Digital Twin of the Ocean: Sensors in DTOs

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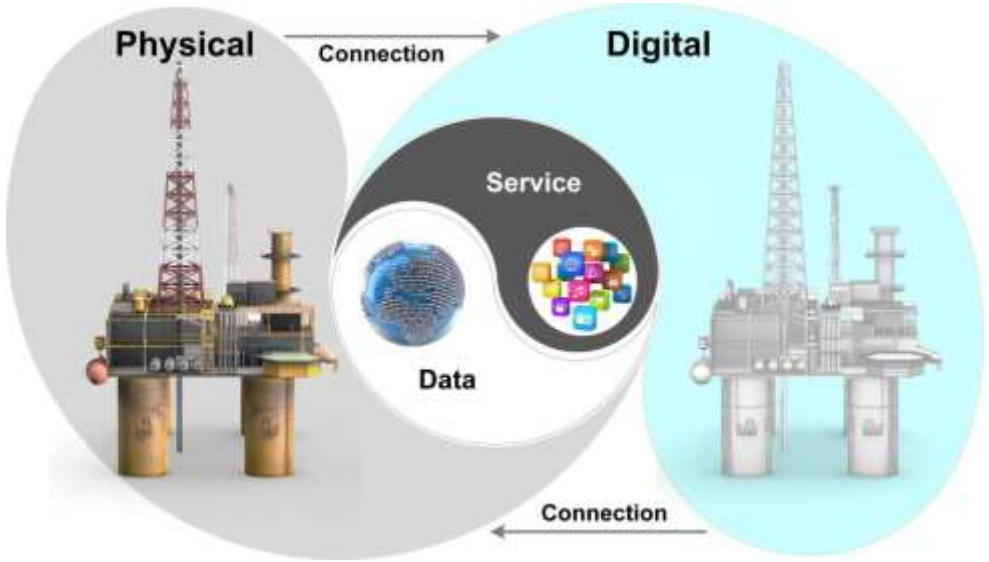
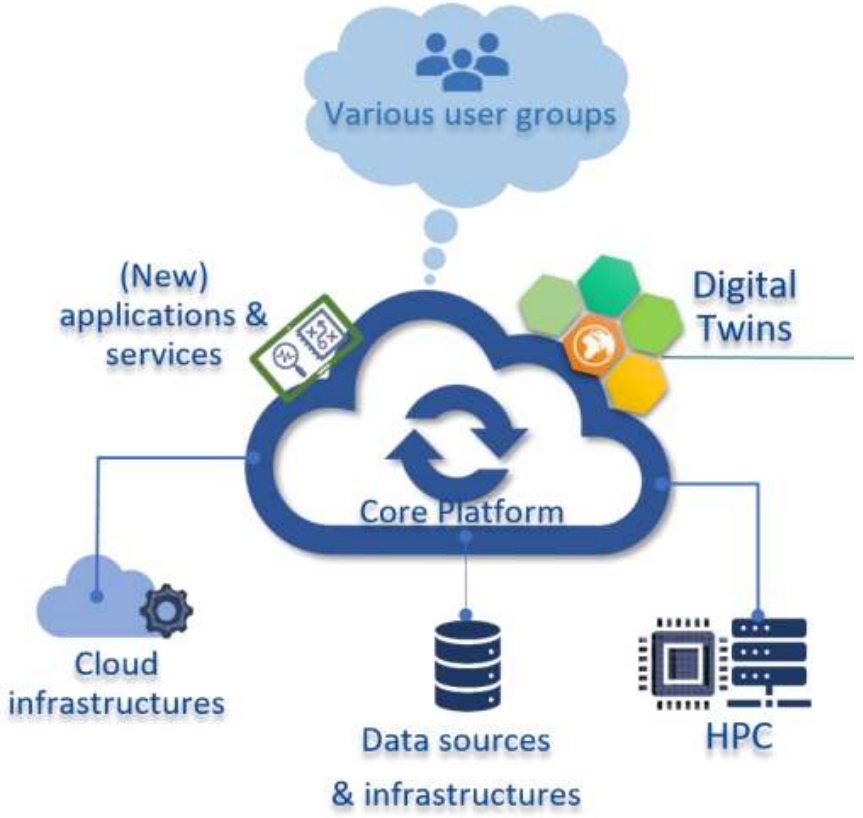
DTs in Industry 4.0

Sensors
Models
Big Data
Cloud storage
ML and AI algorithms



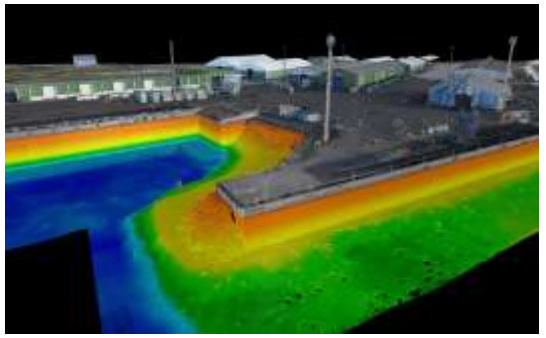
Operations
Controls
Optimization
Diagnosis
Decision Systems



ILIAD Pilot DTs

Offshore Wind Energy Farms

Tidal Energy Farms



Harbor Safety

Onshore Wave Energy Farms

Fisheries/Aquaculture

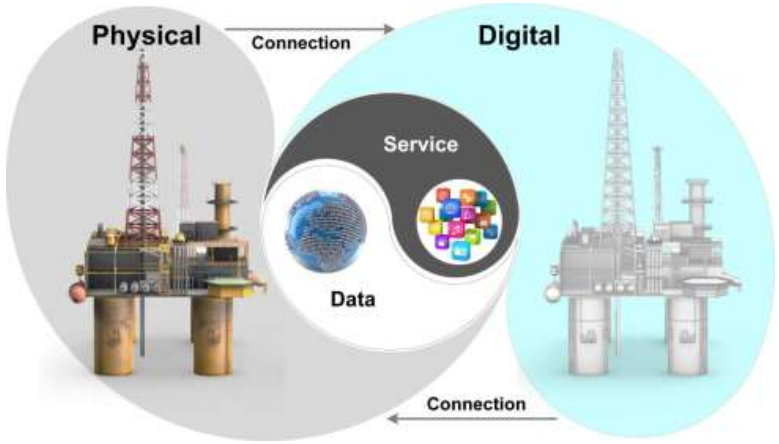
Mucilage/Oil Spills

ILIAD Pilots Classification

A DT is a real-time digital replica of a physical entity, in which **the real part can be mirrored in a virtual environment** and continuously updated from multiple sources for various purposes (Fuller et al., 2019).

One – way Digital Twins

Sensors
Models
Big Data
Cloud storage
ML and AI
algorithms



Operations
Controls
Optimization
Diagnostics
Decision Systems

Marine
Environmental
Ecological DTs

The Oil Spill DT

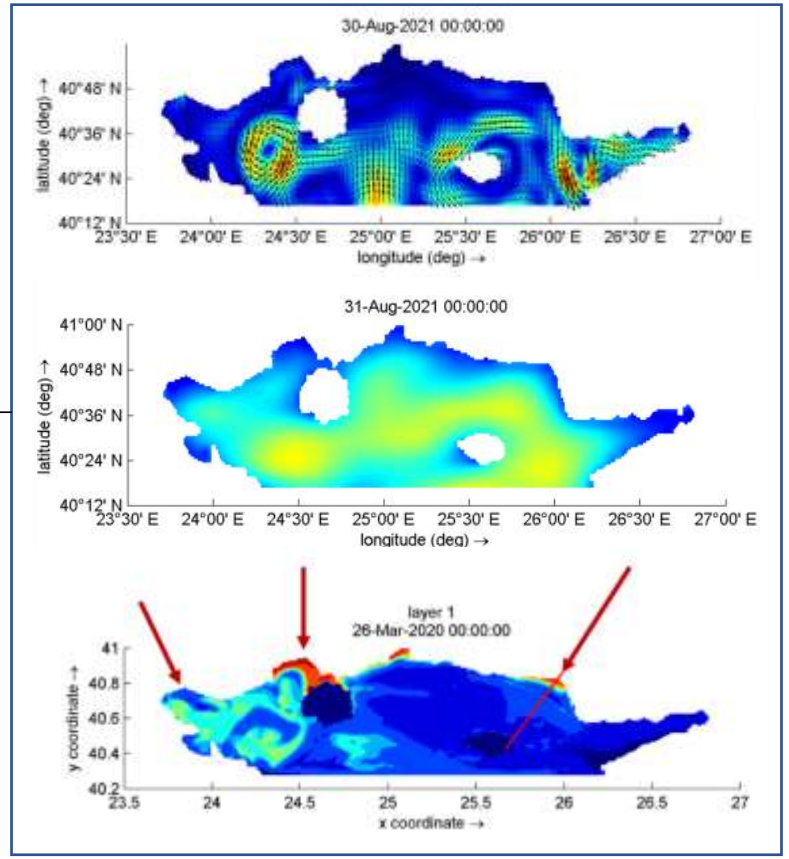
Scan Satellite Images For Oil Spills

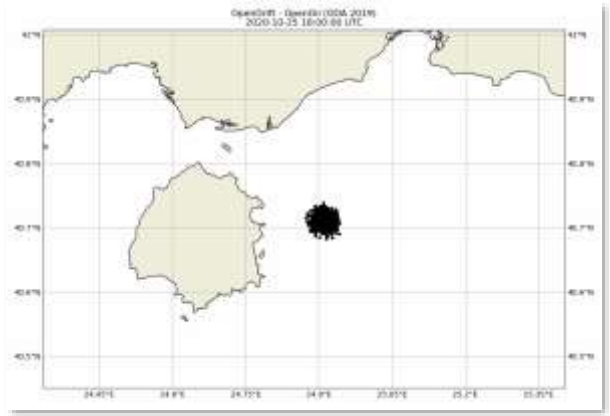
Scan Social Media Posts For Oil Spills References

Use Citizen Science Apps For Oil Spills Records

Event Identification Pack

Marinomica Package





Alarm and Aid Authorities' Response

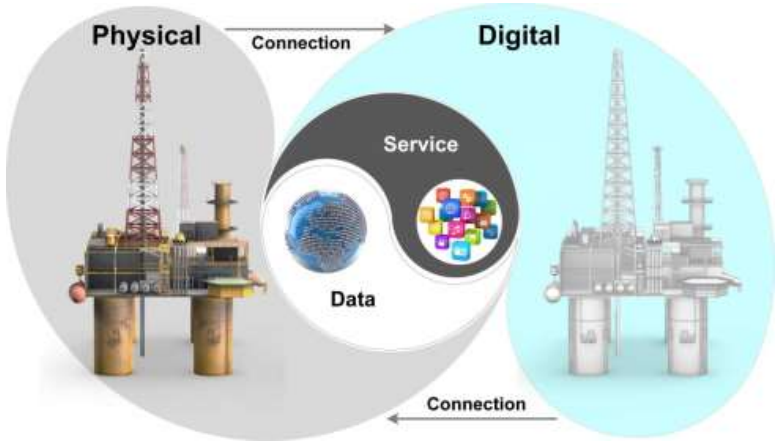
Use Sensors, Citizen Science Apps & SM posts to Evaluate Clean up

ILIAD Pilots Classification

A DT is a digital replica that maintains data and dynamics information in parallel with every individual component of a real-time system (Kim et al., 2020).

Two – way Digital Twins

Sensors
Models
Big Data
Cloud storage
ML and AI
algorithms



Operations
Controls
Optimization
Diagnosis
Decision Systems

Engineering DTs
Industrial
Maritime DTs

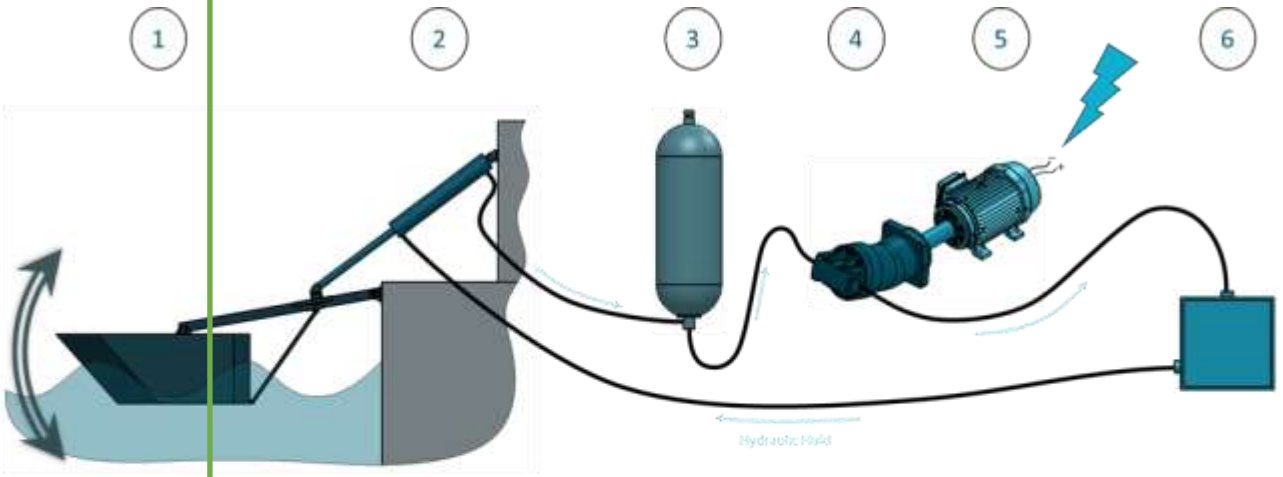
The WEC DT

Offshore winds

Offshore waves

Waves Transformation

Nearshore waves → Sensors WEC Models →



1 Floater	2 Piston	3 Accumulator	4 Hydraulic Motor	5 Generator	6 Hydraulic Fluid Tank
Floater moves with motion of waves	Motion moves a piston, compressing hydraulic fluid	Accumulator stores compressed fluid	When compressed fluid is released, the energy turns a hydraulic motor	Hydraulic motor turns an electric generator, producing clean electricity	Hydraulic fluid returns to a tank, where it is stored until the next wave

→ Electricity Production

Electricity Storage

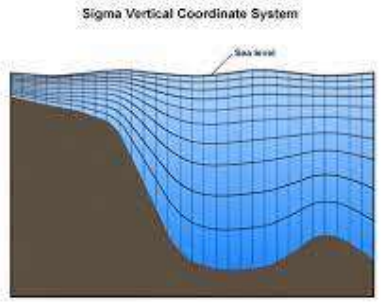
Electricity Grid

DT Services

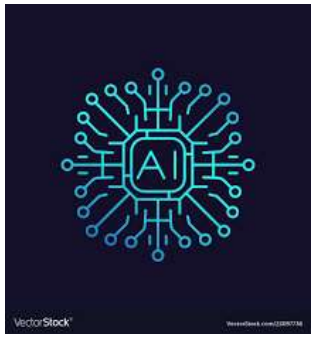
Wave farm optimization layout; operational decision-making; prevention of mechanical damage from extreme wind/wave loadings; corrosion alert; Operational prognostics; siting assessment.

ILIAD Digital Twin Ingredients and Novelties

Sensors
Gliders
Drones
MPS
Drifters
Ecosounders
LiDAR
Low-cost Sensors



Models
Coupled,
Downscaled
Hydrodynamic
Wave
Biogeochemical
Ecosystem
Oil Spill
Fish & Mussel
GFD to CFD



AI Algorithms
Data Fusion
Data Analytics
Data-driven Models
Machine Learning
Pattern Recognition
Event Detection

Existing Resources
Satellites
Sensor Networks
Databases
Large-scale Models

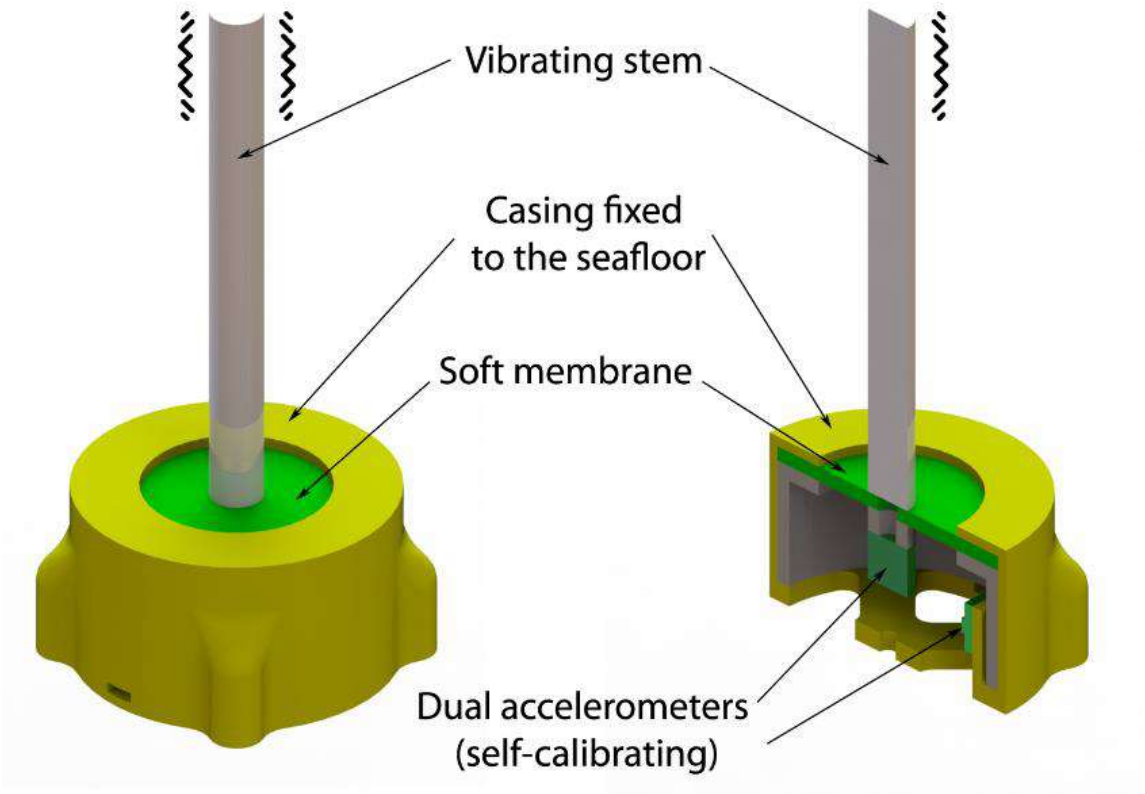
Citizen Science
Networks
Reporting Apps
Social Networks
Semantics

DTO Platform
Federated
Interoperable
Data Collector
Simulator
Control Room

Dashboards
Geo-Visualization
User XP, VR

Sensors in ILIAD – Hydromast (Taltech)

Hydromast was developed within H2020 Project LakHsMi



- Ship wake detection and ship traffic monitoring
- Wave action monitoring
- Surf zone bedload flow speed monitoring
- Current monitoring

Flow and wave meter: Hydromast (TalTech)

The **hydromast** is a flow and water level point measurement device. The hydromast allows to measure instantaneous flow changes based on the tilt of a cylindrical mast on the device and continuous average flow magnitudes based on vortex induced vibrations on the same mast. The incorporated pressure sensor on the device allows to measure changes of the water column and also waves if installed in close vicinity of the water surface.

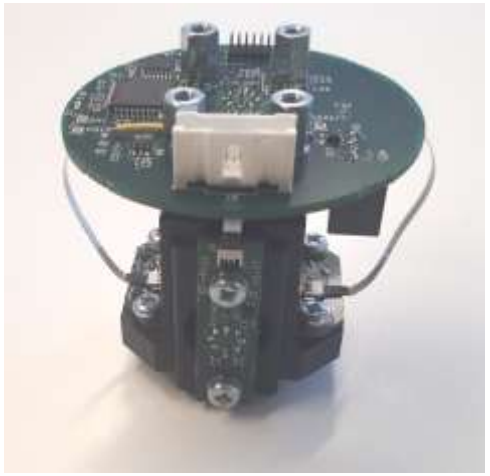
	Mechanical	*Electrical*	*Connectivity*
Specifications	Base: 80x45mm, total height up to 400 mm, depending on desired velocity range Material: POM, stainless steel, mast covered with Cu sheet Fixation: Upright, bottom mounted Connection: Wet SeaCon 4-pin connectors	Input Voltage: 5 – 12 V (possible to extend to 30V) POE available Data Rate: Interval, sampling rate 50 Hz Data logging: RS485 serial or stand-alone logging with batteries	Ethernet GSM(2G,3G,4G) WiFi LoRaWAN Serial: RS-485

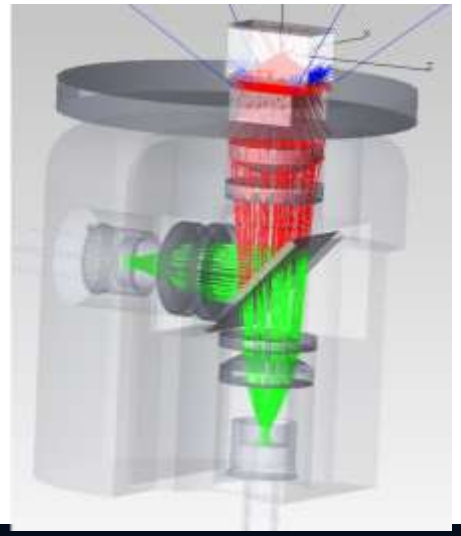
	Maintenance	*Collection of Data*
Requisites	Once per 3 months On demand basis	Through AWS IoT service using secured MQTT protocol Local storage of data possible

Next steps for deployment (including estimated dates):

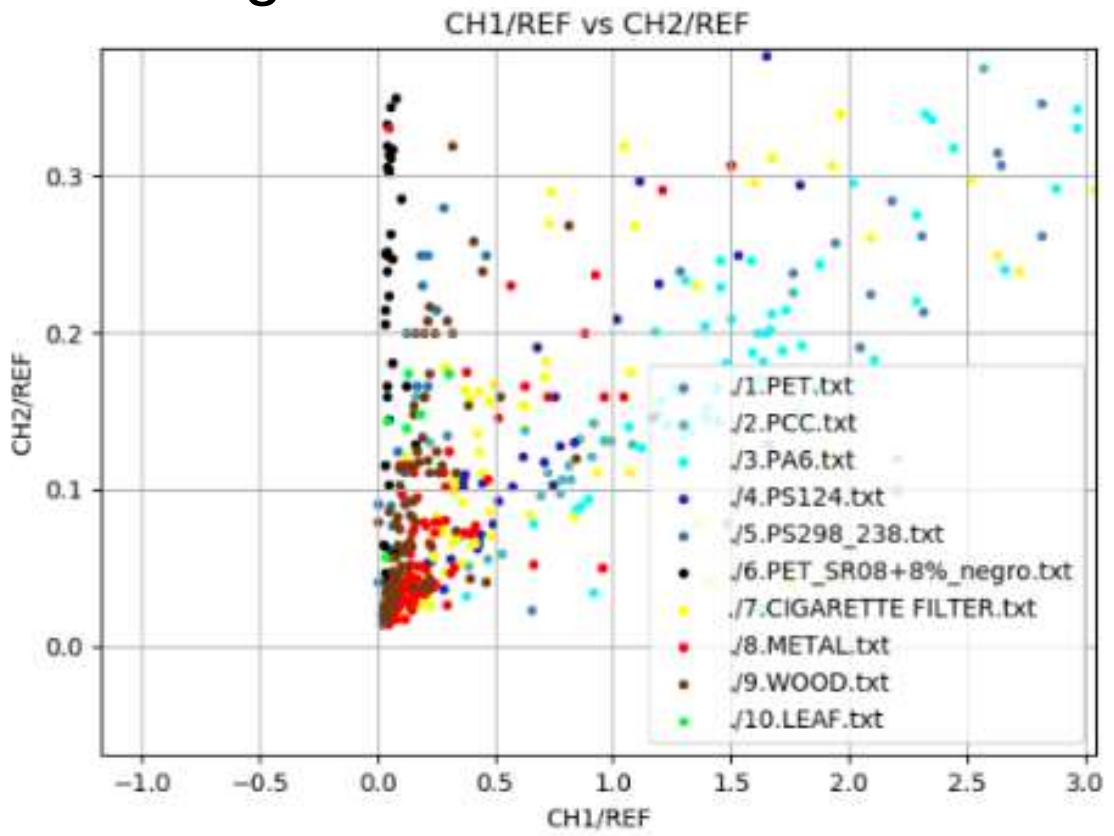
- Offline tests and validations done on sediment study by TalTech (August 2022)
- **Sensor deployed at**: Talin, Crete (Heraklion) and Israel (Jaffa)
- **LoRaWan protocol tests** ongoing (started March 2023)
- **Sensors available to partners**: Varna port, Adriatic coast (AMA), Valencia port, Iraklion Port

Sensors in ILIAD – MPS (LEITAT)





MPS monitoring based on the RT analysis of the fluorescence light emitted by plastic particles when they are excited with a UV light source.



UAV Video Analysis and Reporting (Alpha)

Alpha develops an app that, based on **AI video analysis generates reports and/or notifications upon the occurrence of an detection event**. The app will be used to (1) **detect external damages on the structure of wind turbines**; and (2), **early detection of off-shore jellyfish swarms**. In both cases it will generate an **image with metadata about its location**. The image(s) will be sent to the pilot servers, enabling to trigger automated actions using its information, such as **notifications or the generation of maintenance reports.**

	Software features
Specifications	• Real time video analysis of video feed. • Configurable confidence threshold and detection parameters • Scalable, being able to use CPU, GPU or Multi - GPU racks for video analysis. • Able to ingest remote video feed to use remote processing power. • Adaptable to every drone model exposing an interface

	Collection of Data
Requisites	• Detection models need to be trained in advance • UAV Autopilot need to expose an interface to gather its location information. • Nvidia RTX 2060 or better are recommended to obtain decent FPS in the analysis.

Next steps for deployment (including estimated dates):

- Gather additionally imagery and train models (06/24)
- Finalize app development (06/24)

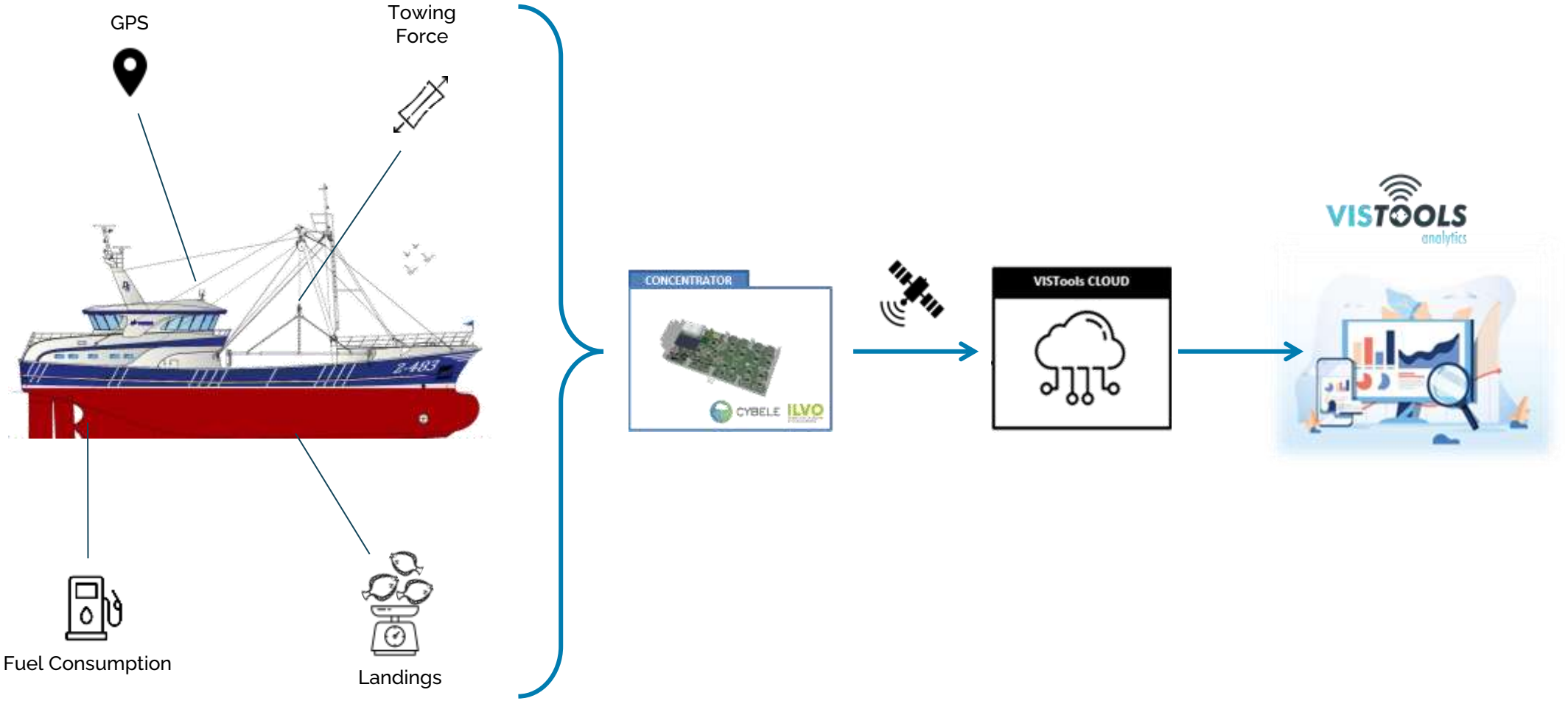
Sensors in WP2 – SeaExplorer (Alseamar)

Alseamar will perform 12 months data acquisition with gliders, equipped with 2 different payloads:

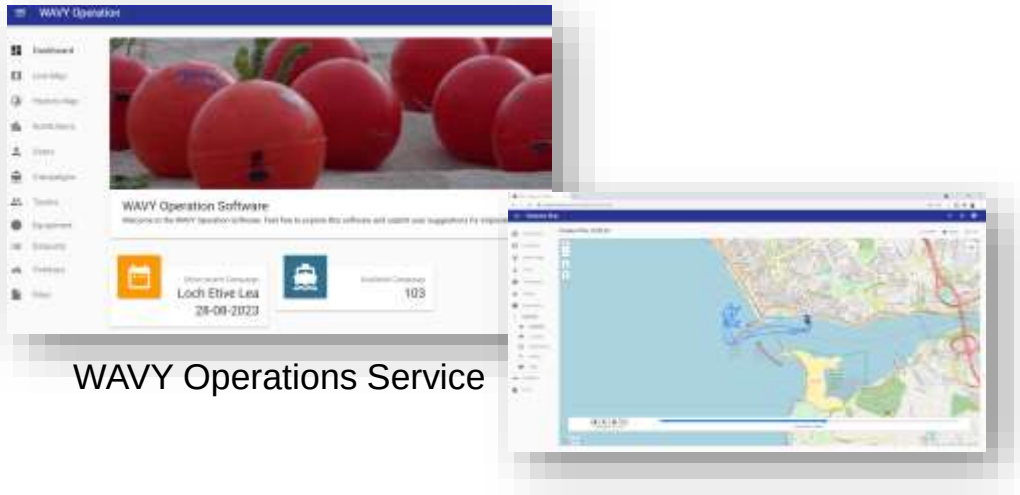
(1) the anoxia payload – equipped with sensors like CTD, Chl-a, turbidity, CDOM, Dissolved Oxygen, Methane, Hydrogen Sulphide and CO2,

(2) the ecological payload - CTD, Chl-a, turbidity, CDOM, zooplankton.

Sensors in WP2 – ILVO sensors



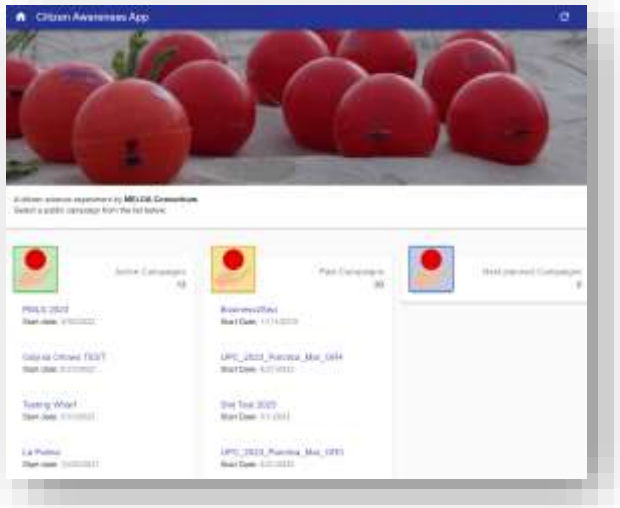
WAVY - User Applications



WAVY Operations Service

(selected) features:

- operations planning
- deployments management
- data management
- data processing
- datasets management and curation



Citizen Awareness

(selected) features:

- real time
- open access
- limited disclosure of the data
- Involve general public in campaigns

Wavy configuration App

Fishing Effort Sensors (ILVO)

Sensors	Data Collection	Data Storage	Analytics	Visualisation
GPS, Fuel, Scale and Towing force	3 vessels operational 2 vessels incomplete sensors	Operational, scaleable	basic analytics completed Scaleable -	operational for 4 vessels (PowerBI) Scaleable
TD sensor (Moana)	installed on 3 vessels (2 vessels sending data)	Operational, scaleable	coupling to tow/trip done – link to R package	In R
CTD and TBD sensor (NKE)	vessel A has CTD and vessel B has TBD	operational (when data is received), scaleable	coupling to tow/trip done – link to R package	In R
Weather station	installed on 2 vessels	servers ready to receive data	coupling to tow/trip done – link to R package	In R

Towing Force

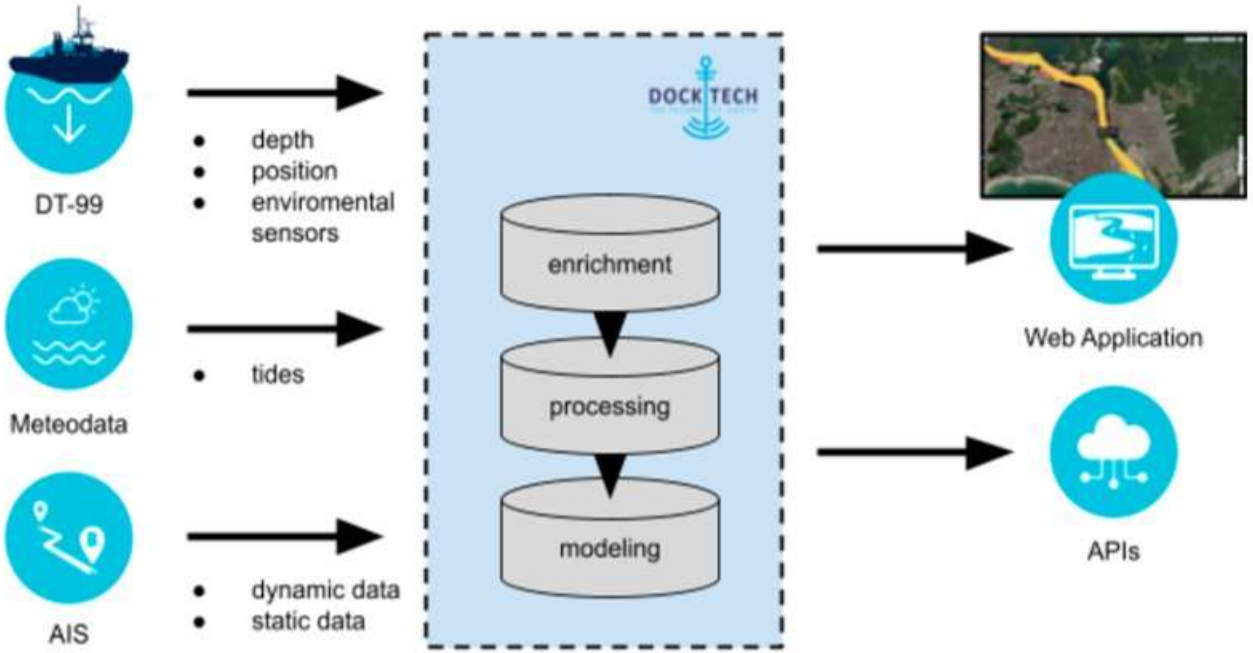
Scale

GPS

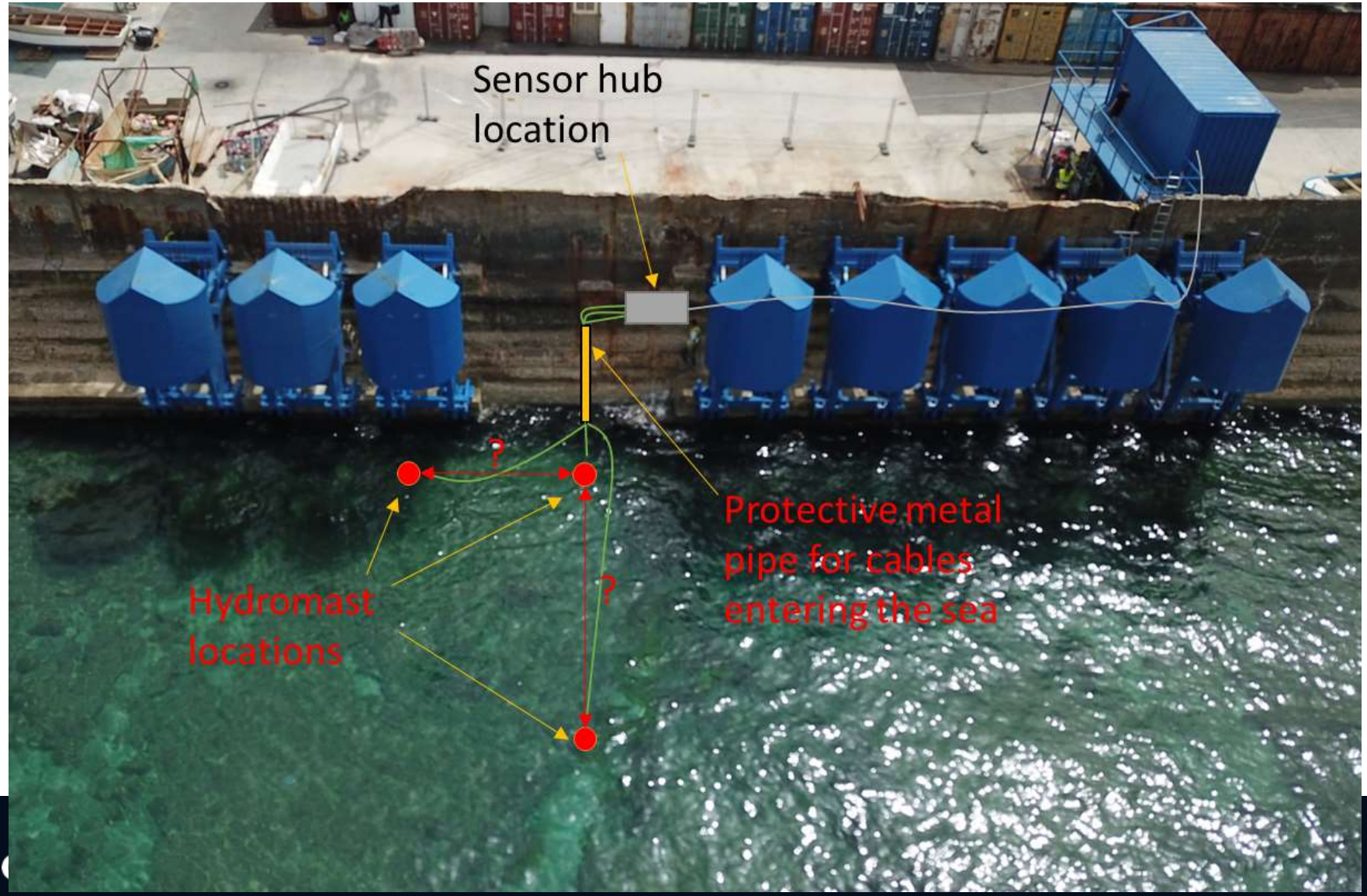
Engine

Concentrator
(centralisation of data)

Sensors in ILIAD – DockTech sensors



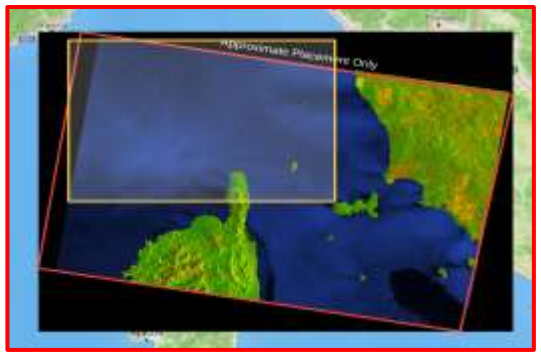
Sensors in Operation at Jaffa Port – WEC DT



Data acquisition and Retrieval – Oil Spill DTs

In-situ data for the Cretan Sea Oil Spill pilot are also provided by HCMR's Poseidon System Fixed Mooring Buoys

Meteorological data (wind speed and direction, air temperature, humidity, precipitation) from local meteorological stations and NOAA METAR observations



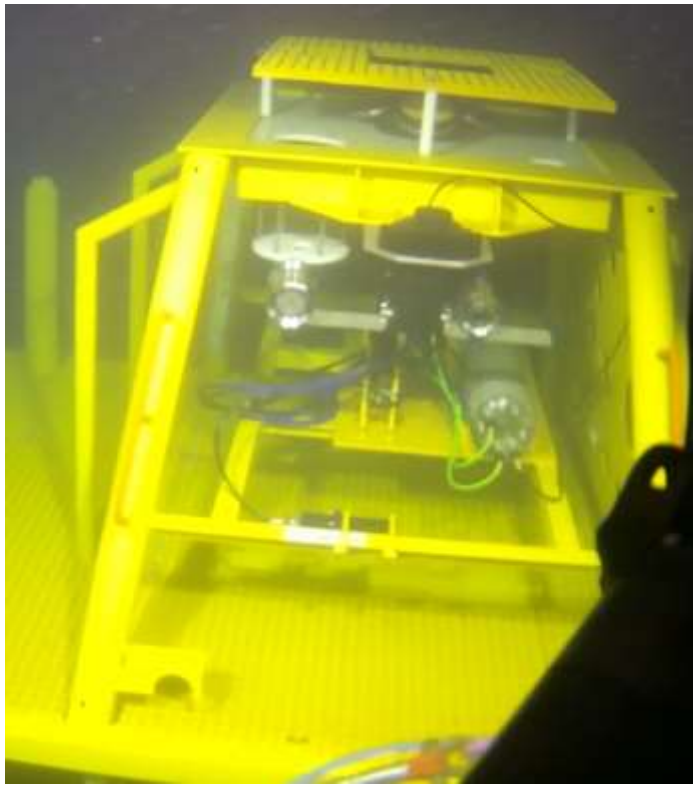
Sentinel-1 images to detect oil spills

Marine Copernicus Med Sea Physics & Waves products:MEDSEA_ANALYSISFORECAST_PHY_006_013 MEDSEA_ANALYSISFORECAST_WAV_006_017

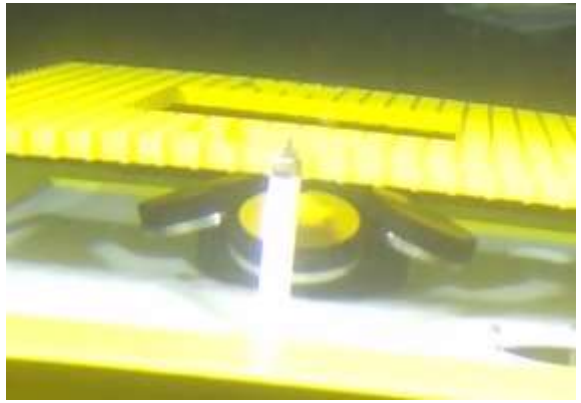
NOAA GFS solution 0.250 resolution

GEBCO bathymetry

Buoys and benthic Lab | Lander – Water Quality DT



Buoys and benthic Lab | Lander – Water Quality DT

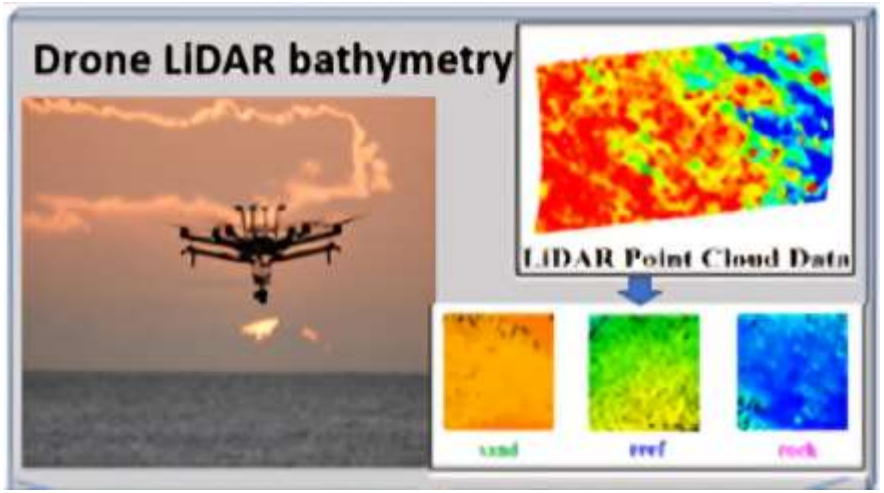


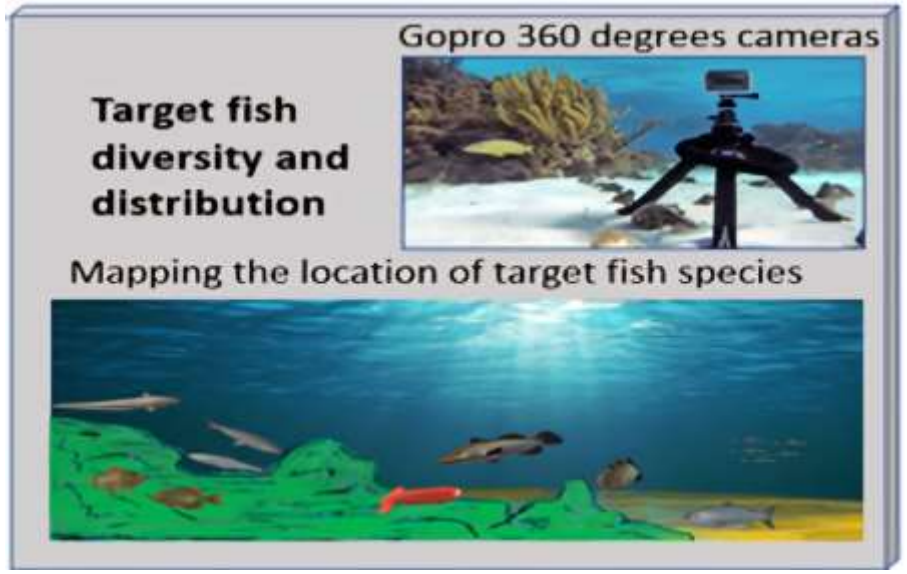
ADCP and CTD from the benthic station

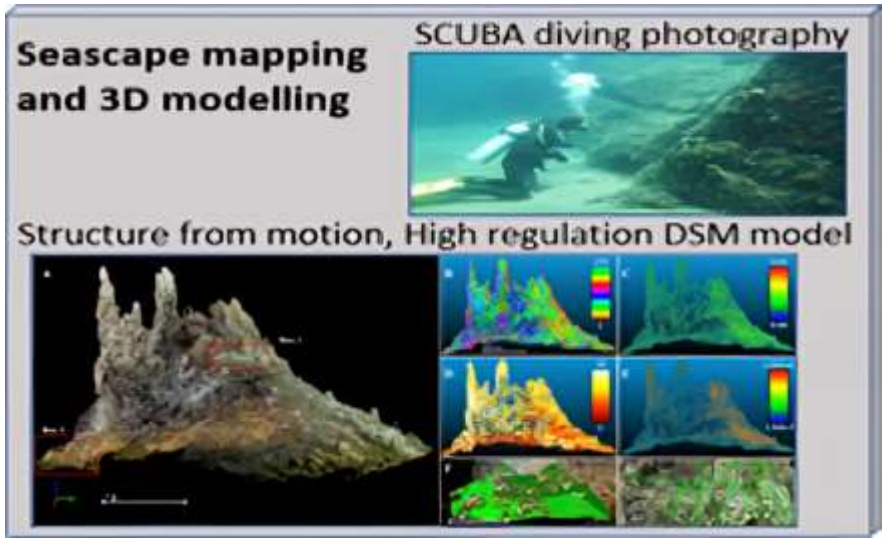
Weather station and SilCam on the buoy

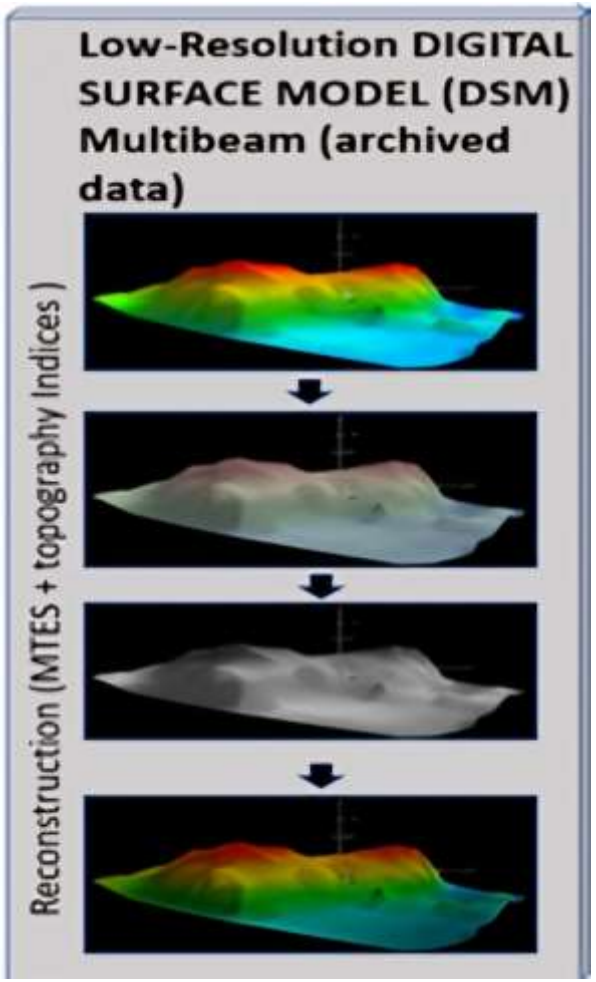
Microplastic sensor testing on the buoy

Data acquisition | input data – Biodiversity and SeaScape DT

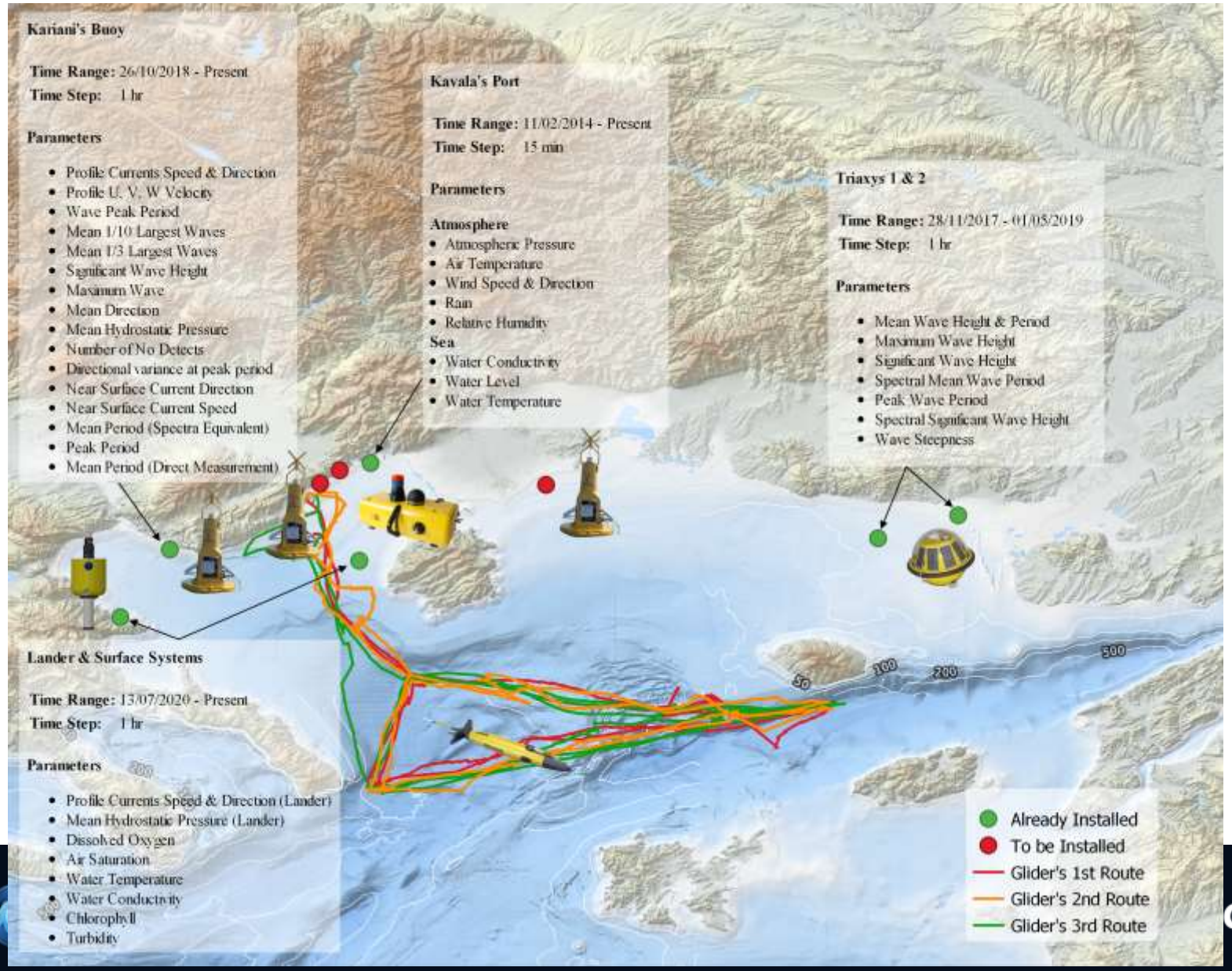




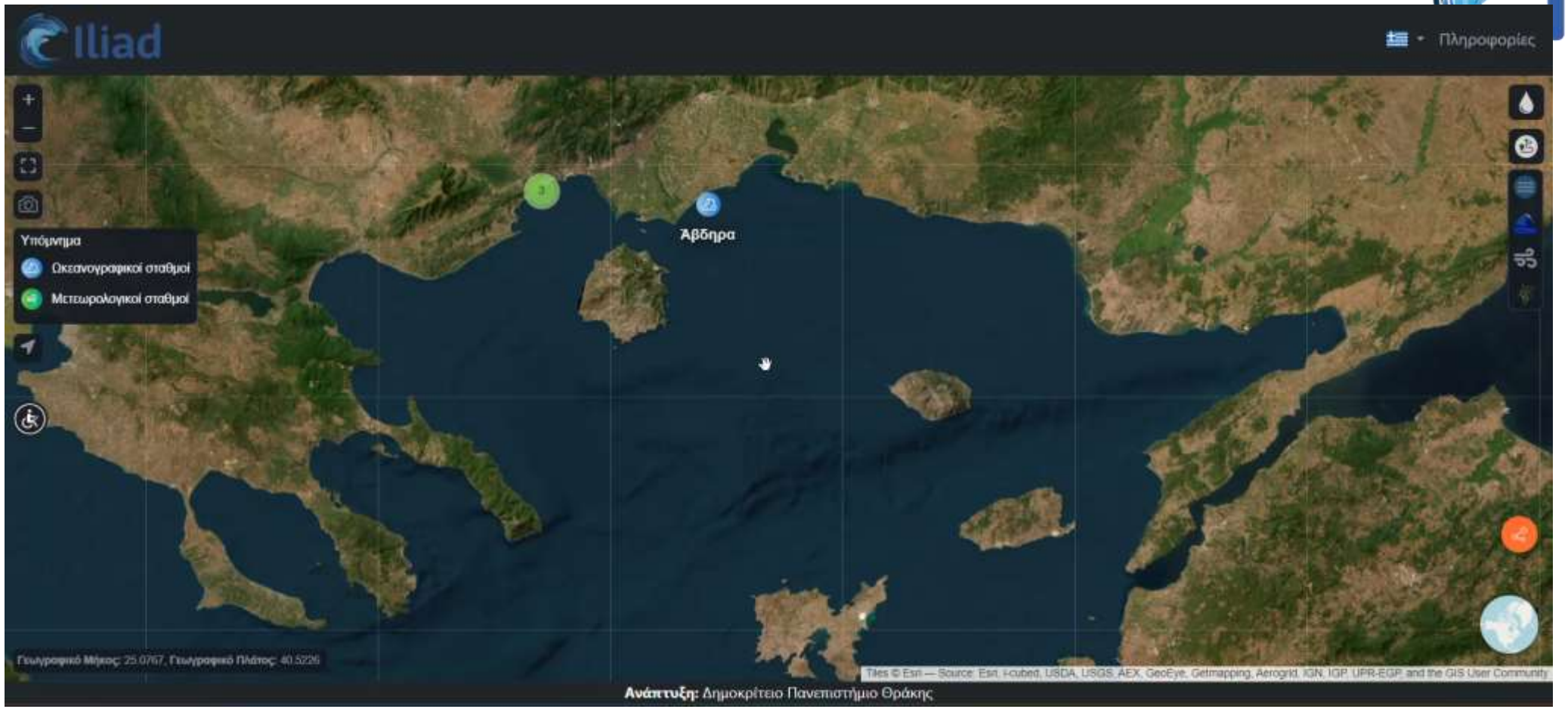




Data Acquisition and RT Transfer | Oil Spill DT



- 4 ADCPs for 3D currents, waves and SPM monitoring
- 1 surface water quality station (SST, S, DO, Chl, pH, SPM)
- 2 Wave riders (wave height, period and direction)
- Glider surveys (T, C, S, σ_t, CDOM, SPM, DO)


Iliad
Πληροφορίες
Άβδηρα
Υπόμνημα
Ωκεανογραφικοί σταθμοί
Μετεωρολογικοί σταθμοί
Γεωγραφικό Μήκος: 25.0767, Γεωγραφικό Πλάτος: 40.5226
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Ανάπτυξη: Δημοκρίτειο Πανεπιστήμιο Θράκης

Thank You

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