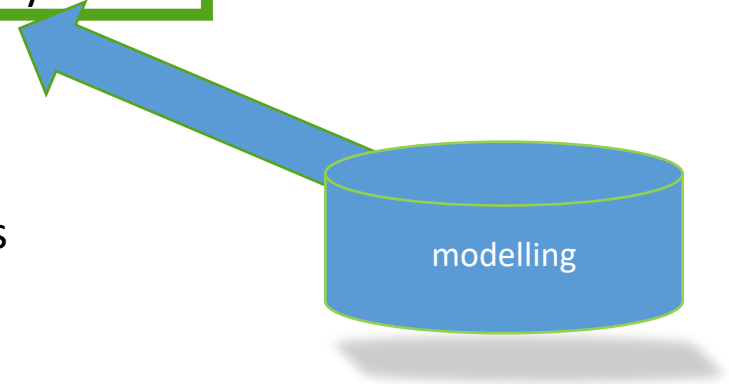


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Why?

- 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
- ...



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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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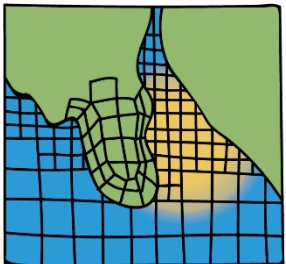


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Why?

- 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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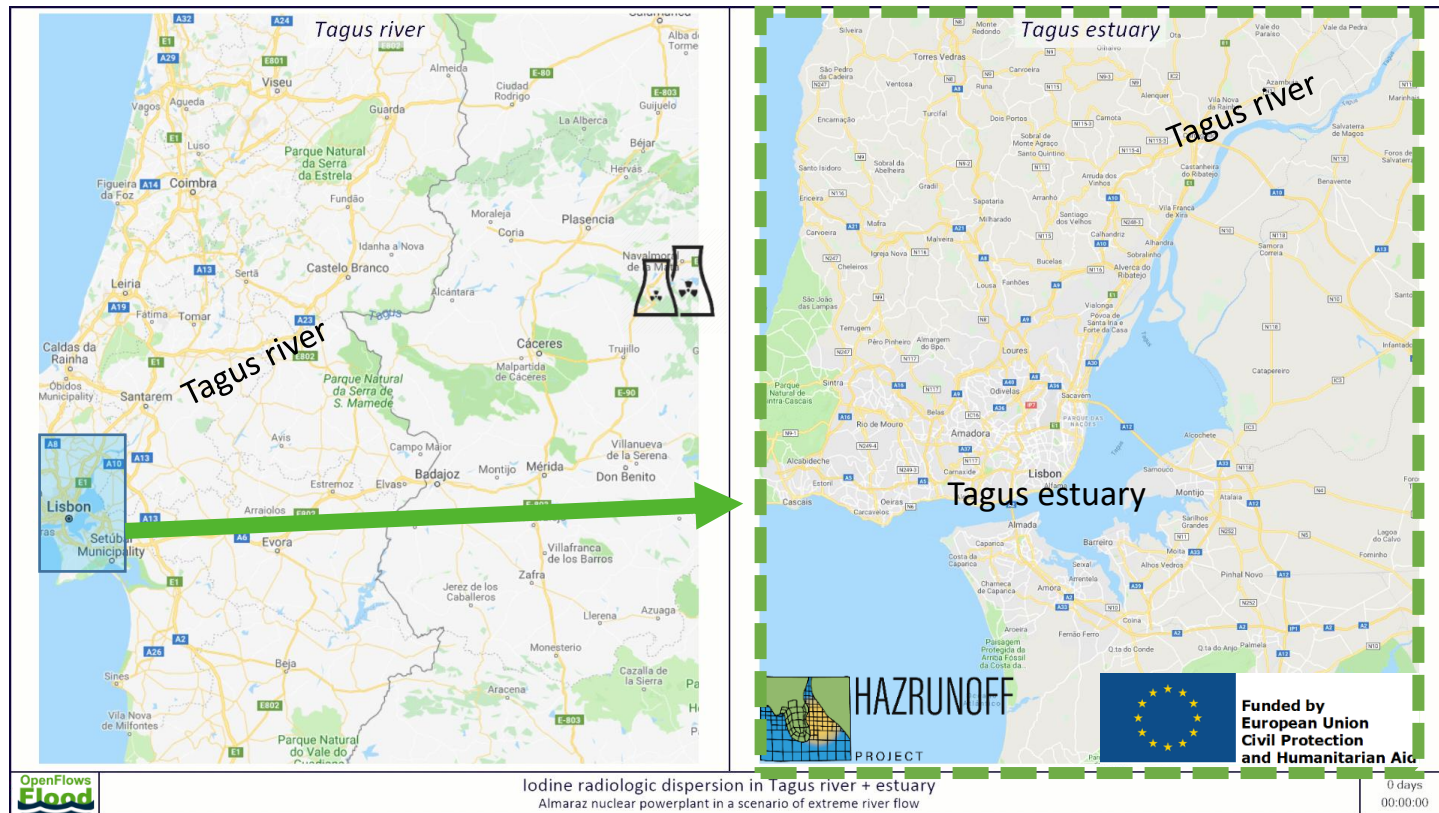


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Floods & Water pollution: mixing scales and processes



Floods & Water pollution: mixing scales and processes

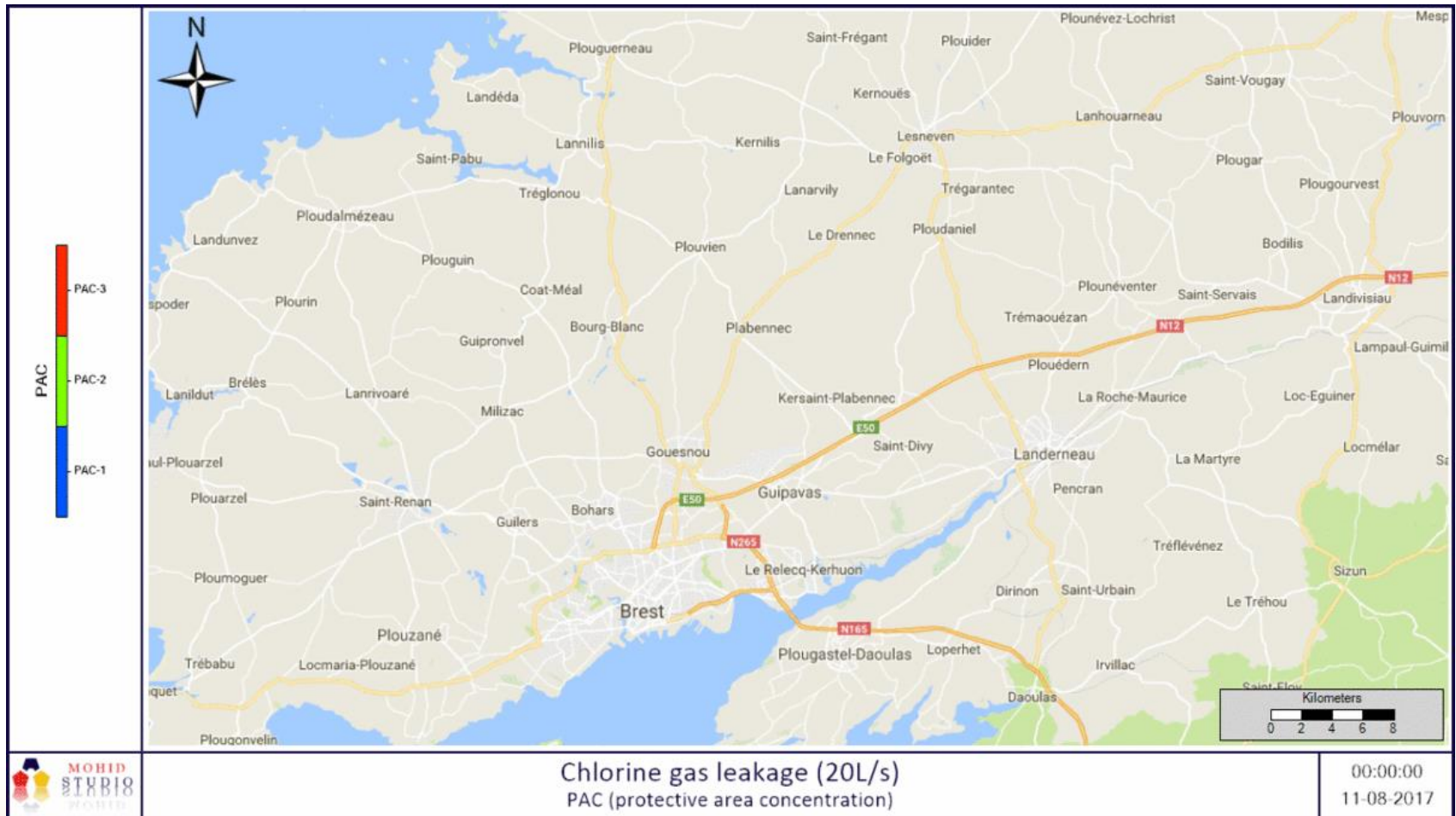


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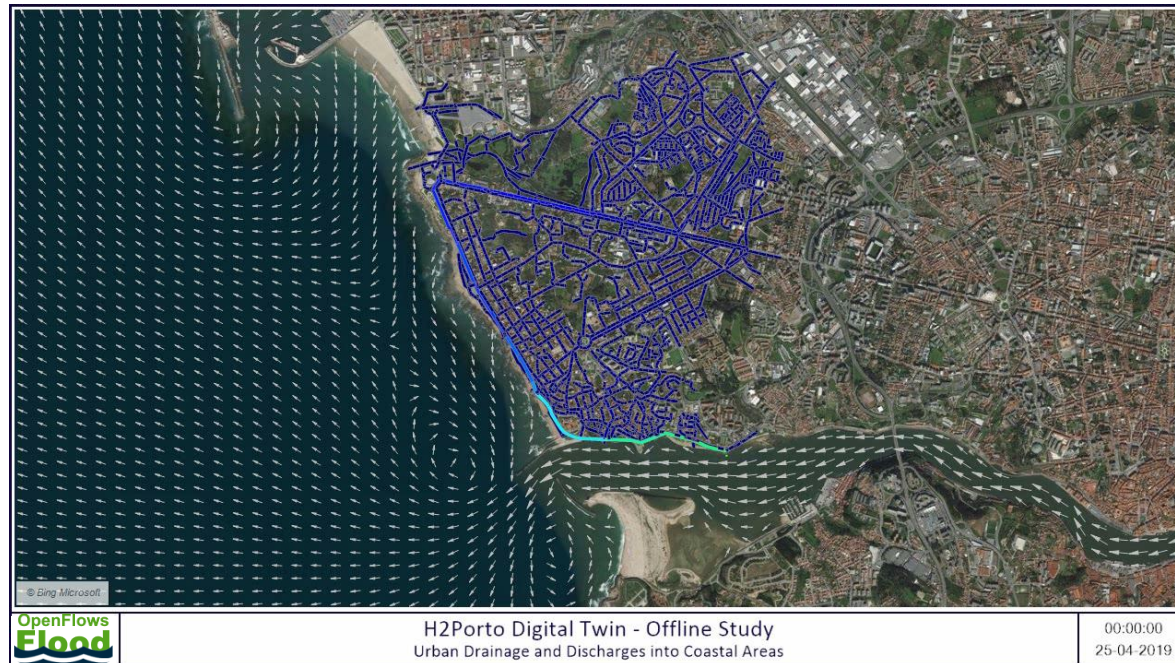
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Floods & Water pollution: mixing scales and processes



Floods & Water pollution: mixing scales and processes

- Urban drainage and fecal coliform concentration in coastal areas



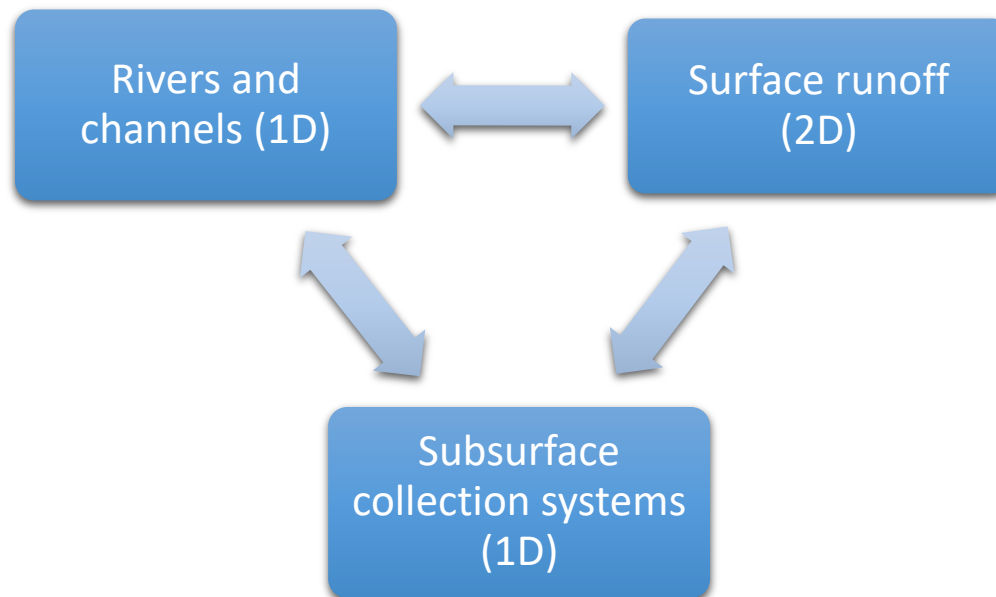
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Floods & Water pollution: mixing scales and processes

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

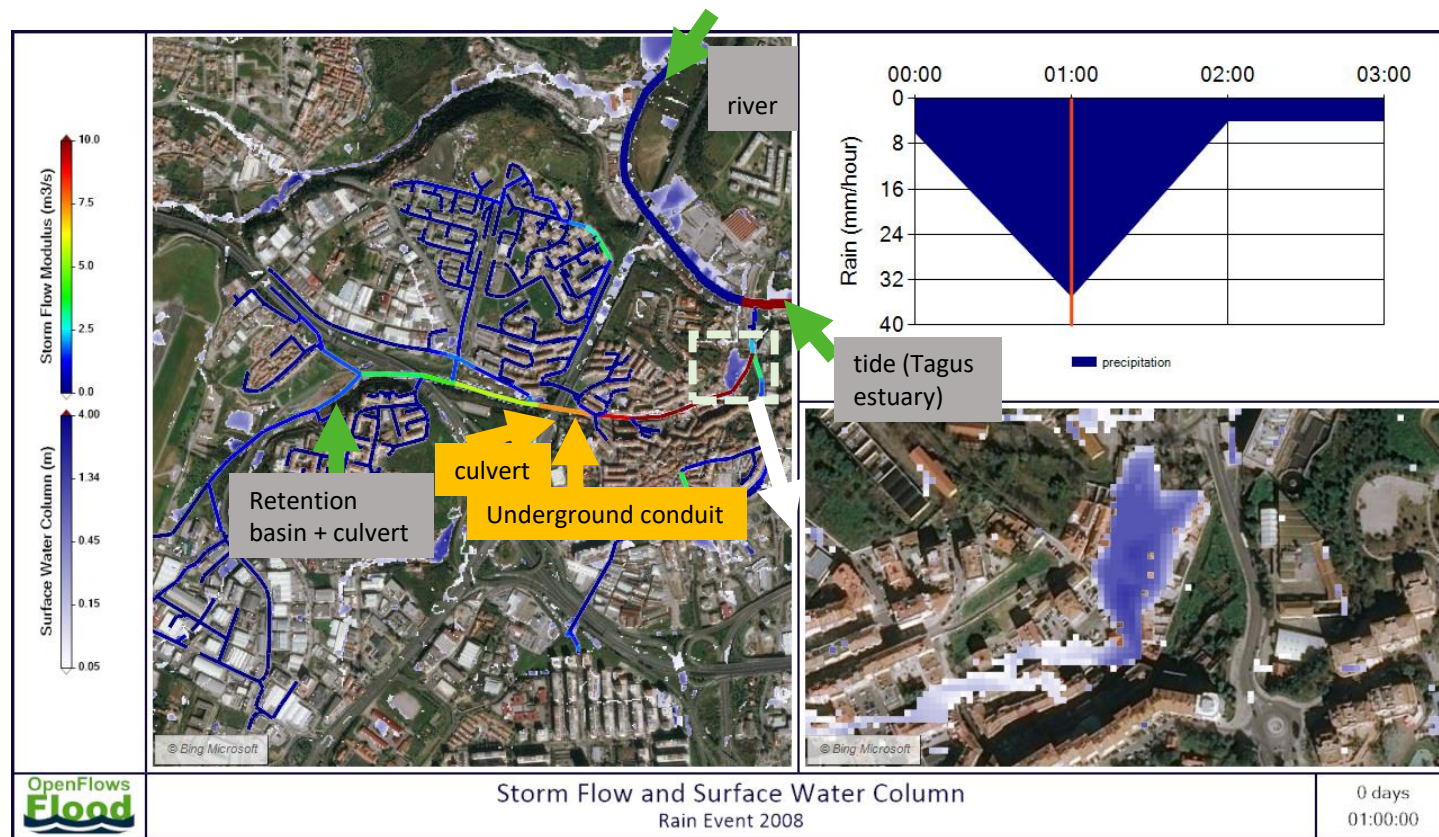


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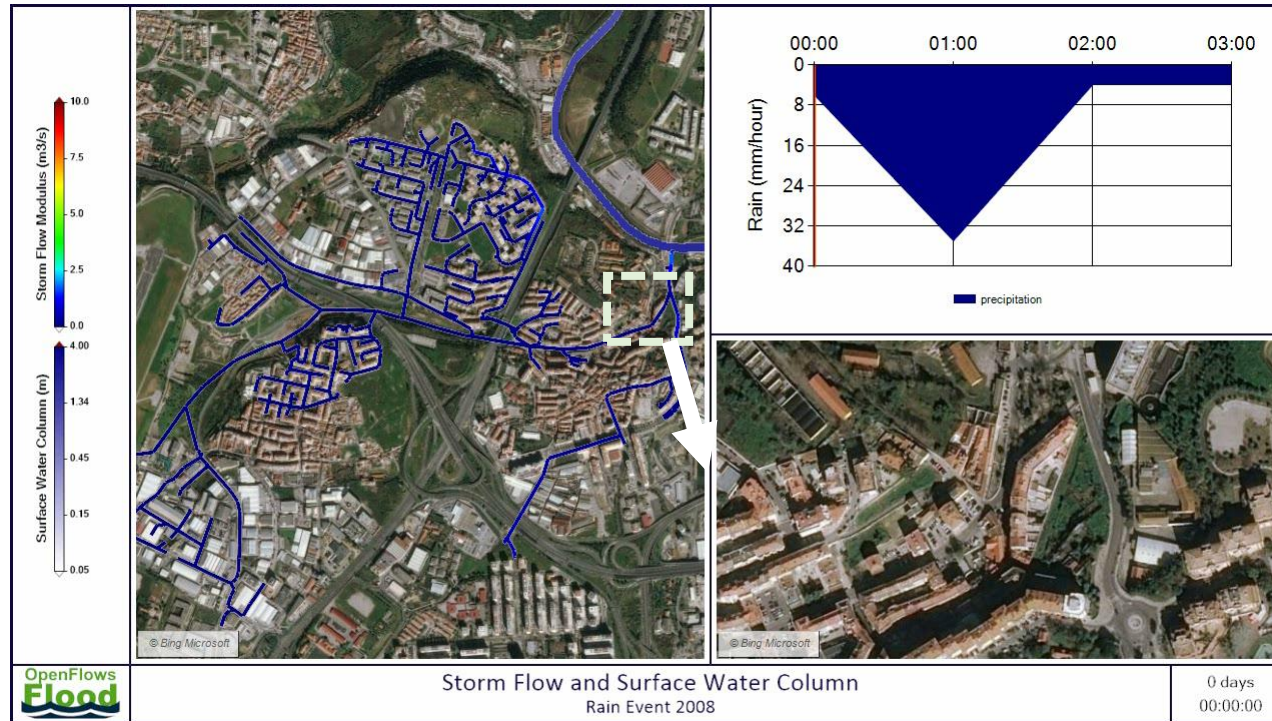


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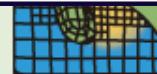
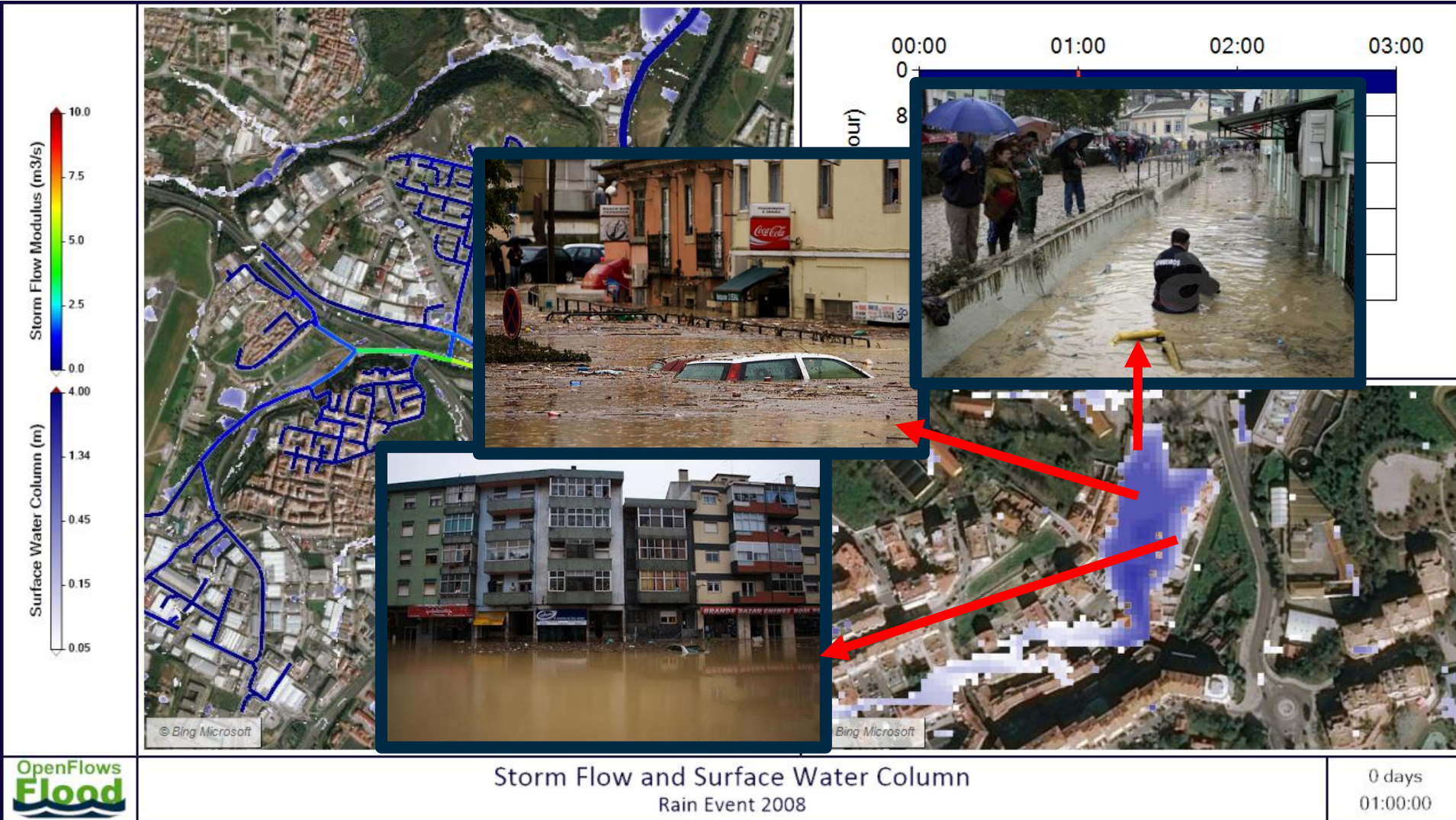
3-way coupled flood modelling (HazRunOff project)



3-way coupled flood modelling (HazRunOff project)



Integrated flood modelling – Sacavém (Lisbon)



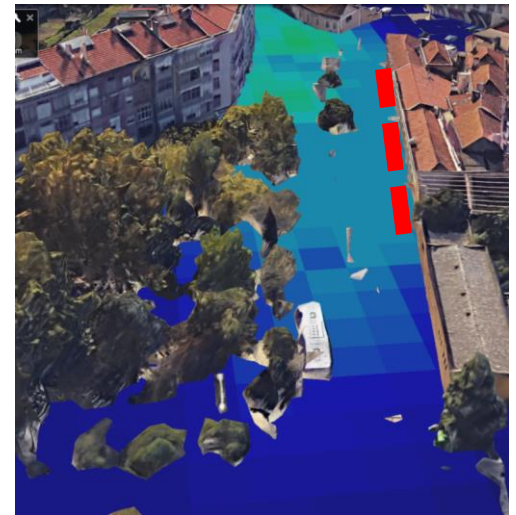
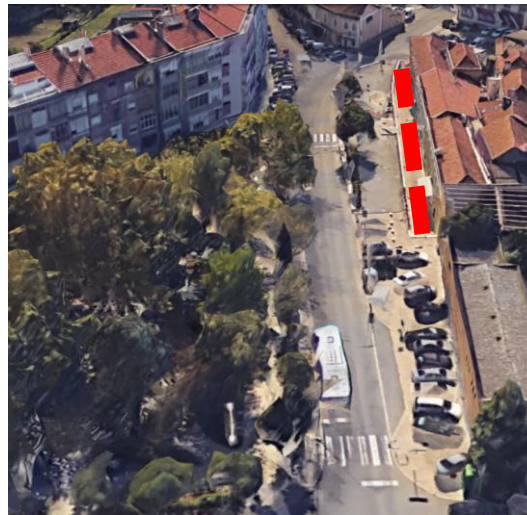
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3-way coupled flood modeling (HazRunOff project)

– Results vs. images



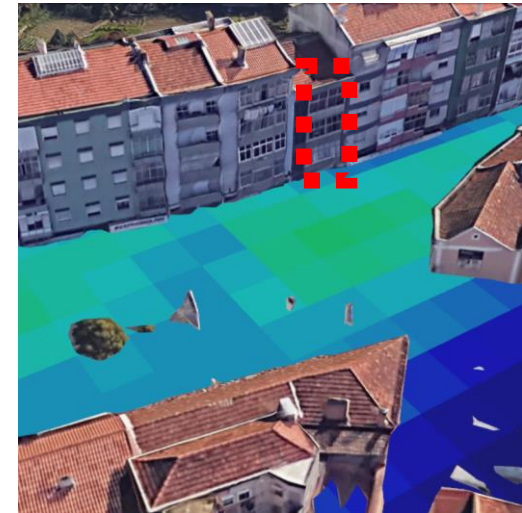
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3-way coupled flood modeling (HazRunOff project)

– 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.)

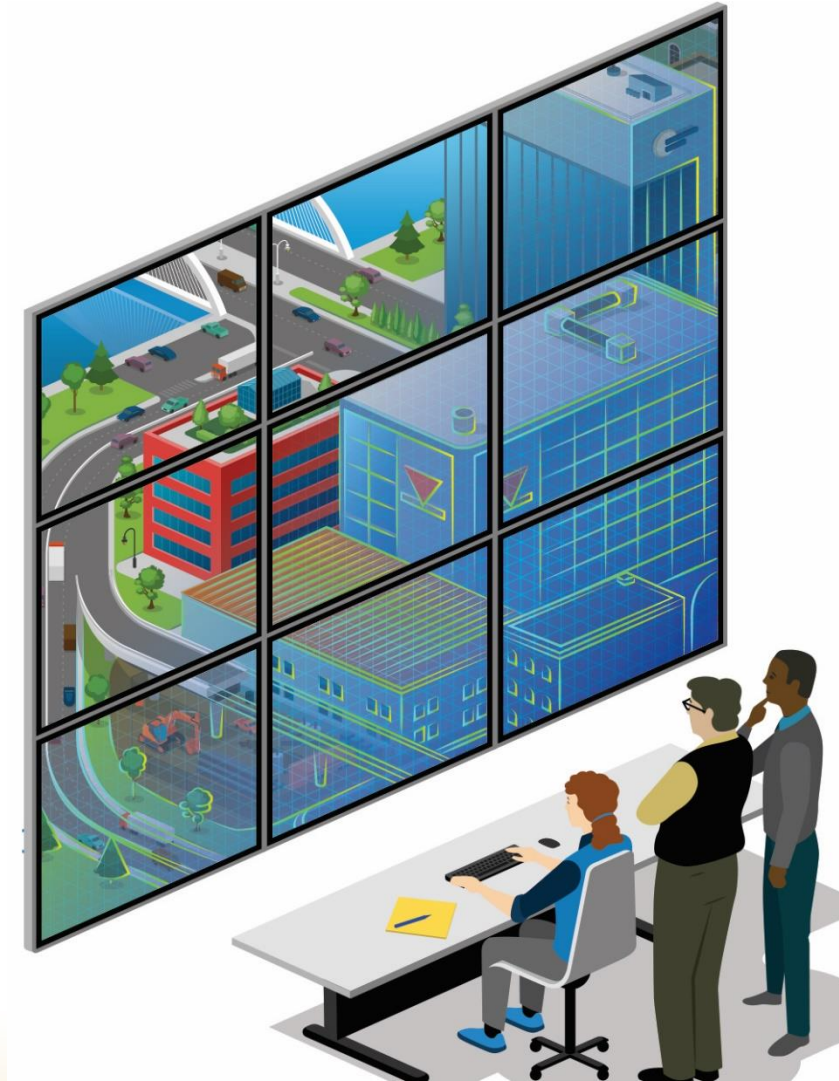
Digital Twin Workflows & Connected Data Environment (CDE)



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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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Digital Twin Workflows & Connected Data Environment



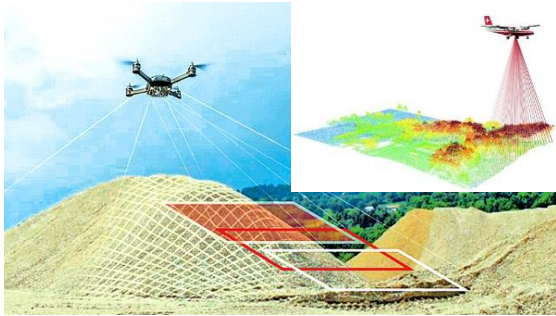
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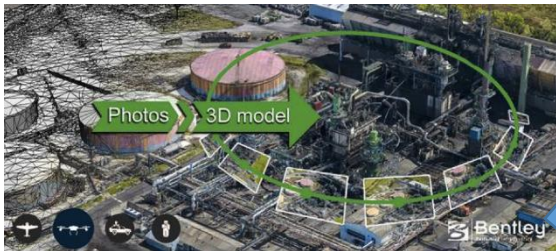
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Workflow in a Connected Data Environment

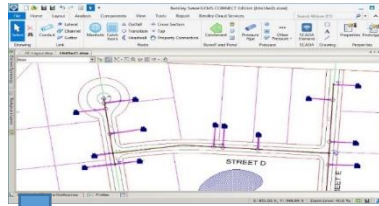
Photos + LiDAR points cloud



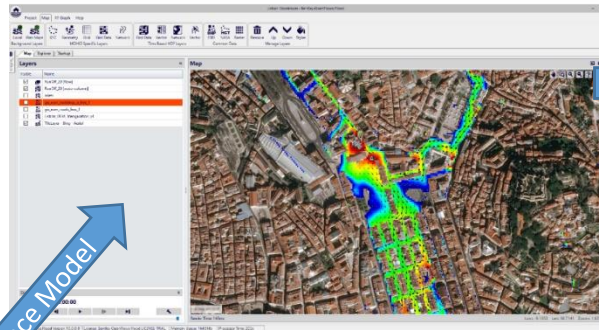
ContextCapture | 3D mesh model



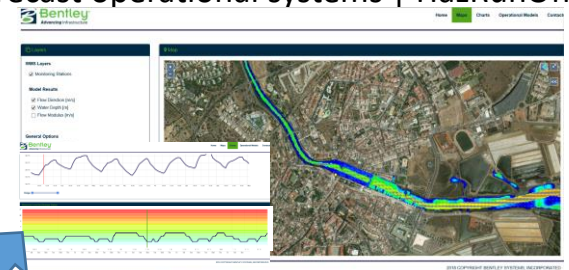
SWMM / SewerGEMS |
Drainage networks



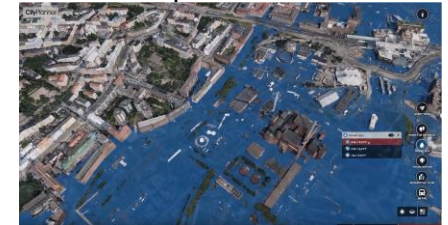
OpenFlows FLOOD | Flood model



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?

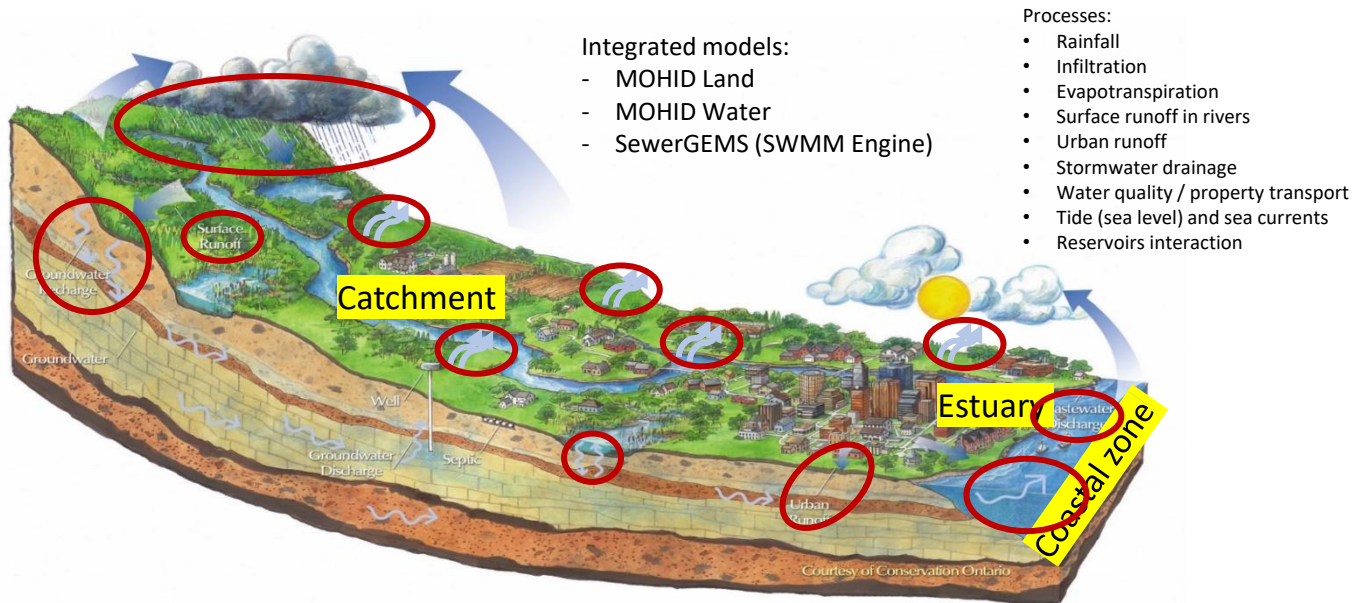


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Model engines



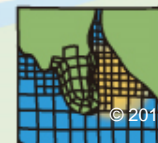
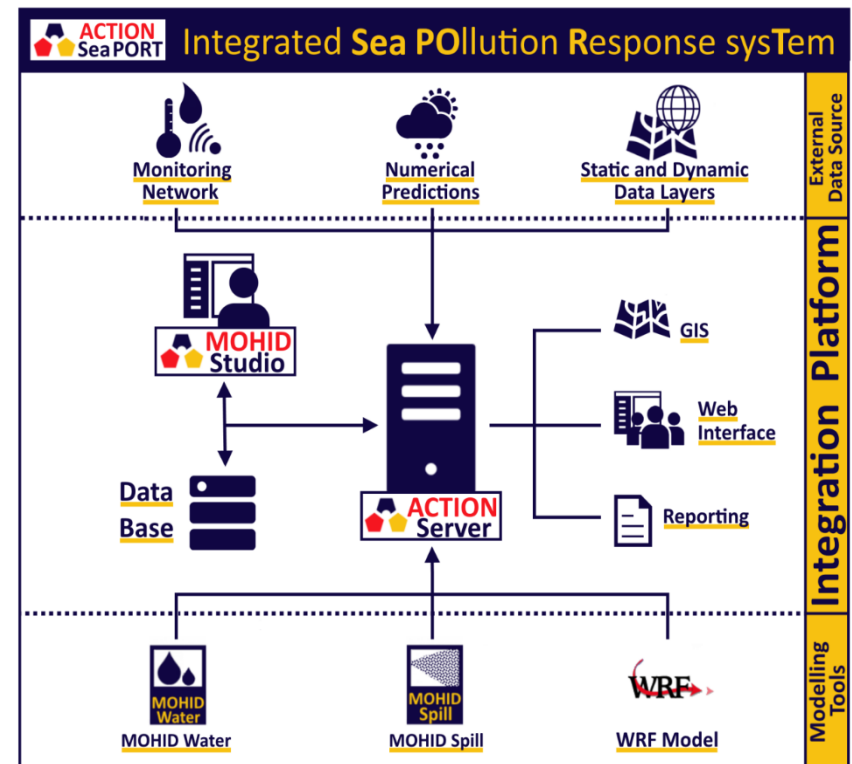
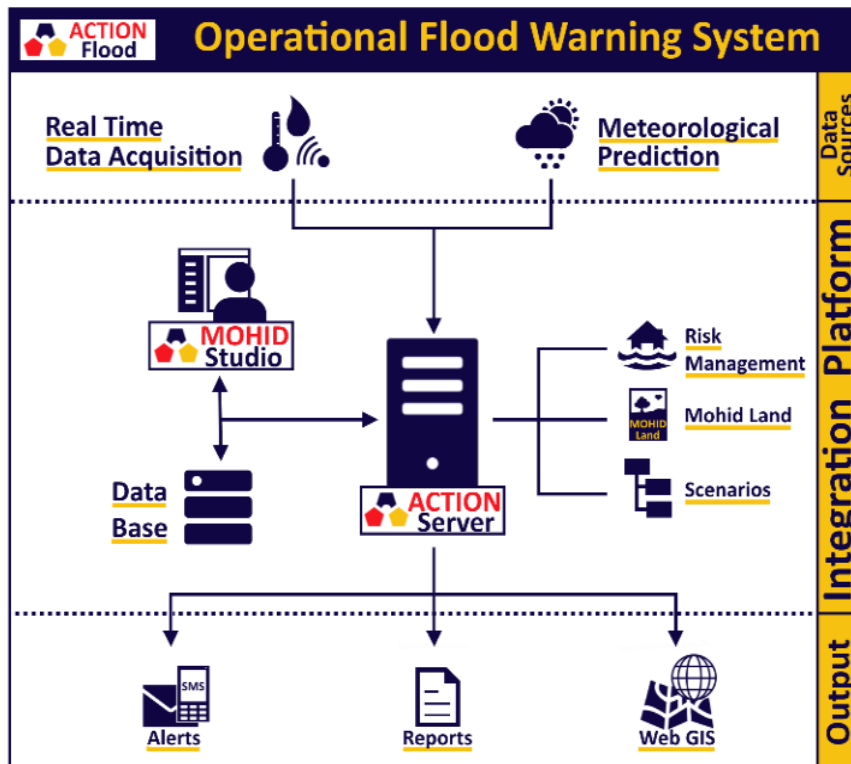
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HazRunOff preparedness & response tools

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



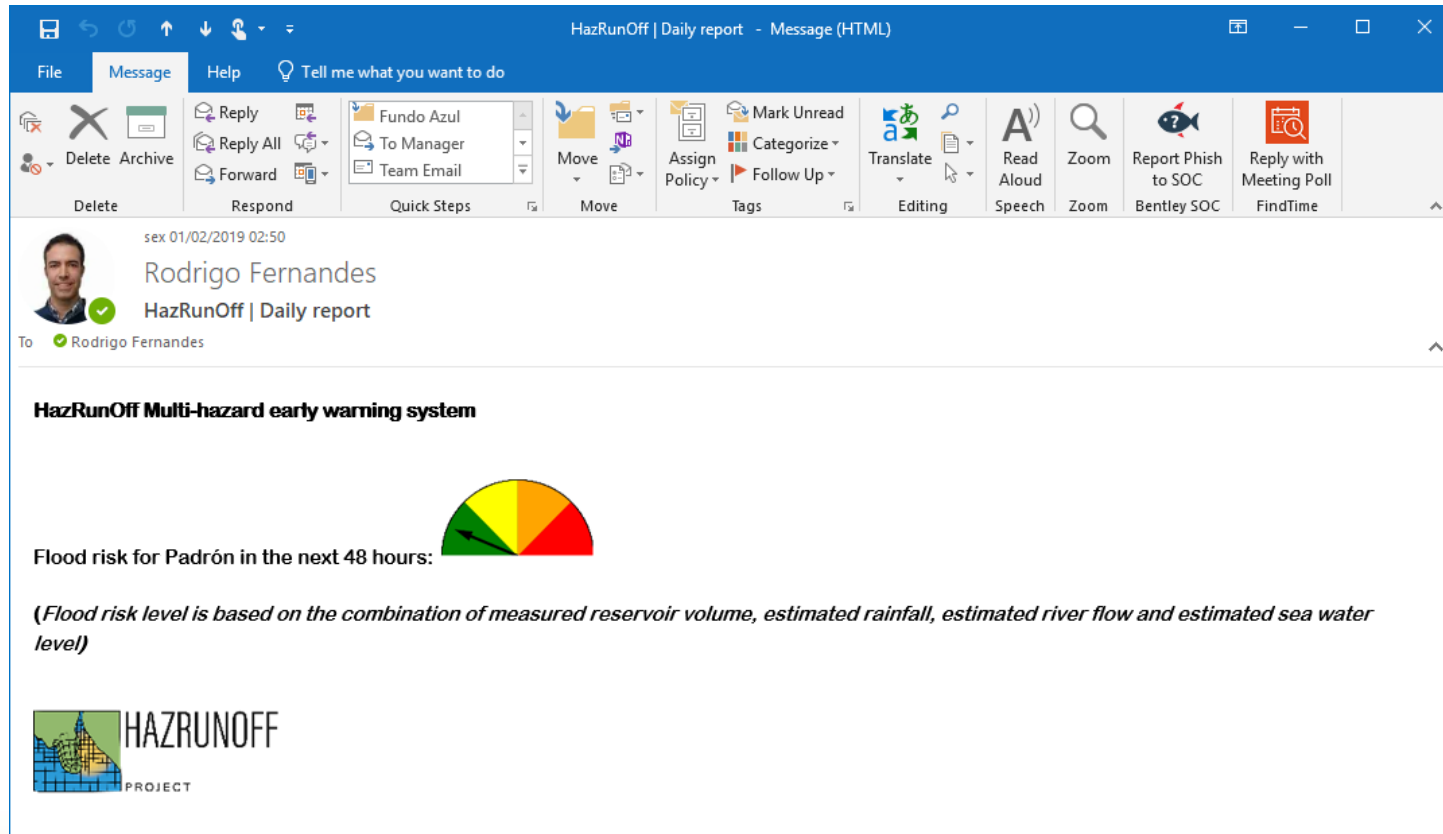
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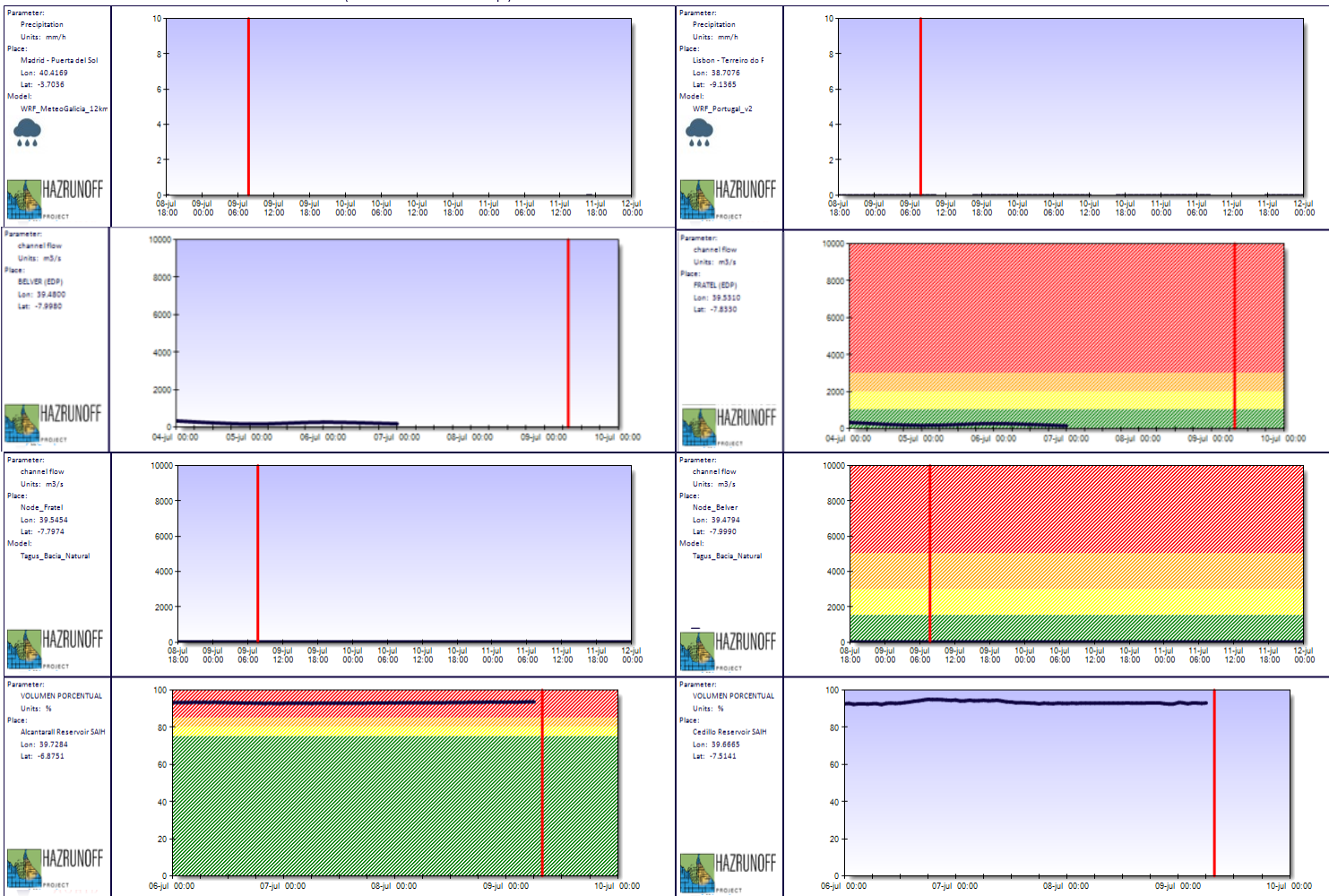
Multi-Hazard early warning system

- 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

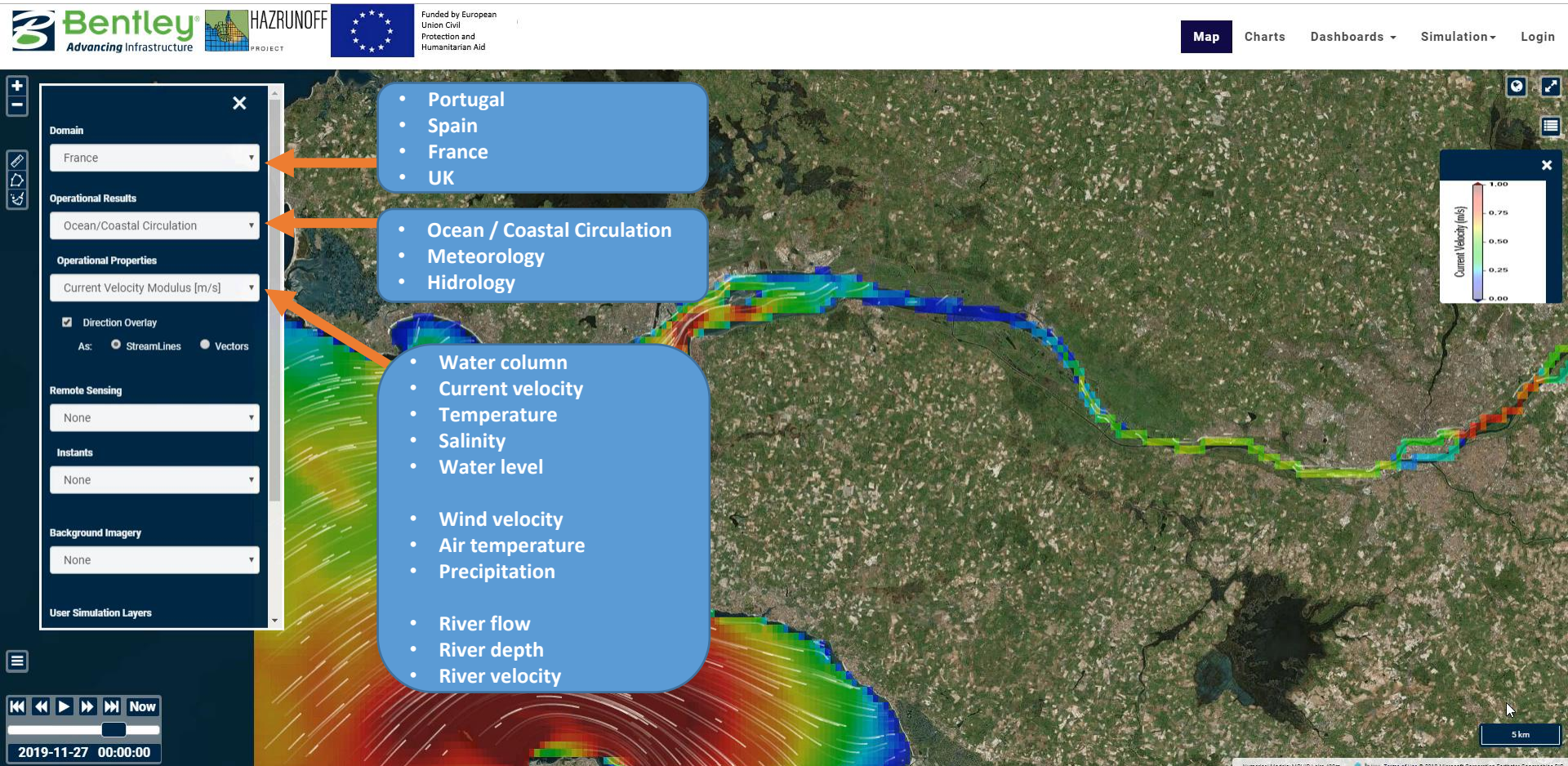


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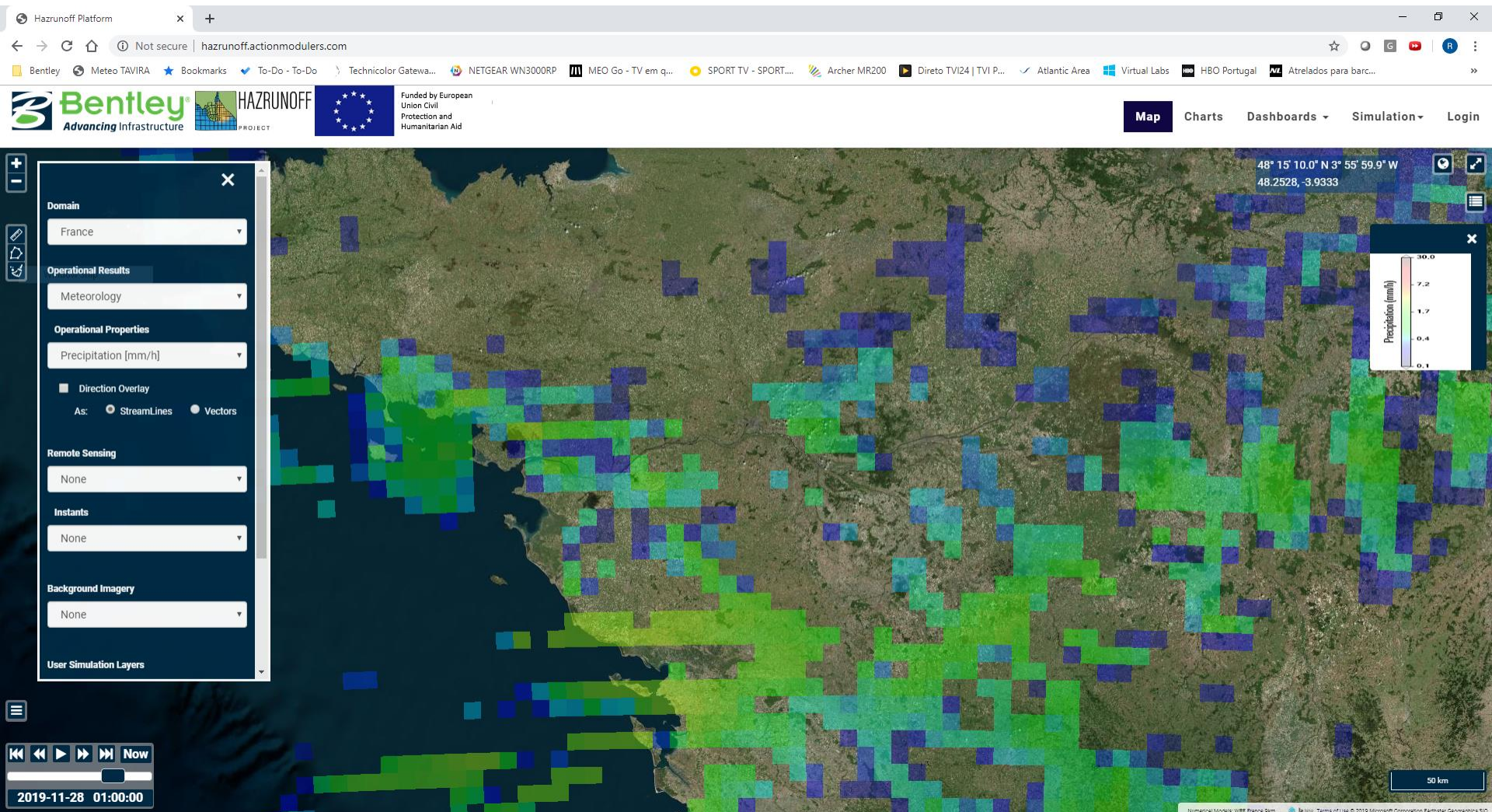


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HazRunOff Platform & coastal current velocity



Meteorology – low resolution

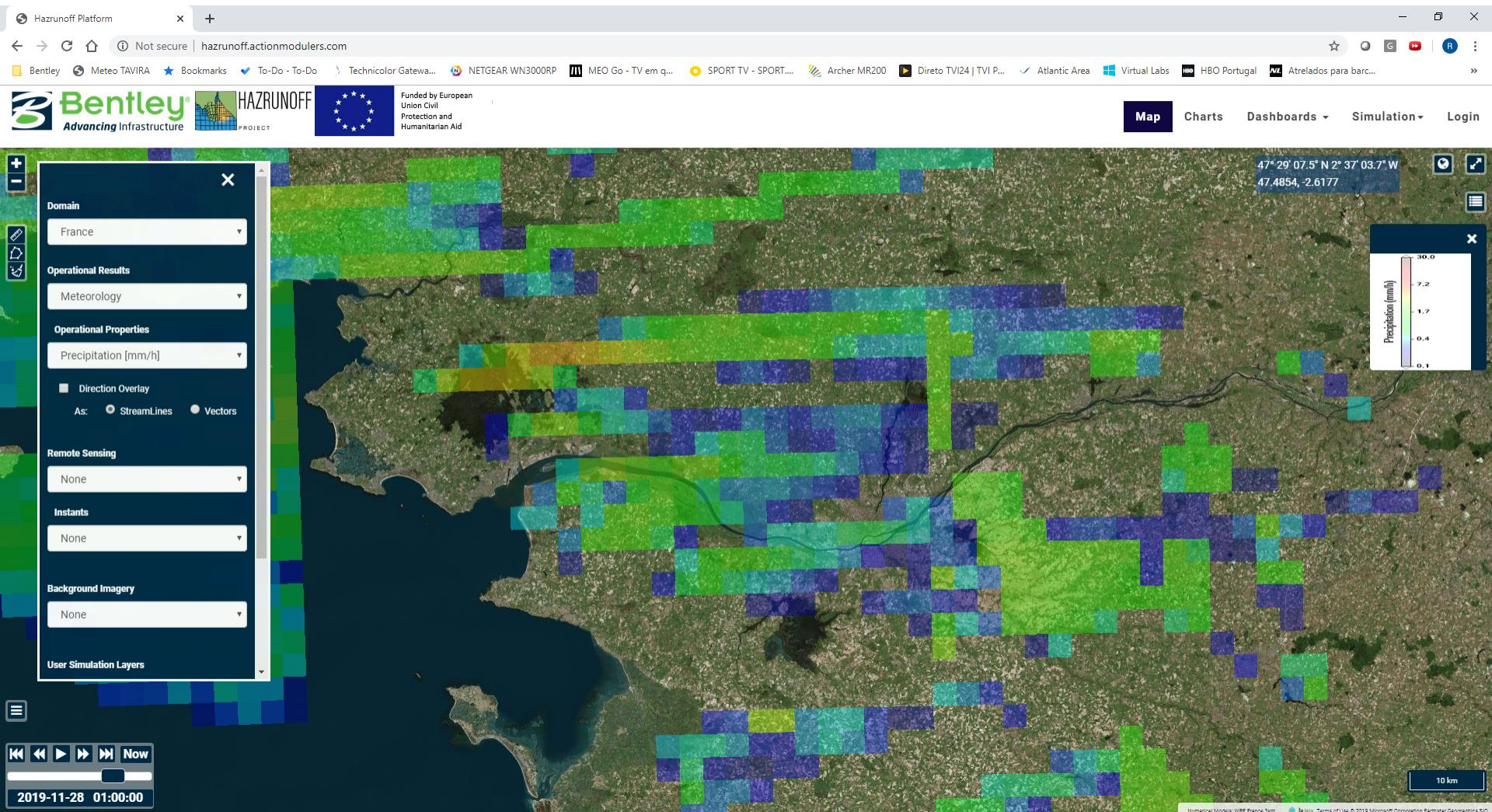


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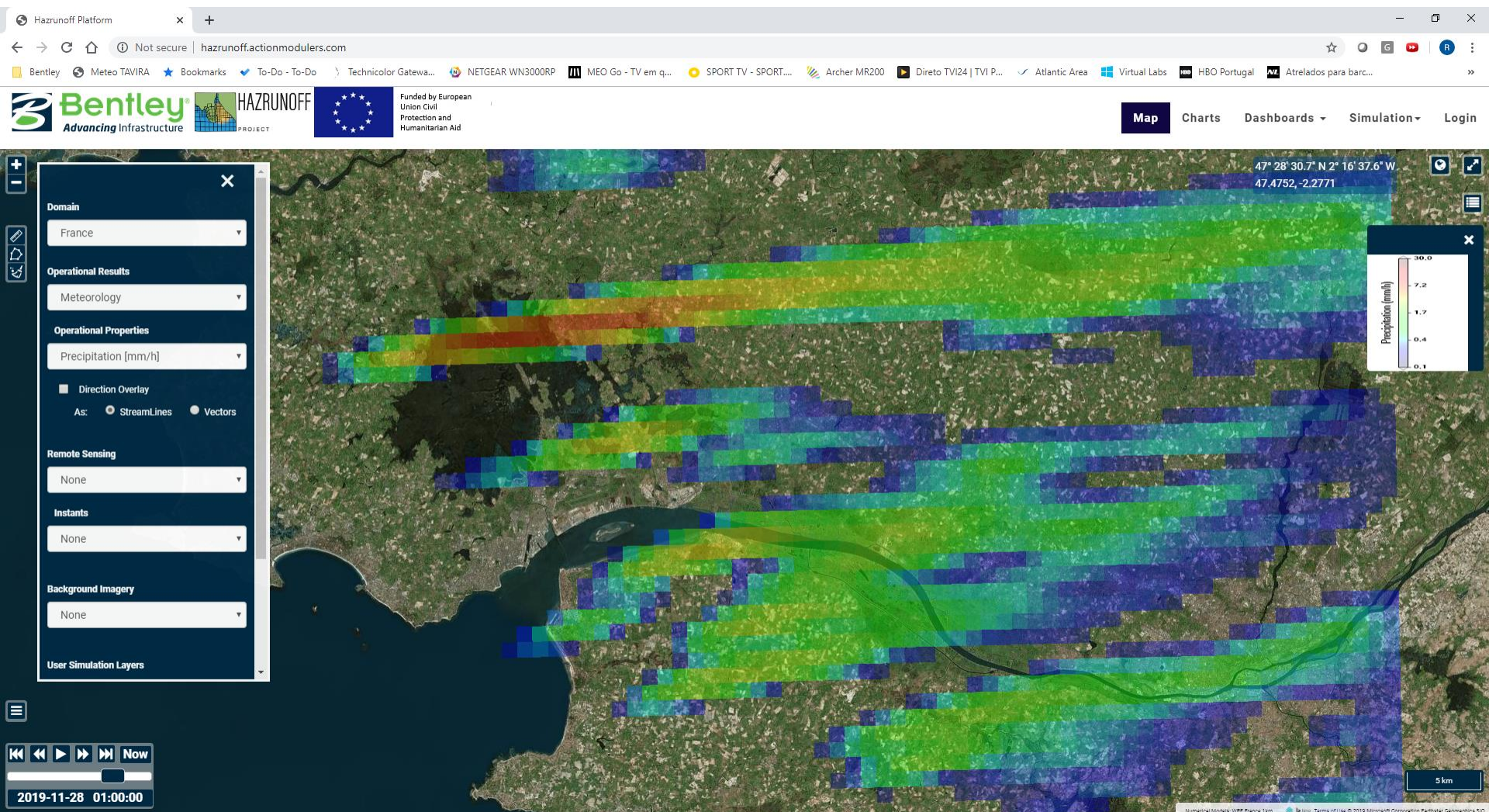


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Meteorology – medium resolution



Meteorology – high resolution

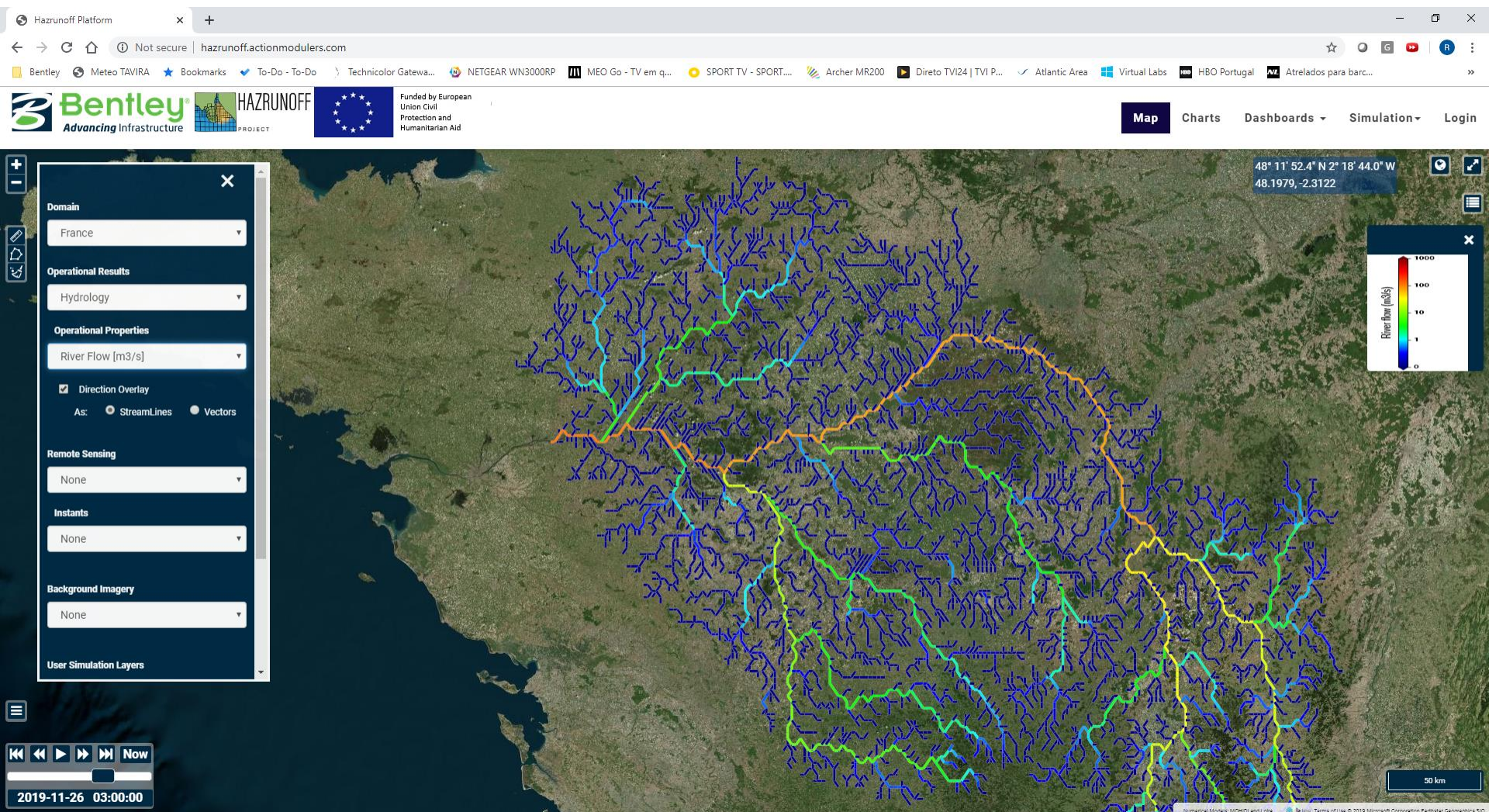


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Hidrology



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Remote sensing

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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: 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

- Turbidity
- Aerial Imagery
- Water coverage



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Remote Sensing – aerial photos

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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: Aerial

Instants: 2019-11-18 11:18

Background Imagery: None

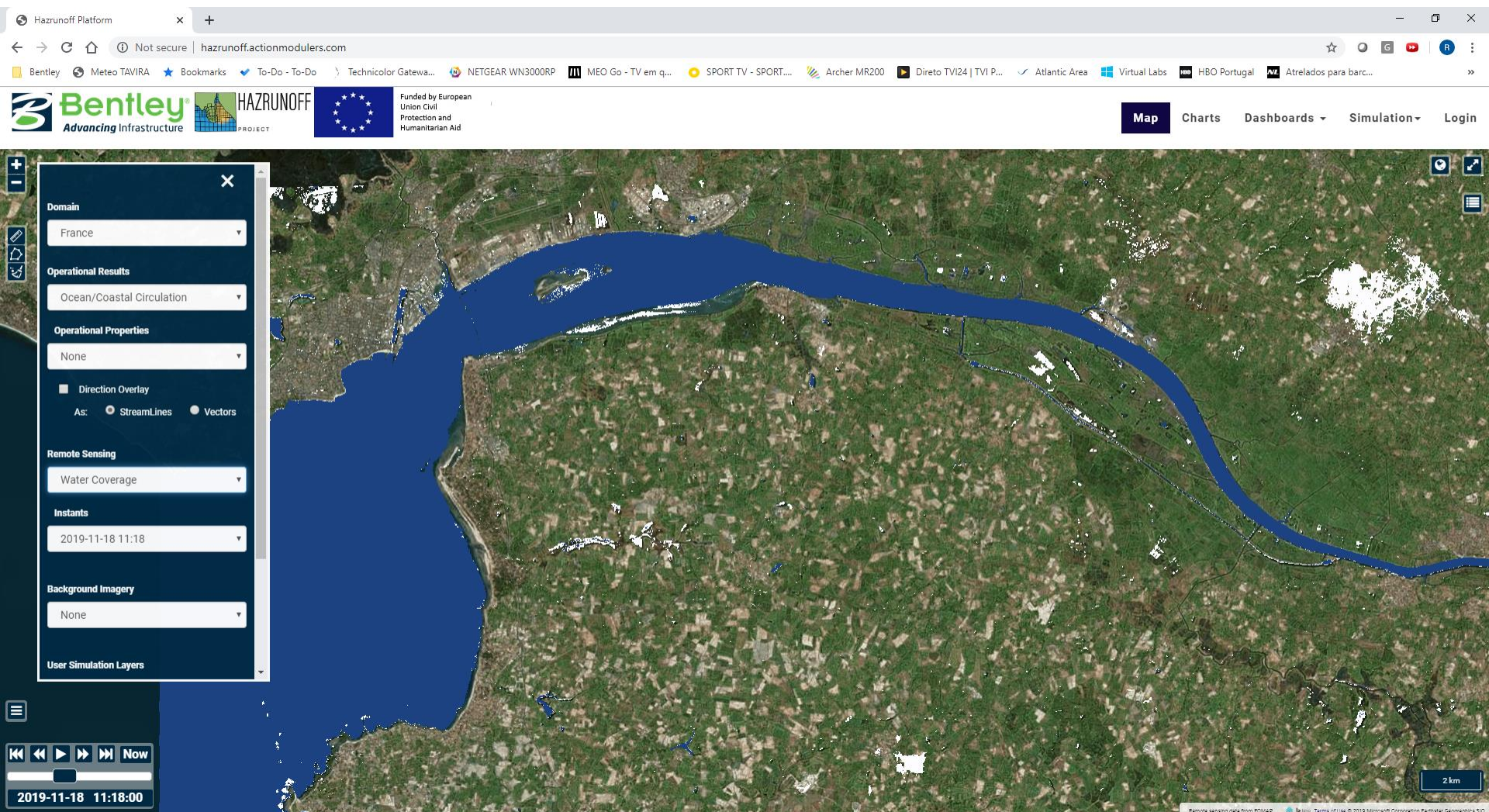
User Simulation Layers

2019-11-18 11:18:00

2 km

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

Remote Sensing – water coverage

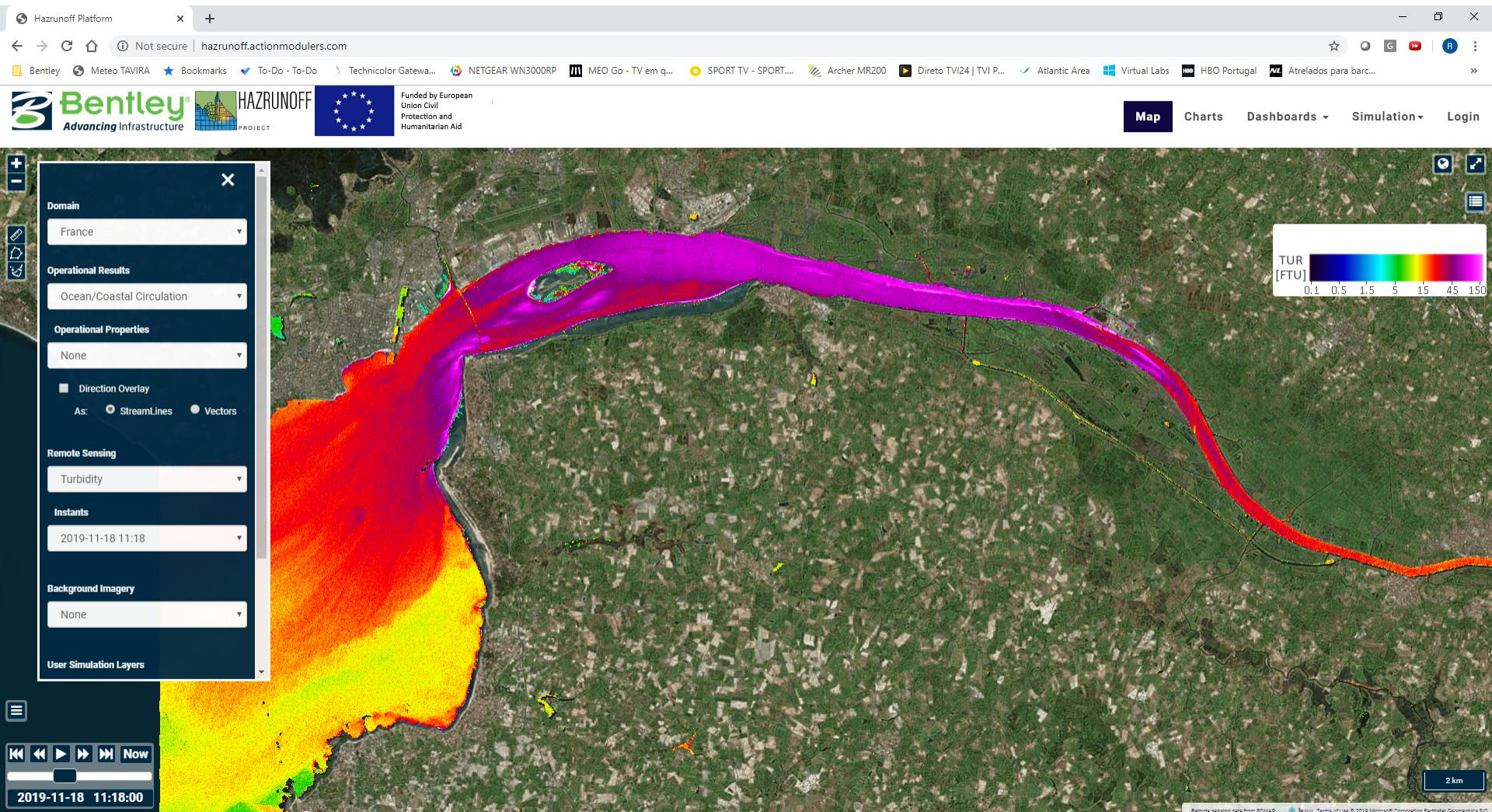


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Remote Sensing – turbidity

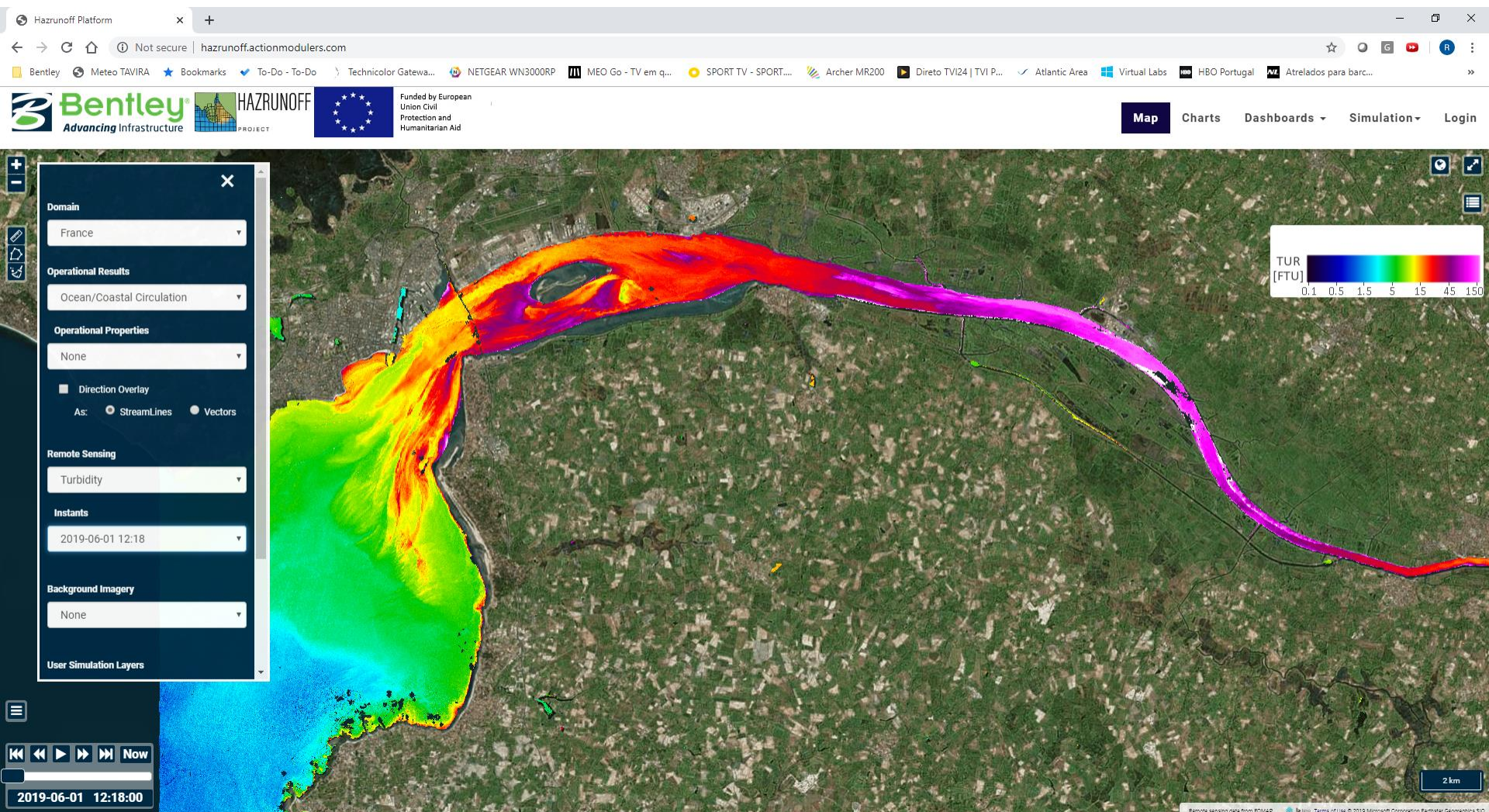


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Remote Sensing – turbidity

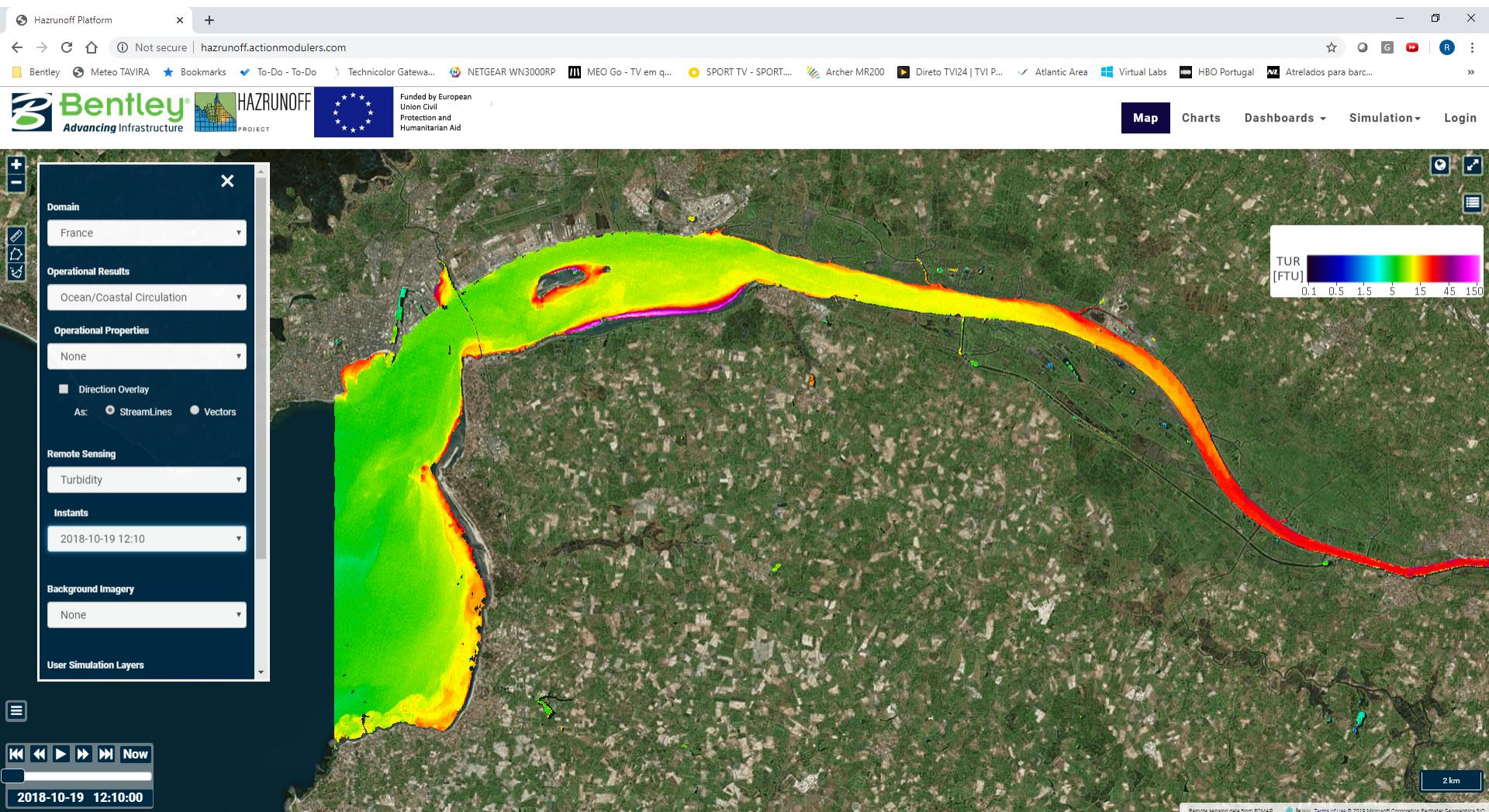


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Remote Sensing – turbidity



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UAV / drone imagery

Hazrunoff Platform

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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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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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Map | Charts | Dashboards | Simulation | Login

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Instants: None

Background Imagery: Latest Image - 2

User Simulation Layers

2019-11-27 00:00:00

5m


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UAV / drone imagery

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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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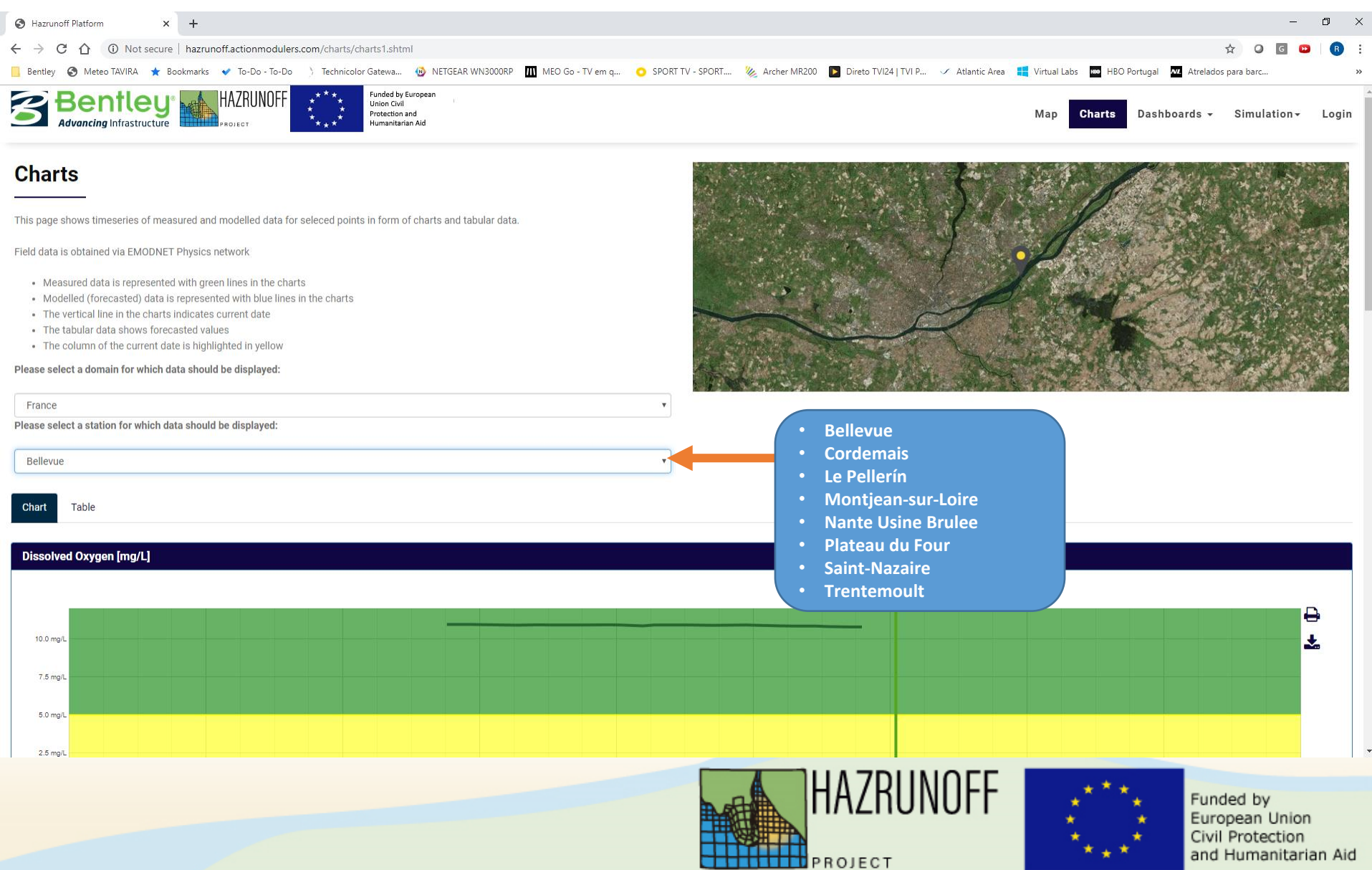


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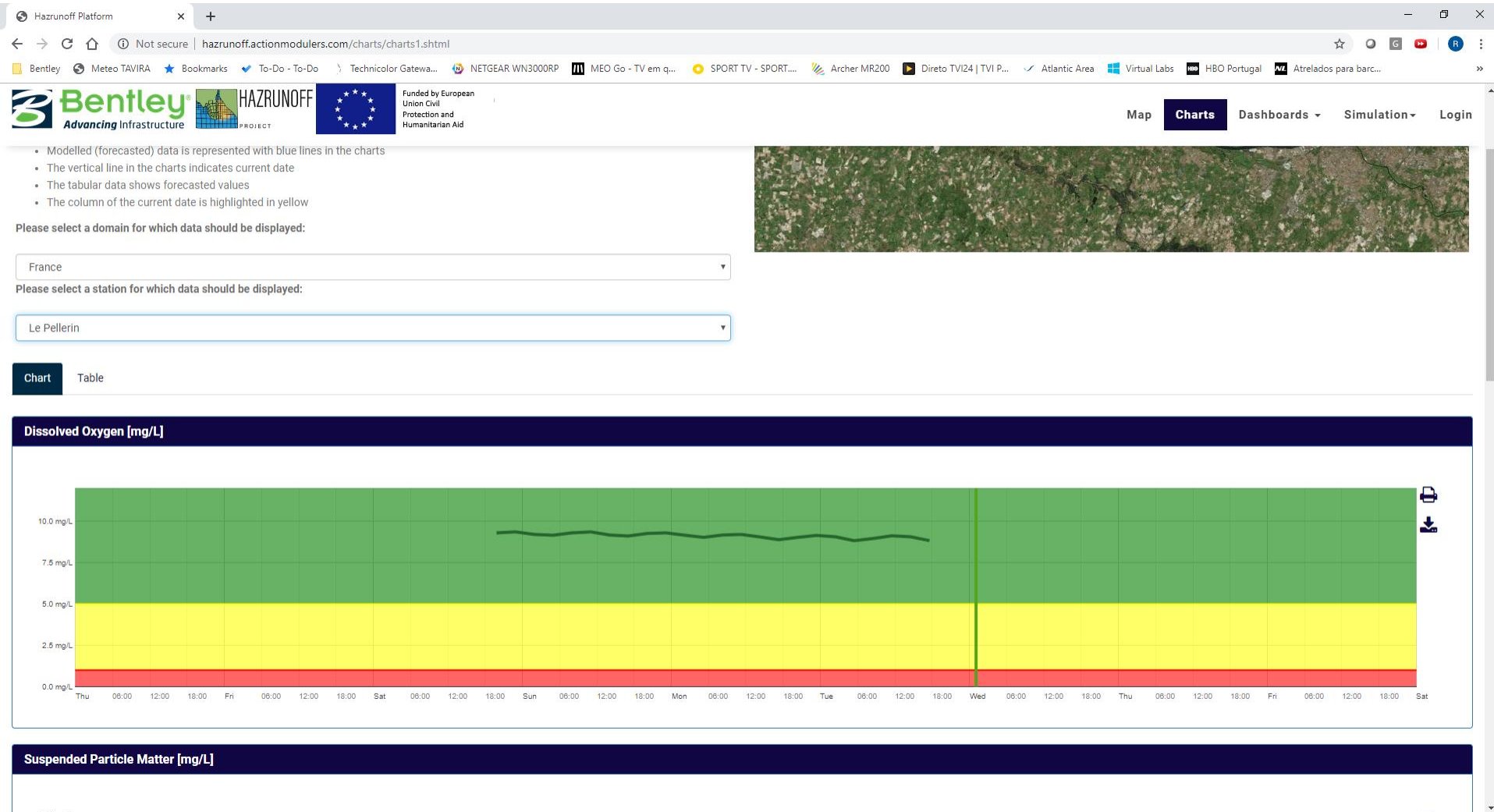


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Charts from stations



Charts from stations

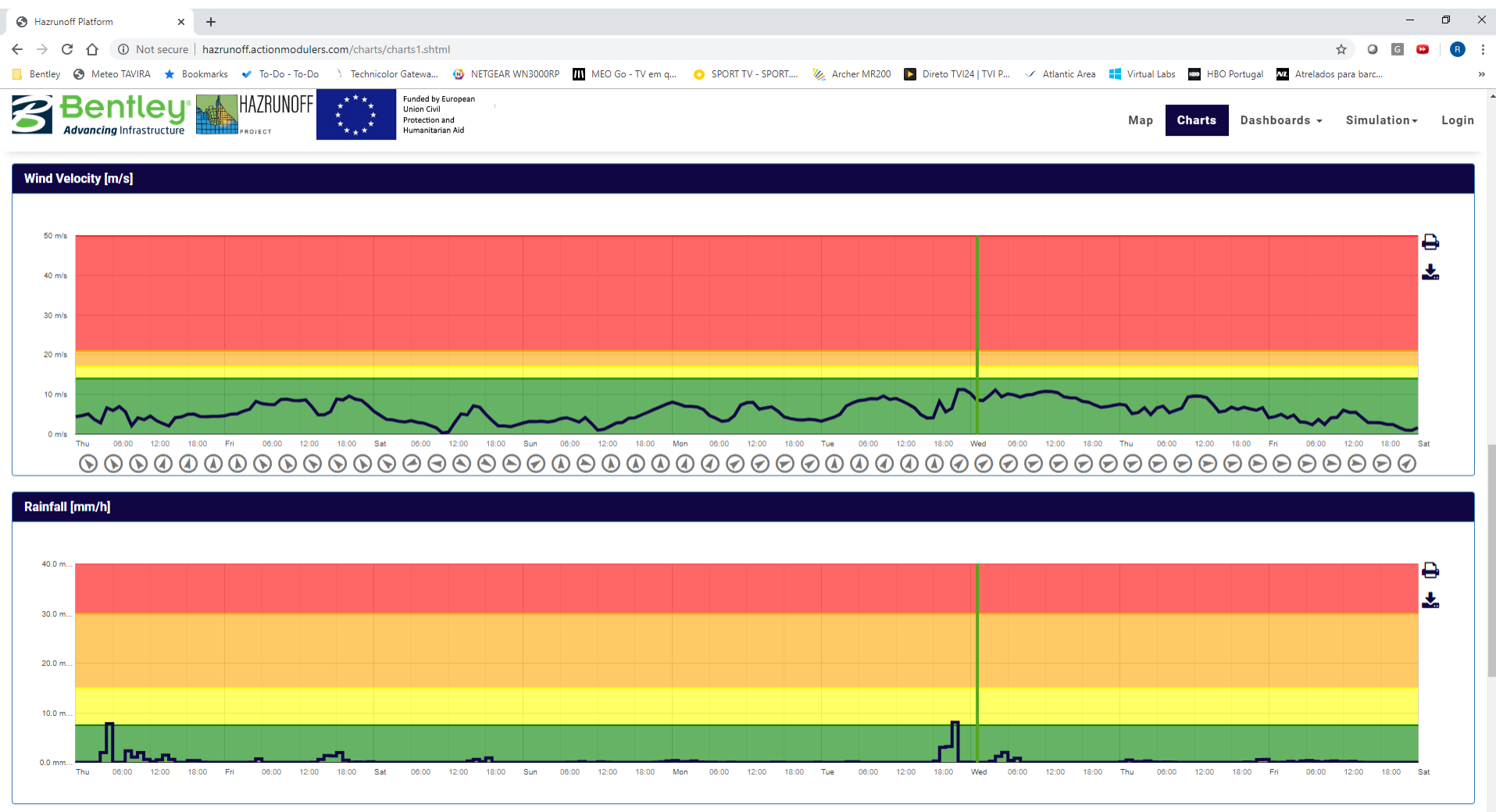


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Charts from stations



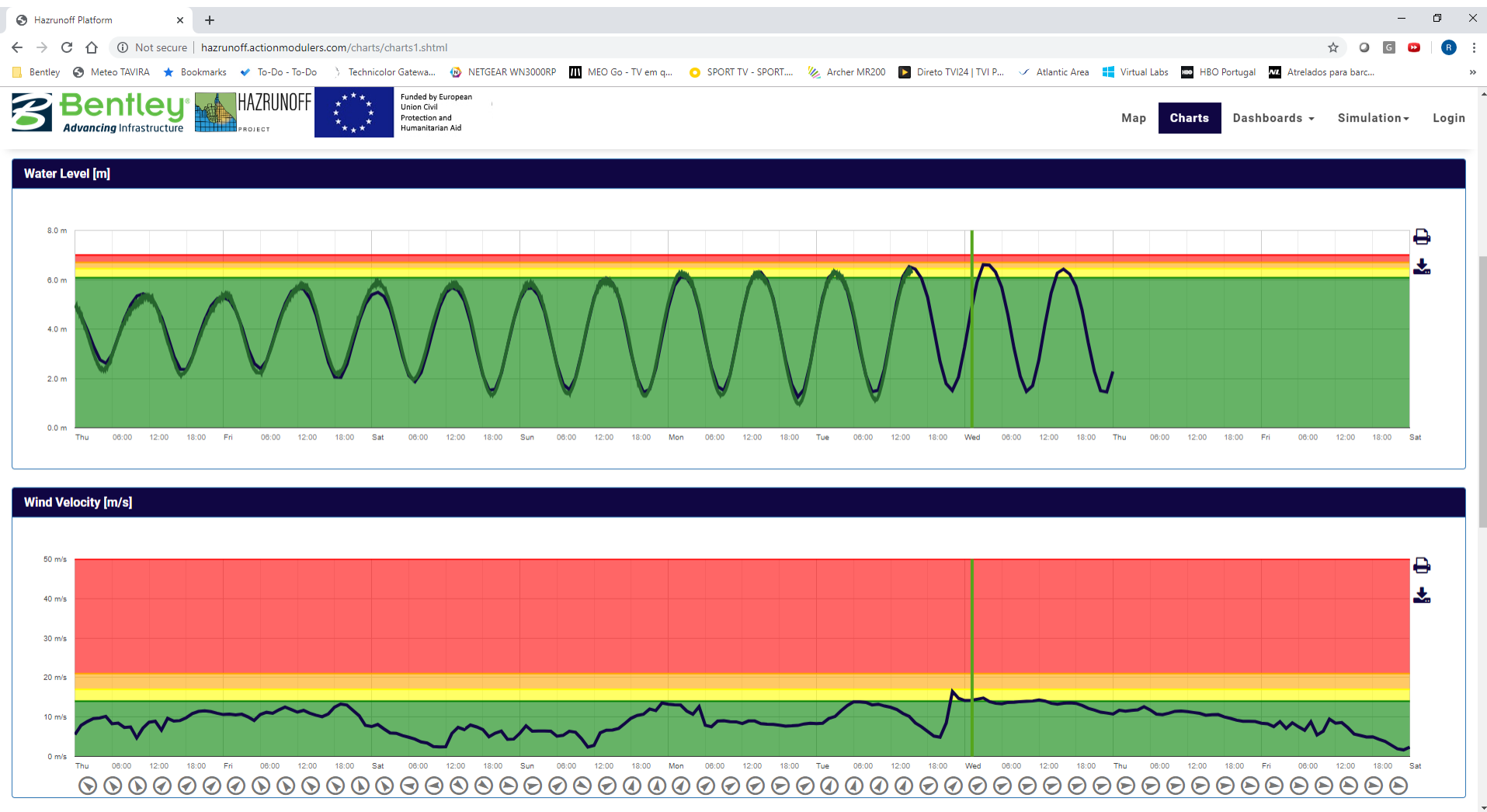
Charts from stations



Charts from stations



Charts from stations

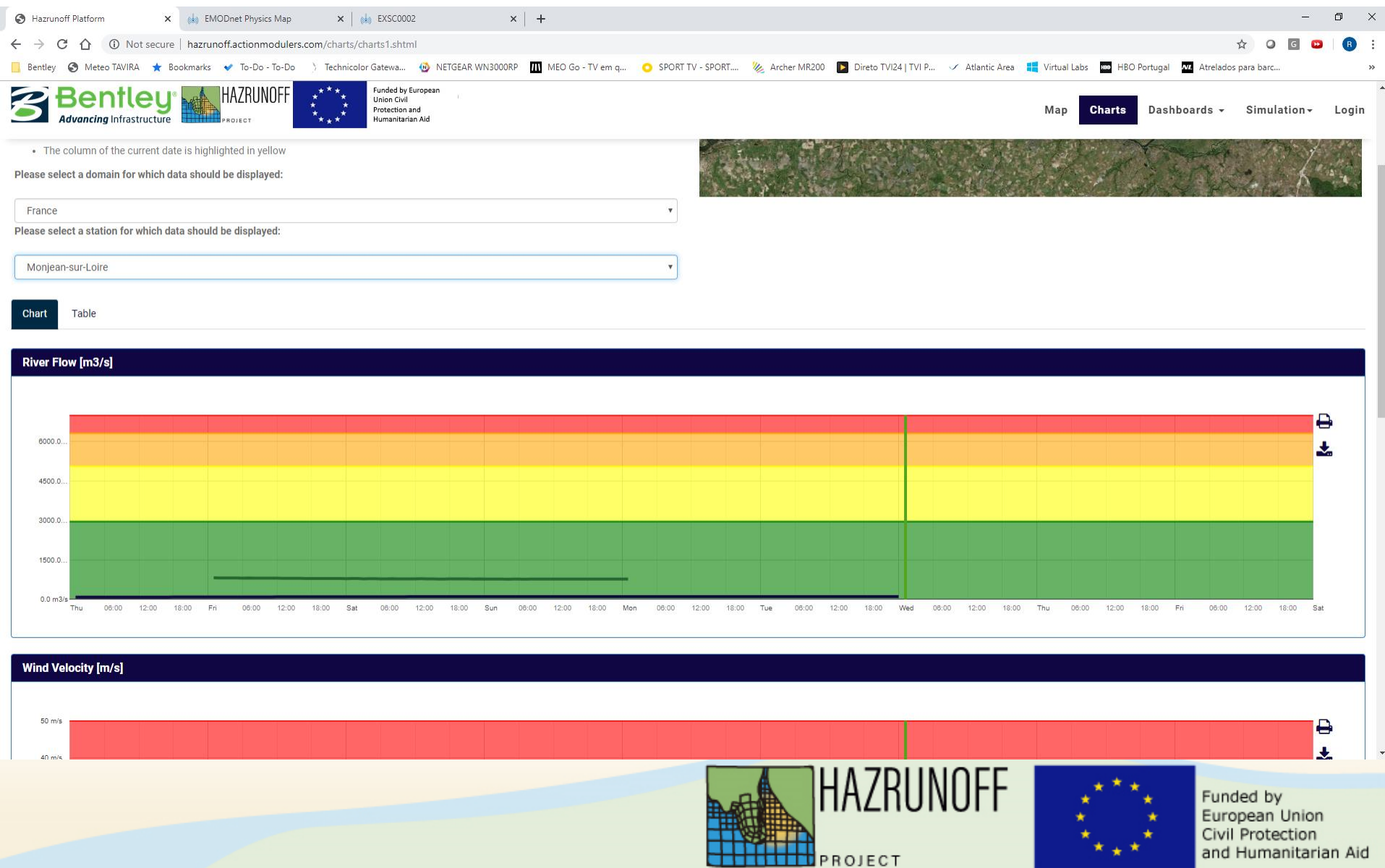


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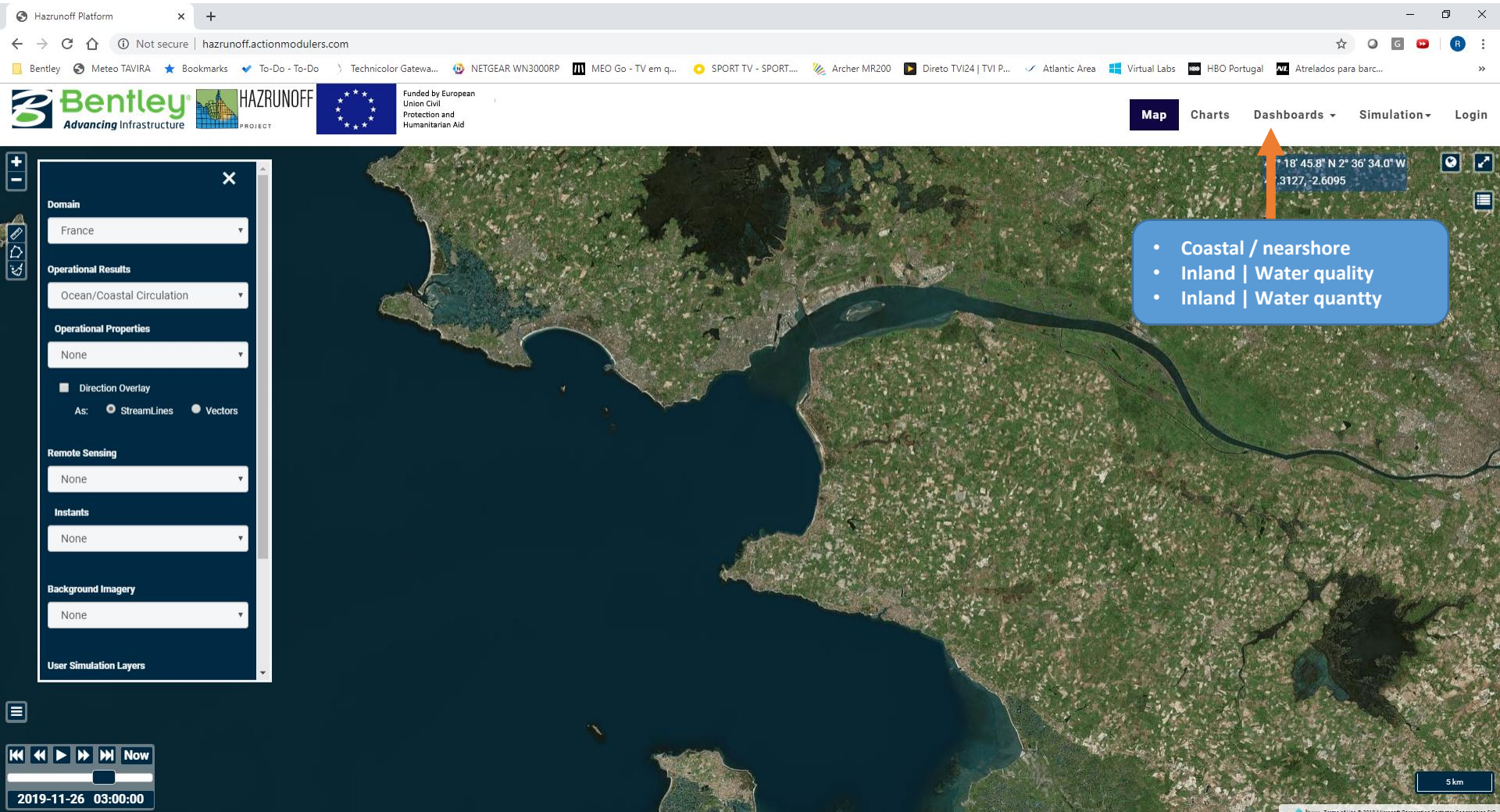


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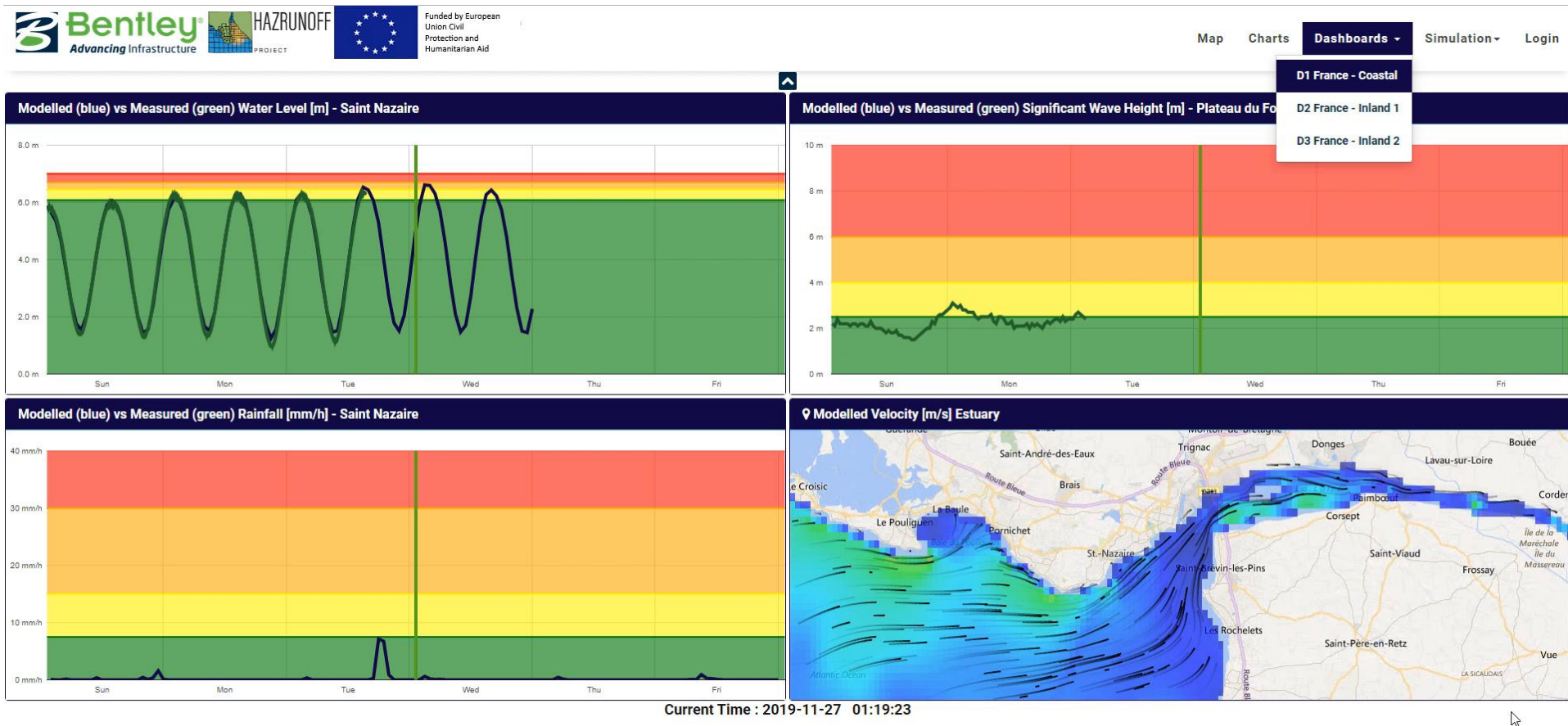
Charts from stations



Dashboards



Dashboard – nearshore data

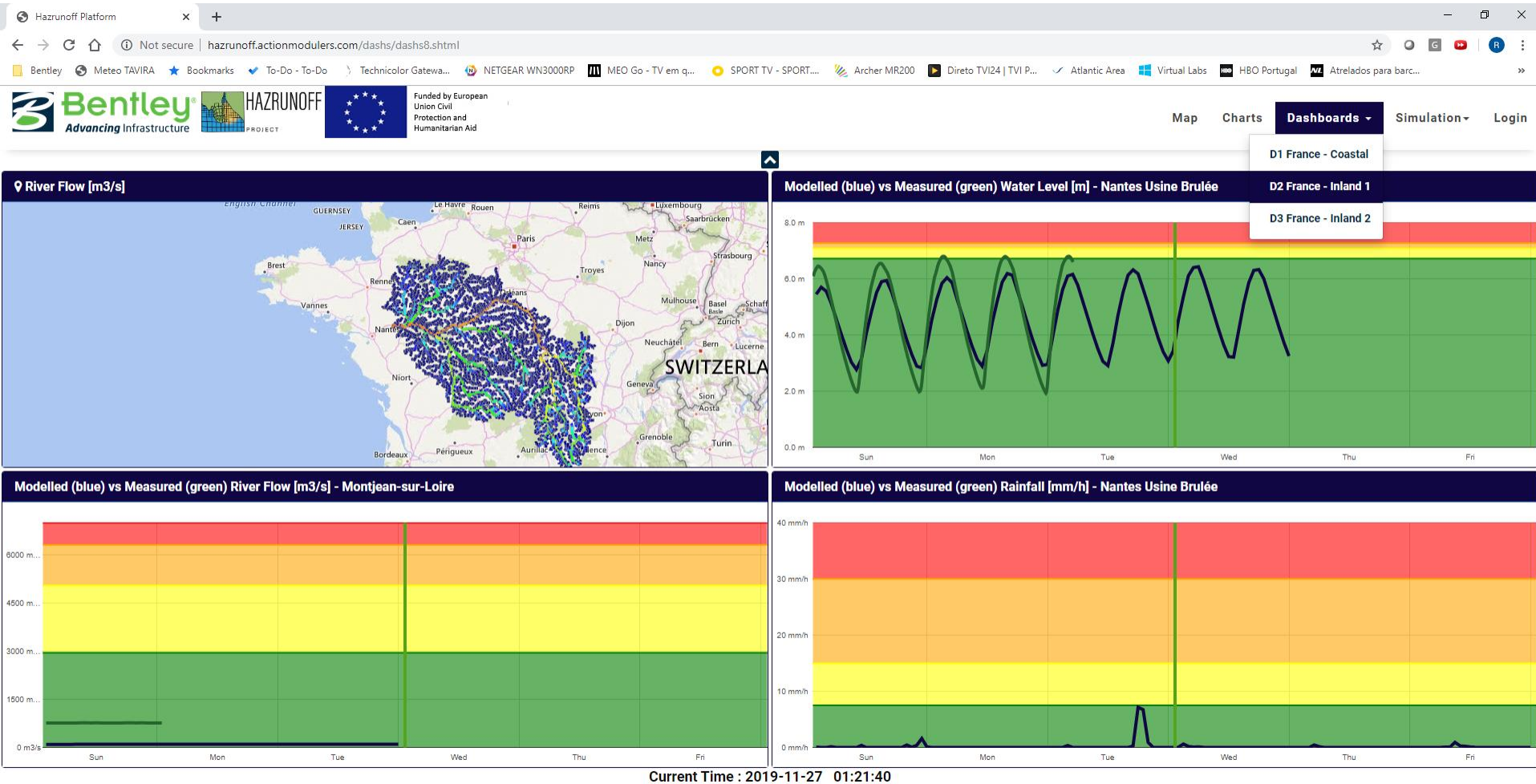


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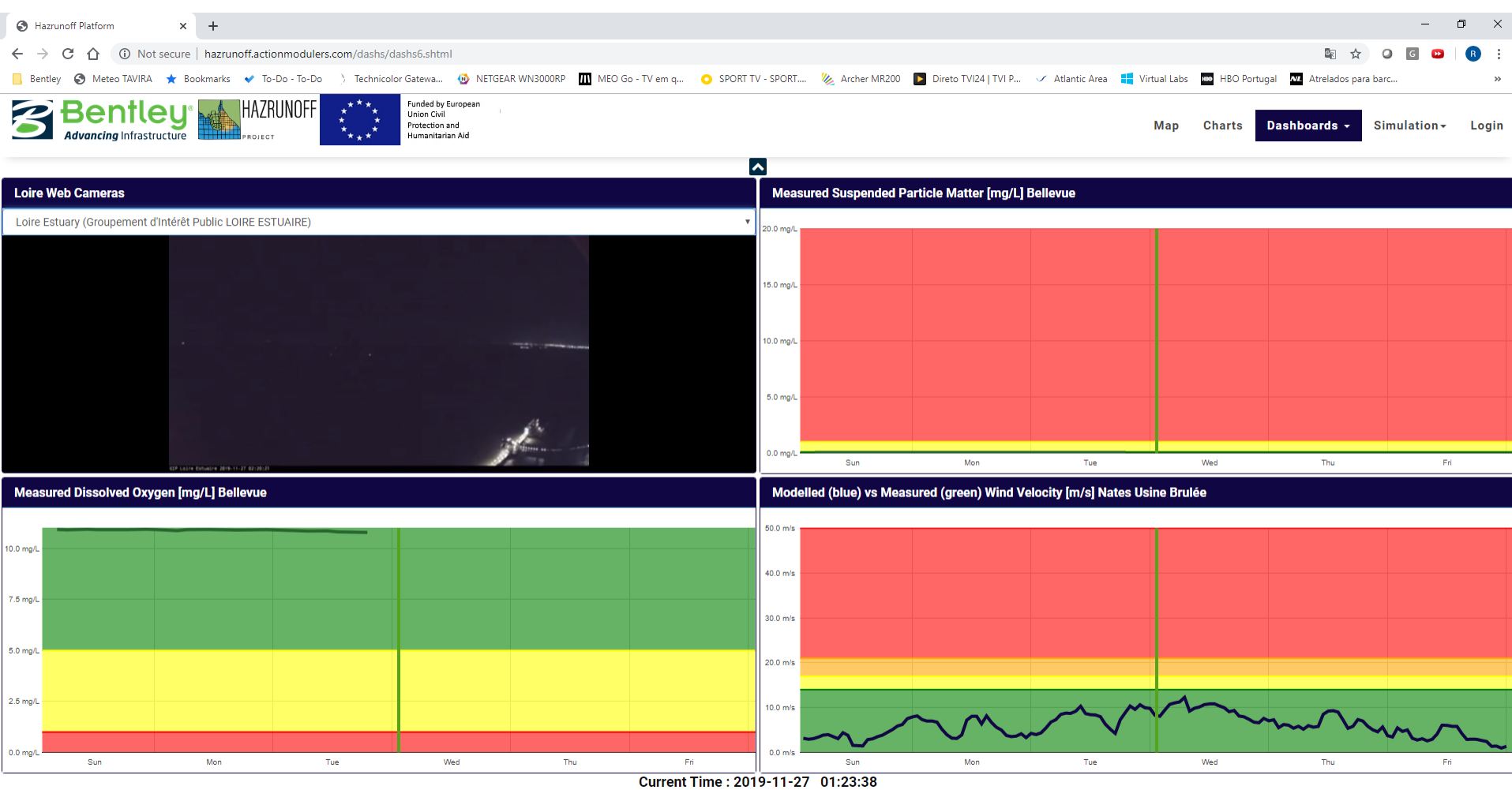


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Dashboard – inland data 1



Dashboard – inland data 2



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Spill simulations

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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

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
Spill simulations


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Advancing Infrastructure

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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

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Spill simulations

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Incident Name

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

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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

Previous12345...270Next



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Previous12345...270Next

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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

Previous12345...15Next

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4. Run

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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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Spill simulations

Hazrunoff Platform

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MapChartsDashboardsSimulationhazrunoff

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

Previous

Next

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Humanitarian Aid

Map

Charts

Dashboards

Simulation

hazrunoff

1. What?

2. Where?


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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

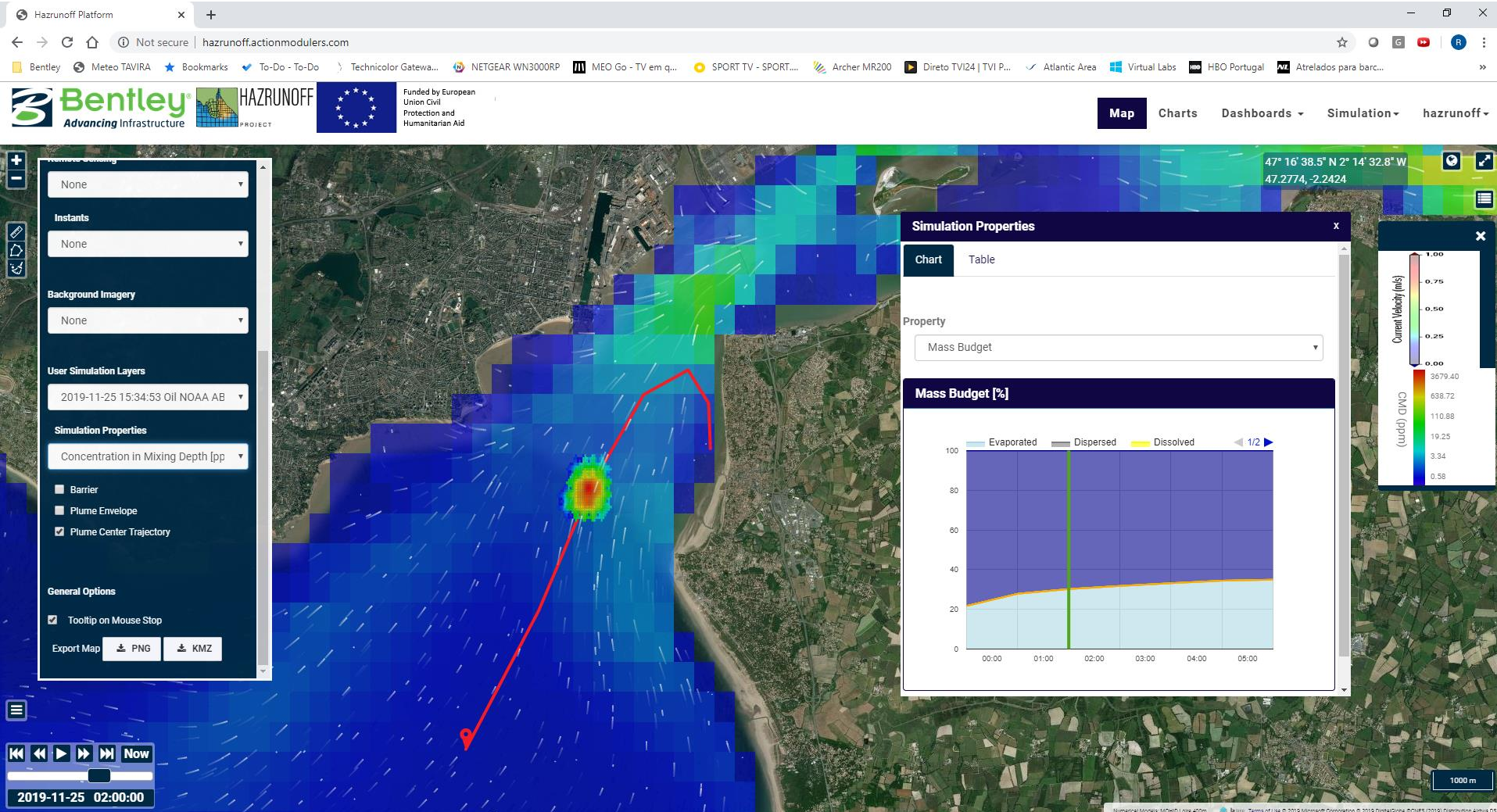
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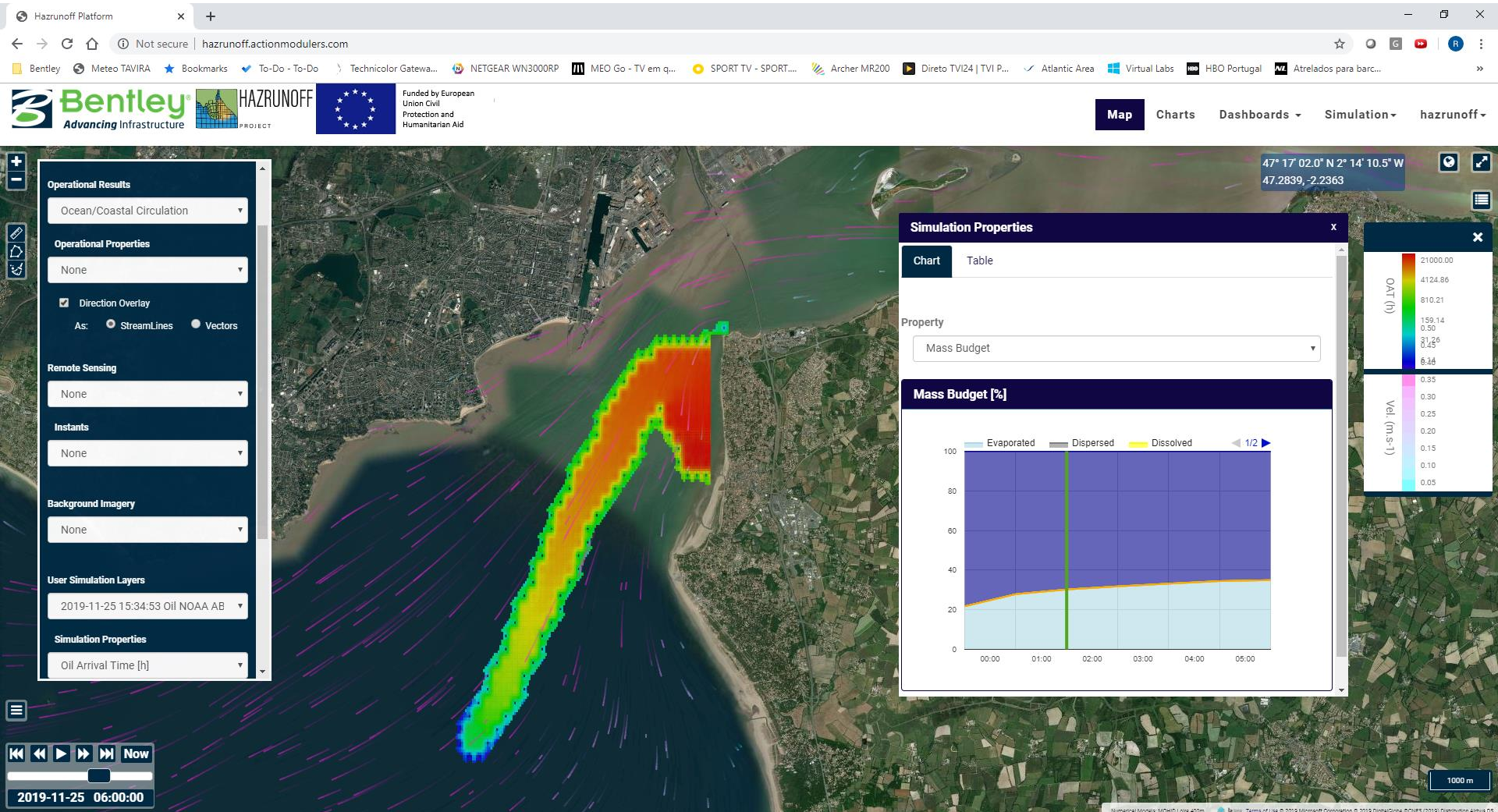
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Spill simulations - oil concentration in the surface



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.



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Thanks!

rodrigo.fernandes@bentley.com