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Deliverable 6.2

Description of data flows, manuals and training materials

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Abstract	The document covers an overview of the HiSea platform, data acquisition methods, analytical services, manuals, training materials, cost-effectiveness analysis, and final remarks. The ULTFARMS project integrates advanced monitoring technologies and database management through the

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	HiSea platform to optimize low-trophic aquaculture activities, reducing production risks by integrating various data sources and providing user-friendly decision support tools.
Keywords	Low-trophic aquaculture, offshore wind farms, monitoring, Decision Support System, HiSea platform

History of changes

Version 1.0	December 2023	
Version 2.0	December 2024	The reviewers' comments were addressed by including tables for each pilot with the data being collected and a timeline for integration in the HiSea platform. Manuals and training materials have been added as annex to the deliverable. Pilot descriptions have been updated with recent information. The minimum metadata requirements for data upload have been included.

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Table of contents

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Acronyms

CTD (instrument)	Conductivity, temperature, and depth
LTA	Low-trophic aquaculture
MU	Multi-use
OWF	Offshore wind farm
PAR	Photosynthetic Active Radiation

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Executive Summary

Ocean multi-use is becoming increasingly important due to the growing need for renewable energy, sustainable food production, and the competing demand for the use of space and resources. One of the possible multi-use options is the integration of aquaculture into offshore wind farms. This combination is the focus of the ULTFARMS project, which aims to develop and operate six low-trophic aquaculture pilots in offshore wind farms across the North and Baltic Seas. One of the goals of the project is to optimize low-trophic aquaculture systems in harsh offshore conditions and low salinities, using novel engineering, technical, ecological, and biological processes to optimize production and integration of these activities.

Efficient environmental monitoring strategies are important to ensure successful multi-use scenarios. Choosing the best type of multi-use for a specific site depends largely on the availability of hydrological and environmental data for that location. Monitoring is also essential for process control, to meet legal requirements and to provide references for future licensing procedures. Location-specific data also allow for tracking environmental impacts and determining appropriate operation windows at sea. To achieve these purposes, an IT platform developed in the framework of the previous H2020 EU HiSea project, capable of properly managing different types of data, models and algorithms, and publish/distribute information in fitted to use forms, is adopted in the project.

This document reports on Task 6.2 of the ULTFARMS project: "Integration of monitoring technologies & data-base management and Services". The objective of this task is to offer a service that integrates advanced monitoring technologies and database management for effective monitoring and decision support for low-trophic aquaculture activities in the ULTFARMS pilots. The resulting deliverable describes the HiSea platform, its main components, data flows, services, manuals and training materials to support the integration of data from various sources, such as satellites, buoys, ships, and models, and a user-friendly interface for accessing and visualizing the data. The platform goes beyond data visualization by supporting operational or on-demand tasks that can assist in decision making or future planning of pilot activities.

The deliverable is organized as follows. First, it provides an overview of the HiSea platform and its main components. It then presents the data acquisition methods and the public data already available on the platform. This is complemented by the additional data flows that the pilots consider relevant to include in the future. The following section is focused on the platform's analytical services, which include calculation services, alerts and notifications, and other services desired by project partners and pilots. The deliverable concludes with a summary of available manuals and training materials, an analysis of the cost-effectiveness of the suggested monitoring strategy, and final remarks.

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1. Introduction

1.1 Description of the project

The ULTFARMS project aims to move beyond the current application of Low-Trophic Aquaculture (LTA) systems with novel engineering, technical, ecological and biological processes to optimise production in harsh offshore conditions, low salinities, and their integration within Offshore Wind Farms (OWFs). ULTFARMS will cover the whole value chain expertise for LTA production in OWFs. The project will work with research and industry partners to develop and operate six innovative Low-Trophic Aquaculture Pilots (LTAPs) in six different OWF locations across the North and Baltic Seas.

These six pilots are implemented in the following areas (Table 1):

Table 1: Overview of the six LTA pilots of ULTFARMS.

Member state	Name of OWF	LTA production
Belgium	Belwind	Seaweed-Mussels-Oysters
The Netherlands	Borssele	Mussels
Germany	FINO2	Seaweed
	FINO3	Seaweed-Mussels-Oysters
Denmark	Anholt	Seaweed-Mussels
	Samsø	Mussels

Efficient environmental monitoring strategies are important to ensure successful multi-use (MU) scenarios. Choosing the best type of MU for a specific site depends largely on the availability of hydrological and environmental data for that location. Moreover, monitoring is essential for process control and to meet legal requirements and can be useful to provide references for future licensing procedures. Location-specific data also allow for tracking environmental impacts and determining appropriate operation windows (e.g., avoiding severe weather, currents or extreme waves, or unsuitable water temperatures for the cultured species). To achieve these purposes, an IT platform developed in the framework of the previous H2020 EU HiSea project, capable of properly managing different types of data, models and algorithms, and publish/distribute information in fitted to use forms, is adopted in the project.

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1.2 Brief description of pilot activities

1.2.1 Danish pilots

The wind farms of Samsø and Anholt are operated by Wind Estate and Ørsted respectively. Previous studies have shown that Danish waters have the potential for LTA production, and the mapping exercises conducted, which denote areas of production potential, include the Samsø site. The two locations are very promising for the production of sugar kelp (*Saccharina latissima*) and dulse (*Palmaria palmata*). Anholt and Samsø also provide unique opportunities for mussel cultivation.

For the pilot at Anholt, the farm structure consists of three longlines and with the potential of adding one-two submersible PE tubes with nets depending on pending test results from coastal areas. The longlines and tube-nets are 100m of working line with buoys and concrete blocks for balanced buoyancy/ballast. In autumn 2023, two longlines were established for seaweed deployments of sugar kelp (*Saccharina latissima*) and dulse (*Palmaria palmata*). In spring 2024, a third line was established and after harvest of the seaweed on the existing two longlines, two longlines was prepared for mussel farming by deploying continuous spat collectors of different materials. Two submersible PE tubes with nets (3m deep) for mussels are deployed at a controlled test site in Limfjorden for ongoing tests in an easy assessable area.

Samsø is a commercial mussel farming test site, where the farm structure consists of two tube-nets (3 m deep) on the surface. These were deployed in spring 2024.

1.2.2 German pilots

The German pilot is operating at two pilots and a nearshore site. At the near shore test site in Kiel in the Baltic Sea with a relatively low salinity of up to 12 PSU, calm and sheltered conditions, and a water dept of up to 12 m. The nearshore site allows for testing of equipment and algae cultivation techniques that can be transferred later to the Baltic Sea offshore site FINO2 in the Baltic Sea. The location Fino2 represents harsh weather conditions in most months of the year with a water depth of 22 m in between three wind parks and a low salinity environment with typical short hard waves but overall lower current speeds, compared to the North Sea. Salinity going down to 9 PSU, ruling out mussel cultivation due to low growth rates. Focus is given to algae cultivation. The second German location is FINO3, located in the North Sea, operating 80 km offshore. This site represents the harshest of all ULTFARMS pilot locations with max. wave height of 18 m and a significant wave height of 9 m with strong currents.

The production-related activities within the German pilots are mainly focused on the best available and adapted cultivation techniques intending to increase the maximum biomass gained for seaweed (*Saccharina latissima*, *Ulva intestinalis*) and shellfish (*Mytilus edulis*, *Ostrea edulis*) aquaculture. In the German North Sea pilot different seeding techniques are explored in close collaboration with Hortimare for the harsh offshore currents as the wave and tidal conditions impact the juvenile growth stages of *Saccharina*. For the cultivation of blue mussels (*M. edulis*), four different commercial net types with varying mesh sizes and materials have been chosen to investigate the ideal substrate for the offshore conditions. The cultivation of oysters (*O. edulis*) is envisioned to focus on the grow out of larger mussel spat (>3cm) to reduce mortality, but also to design a most well adapted system for the conditions at the FINO3 site.

1.2.3 Dutch pilot

The Dutch pilot focuses on offshore mussel aquaculture in the wind farm Borssele, in combination with nature-inclusive elements to promote biodiversity. The offshore windfarm Borssele is located about 55 kilometres from the Port of Vlissingen, Netherlands. It consists of four major areas, of which sections III and IV are owned and operated by the consortium Blauwwind. The multi-use planning for these two areas includes a section dedicated to the integration of aquaculture within the wind park. Borssele III is the location where a Submersible Mussel Farm (SMF) is planned to be deployed in the future, and where a small-scale test model (5 longlines of 200 m) will be deployed.

To withstand the strong and adverse offshore conditions in the Dutch North Sea, a depth-adjustable Submerged Mussel Farm (SMF) Platform was designed by OOS for Borssele Offshore Windfarm. This system will utilize a semi-submersible platform as a central point from which the cultivation longline will run. This central platform will serve as the connector point and will remain almost fully submersed in order to guard the aquaculture lines from the harsh environment. The unique line deployment system to be implemented in this configuration is relatively denser than many existing configurations. The system is estimated to have a high potential for other low trophic aquaculture besides mussels. The test platform and longlines were installed in Borssele III in 2024 and dropper lines will be installed in 2025.

The full-scale SMF platform is still under development and will not be ready within the timeframe of the ULTFARMS project. First, a small-scale pilot SMF consisting of 5 lines of 200 m in Borssele Offshore Windfarm was installed in 2024. In December 2023 a 'go' was given for this project. Meanwhile we used a nearshore mussel farm and a nearshore reef area for testing various monitoring techniques that later can be used offshore. This nearshore mussel farm was installed in the Voordelta in August 2023.

Moreover, other activities in the pilot involve applying Biodegradable EcoSystem Engineering Elements (BESE) structures underneath the mussel cultivation system in the Borssele windfarm to enhance nature on the seabed, possibly resulting in a reef (*Sabellaria spinulosa* or *Lanice conchilega*, blue mussel *Mytilus edulis*, or the native European oyster *Ostrea edulis*) that can enhance and support ecosystem functioning. BESE elements are 3D, biodegradable structures made of potato starch that are used to kickstart ecosystem restoration, by providing a temporary protection and structure for organisms to grow. A first nearshore test with BESE elements took place in 2024 in the Voordelta.

1.2.4 Belgian pilot

The Belgian Pilot will combine mussel, oyster and seaweed cultivation alongside nature restoration efforts within an offshore wind farm. The pilot consists of two nearshore testing sites – the Blue Accelerator test platform in front of Ostend, Belgium and a nearshore test location in front of Bantry, Ireland – and an offshore site situated within the wind farm Belwind, operated by Parkwind.

The production activities in the Belgian pilot involve a seaweed longline system with the novel Impact-9 system employing a submersible seaweed longline. The pilot also includes a novel design that involves restoration tables and settlement mooring systems, to include restoration in low-trophic aquaculture farms.

Restoration plans for the Belgian pilot have been developed by UGent and RBINS. The purpose is to develop a model of LTA-OWF multi-use that supports conservation and restoration of European Flat Oysters. These oysters are a key species in the North Sea, thanks to their reef building capacity, but have locally disappeared because of overfishing, diseases and habitat loss.

LTA brings the opportunity to have an easy and cost-effective way for the introduction of mature oysters with the cultivated stock. This is necessary, for the oysters cultivated are too young and will not stay long enough at sea to reproduce (they are harvested after two years). The combination with OWF brings the advantage of an area in which fishing and bottom-disturbing activities are excluded, allowing for biogenic reefs to build themselves over time.

While the idea is to test the model effectiveness in the Belgian pilot of ULTFARMS, in the future it is meant to be used in areas where oysters were naturally occurring in the past, such as the Princess Elisabeth Zone and the Vlaamse Banken.

1.3 Objective of task 6.2

This deliverable reports on task 6.2 of ULTFARMS: "Integration of monitoring technologies & data-base management and Services". This task ensures the efficiency and the cost-effectiveness of the proposed monitoring strategies, including global data sets downscaled per pilot combining all types of monitoring in a comprehensive monitoring framework. This is possible by taking advantage of the platform developed in the H2020 HiSea project and making use of its various components and layers, such as data servers, interlinkages with models and simulations, dynamic visualization, algorithms and user interaction at TRL 9. The services include operational or on-demand tasks aiming to support the daily decisions and/or future planning as being described in T6.3. The goal will be to

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offer a service at a TRL 9. Manuals and training materials are reported in this deliverable.

2. The HiSea platform

The ULTFARMS project, under the umbrella of the H2020 initiative, has adopted the HiSea platform as its primary tool for data integration and visualization. The project chose the HiSea platform because of its robust capabilities and alignment with its objectives.

The HiSea platform stands out for its modularity. This feature ensures that the platform can adapt without significant overhauls as the project evolves and the data needs become more complex. It can seamlessly integrate various data sources, whether from public repositories like CMEMS and Gloss or private data exclusive to pilot sites. This flexibility ensures stakeholders have access to a comprehensive data set, enhancing the quality of insights derived.

Another significant advantage of the HiSea platform is its customizable user interface. In today's data-driven world, the ability to visualize data effectively is paramount. The HiSea platform addresses this by allowing users to configure dashboards tailored to their needs. These dashboards, essentially a collection of widgets, present relevant information in an easily digestible format. The user can choose and customize whether it's a graph showing water quality metrics or a map highlighting specific operational activities.

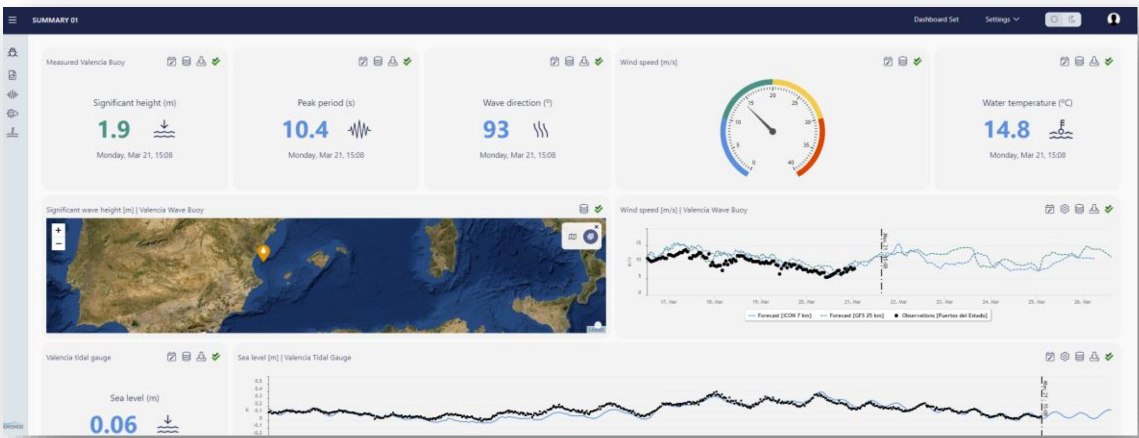

Figure 1. Sample dashboard in the HiSea platform.

While the HiSea platform has an intricate and robust backend, it presents the end-user with a simplified and intuitive interface. The configurable dashboards, displaying maps, charts, and reports, enable users to analyze the underlying geospatial data interactively. This geo-visualization capability empowers users to explore, synthesize, and present data, enhancing their decision-making process.

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The HiSea platform further emphasizes its modularity on the backend. It is architected using a microservices approach, ensuring each component operates independently yet cohesively. This design allows for the accessible accommodation of new data sources through downloads, uploads, or even calculation workloads. The beauty of this approach is that new features or data sources can be added without making significant changes to the platform itself, ensuring longevity and adaptability.

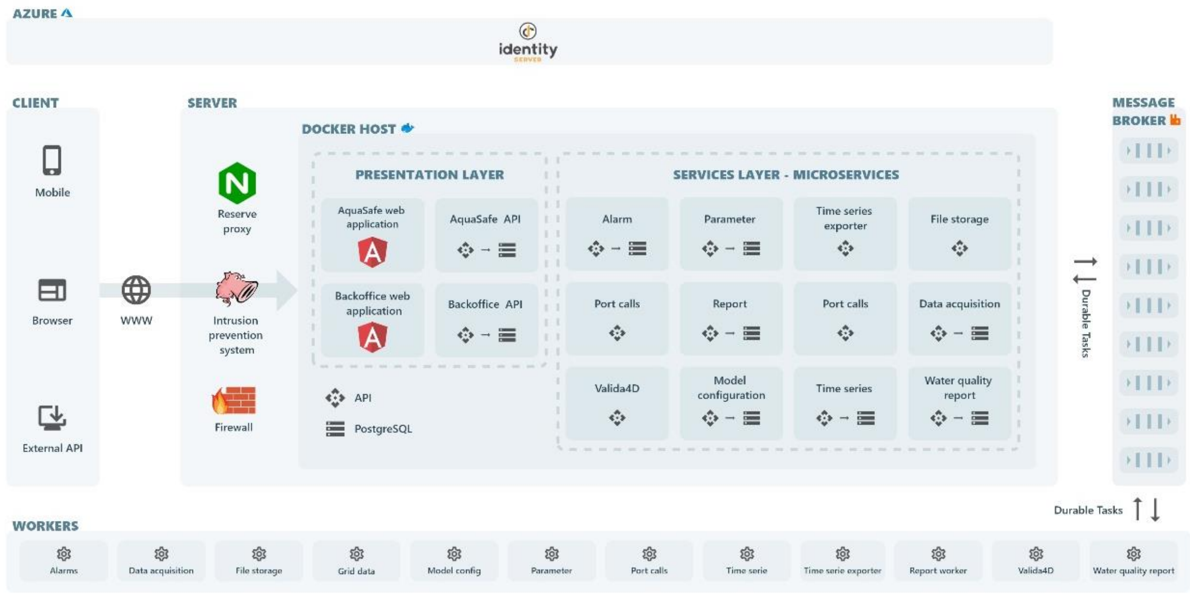

Figure 2. The HiSea platform backend.

In today's digital age, data privacy is paramount. The HiSea platform takes this seriously and ensures all data remains private by employing a project-based approach. Data and users are associated with specific projects, distinguishing access and rights. This structure provides data privacy and streamlines user management, making it easier for administrators to control access and permissions.

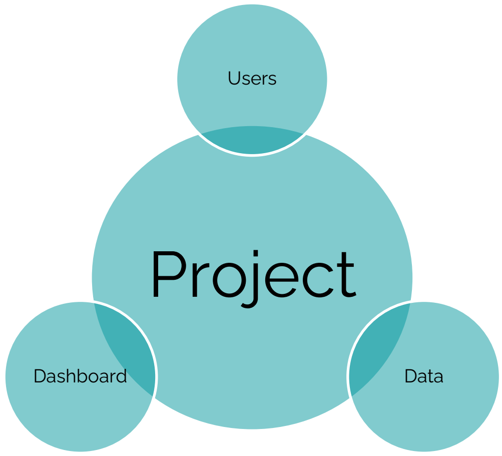

Figure 3. Project associating users, data, and dashboards (who, what, how).

When the administrator creates a project, he assigns users and data. This process ensures that only the users associated with that project can see the data. The same data set can be associated with multiple projects and users.

Another exciting feature is that projects can be public. Any user registered in the platform can see the dashboards from these projects in a read-only mode.

The HiSea platform's capabilities extend beyond mere data visualization. It offers potential value creation for the involved partners, paving the way for pioneering technology in the aquaculture industry. ULTFARMS leverages the platform to develop what-if scenarios, analyzing the impact of various measures. Such analysis aids in enhancing productivity and control, both of which are essential for future competitiveness. The proposed approach aims to refine management practices for LTA, monitor equipment, structures, and biomass, and optimize daily operations, thereby reducing production risks.

In conclusion, the HiSea platform, focusing on modularity, user customization, and real-time responsiveness, has the potential to significantly enhance the ULTFARMS project. As the project progresses, the platform's capabilities will undoubtedly prove invaluable, driving insights and fostering a culture of data-driven decision-making.

3. Data flows

The ULTFARMS project emphasizes the importance of efficient data flows to ensure comprehensive monitoring strategies. Central to this is the HiSea platform's modular approach to data acquisition, designed to be flexible and robust.

3.1 Pull Data Acquisition

One of the primary methods the HiSea platform employs for data acquisition is the "pull" approach. The pull method configures the HiSea platform to download data

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at regular intervals from specified sources. Such a configuration proves particularly useful for data sources that update their datasets periodically, including satellite imagery, weather forecasts, and oceanographic data. By setting up scheduled downloads, the HiSea platform ensures that the most recent and relevant data is always available for analysis and visualization.

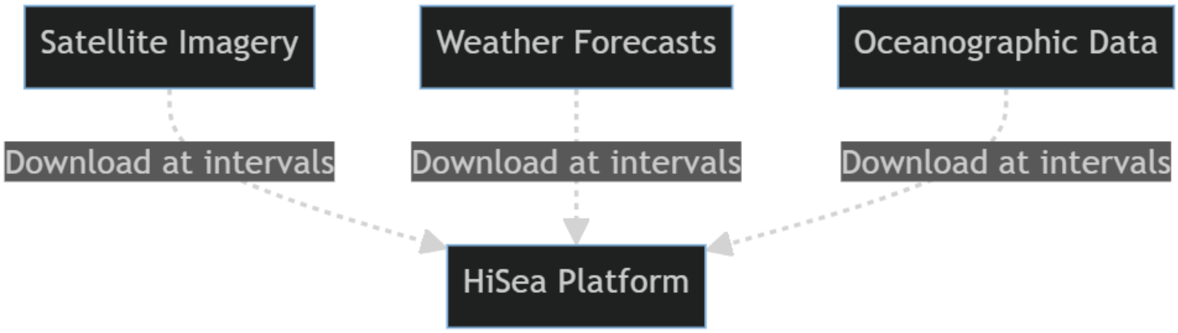

Figure 4. Pull data acquisition.

The HiSea platform employs a systematic approach to the pull data acquisition methodology, ensuring that data integration is efficient and tailored to the project's needs. The platform divides this process into four distinct steps:

1. Data Enumeration:
    a. Purpose: In this step, the platform determines which "files" or datasets are relevant for the download operation. It's a crucial phase as it sets the stage for the subsequent steps, ensuring that only pertinent data is acquired.
    b. Customization: The platform already contains multiple plugins to convert dates into a list of files to download. The consortium will develop new Plugins to accommodate the partners' specific requirements or preferences if necessary.

2. Data Acquisition:
    a. Purpose: Once the platform enumerates the datasets, it transfers the data from the remote system to local storage (using protocols like FTP, OPENDAP, etc.), making it readily available for processing and integration.
    b. Customization: The acquisition process can be enhanced or modified using plugins, allowing for flexible data transfer protocols or methods.

3. Data Conversion:

a. Purpose: After acquiring the data, it's essential to ensure consistency in format and structure. This step transforms the downloaded data into HiSea's specifications, ensuring uniformity and compatibility.
b. Customization: Plugins can support various data transformation techniques or accommodate unique data structures the project partners use.

3.2 Push Data Acquisition

In contrast to the pull method, the "push" approach allows external sources to send data directly to the HiSea platform. Data streams achieve this by continuously or intermittently pushing data into the platform in real-time or near-real-time. This method is ideal for sensors, IoT devices, or other data sources that generate continuous streams. The HiSea platform can accommodate dynamic datasets by supporting push data acquisition, ensuring timely insights and responsive decision-making.

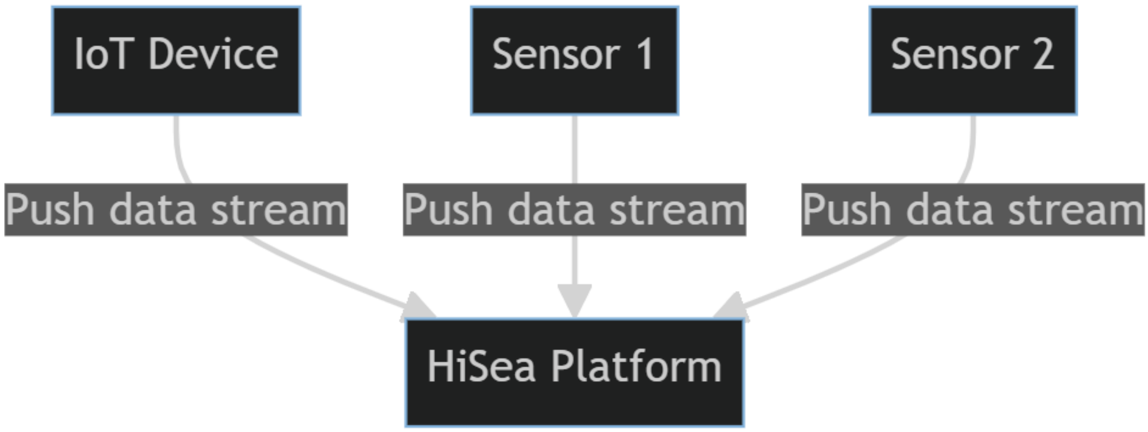

Figure 5. Push data acquisition.

The HiSea platform emphasizes security and specificity in its push data acquisition methodology. As data streams continuously or intermittently push data into the platform, ensuring it is accurate and secure is crucial.

Security through Custom Keys:

- Key Generation: The platform generates a unique custom key for each data stream. This key acts as a secure identifier, ensuring that a specific data stream from a single tidal gauge can only write to its designated data source in the platform.
- Key Specificity: The beauty of these custom keys is their specificity. When the platform generates a key for one data source, the push operator cannot use

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that key to write to another. This specificity ensures that data integrity is maintained, and there's no risk of data streams overwriting or corrupting unrelated data sources.

- Expiration Dates: The platform can set up these custom keys with expiration dates to enhance security further. Setting an expiration date ensures the key becomes invalid after a certain period, preventing any potential unauthorized or outdated data streams from writing to the platform.
- Rejection of Mismatched Data Sources: The platform rejects any data stream that tries to write to a target data source not specified by its custom key. This additional layer of security ensures that even if someone compromises a key, it minimizes the potential damage or data corruption.

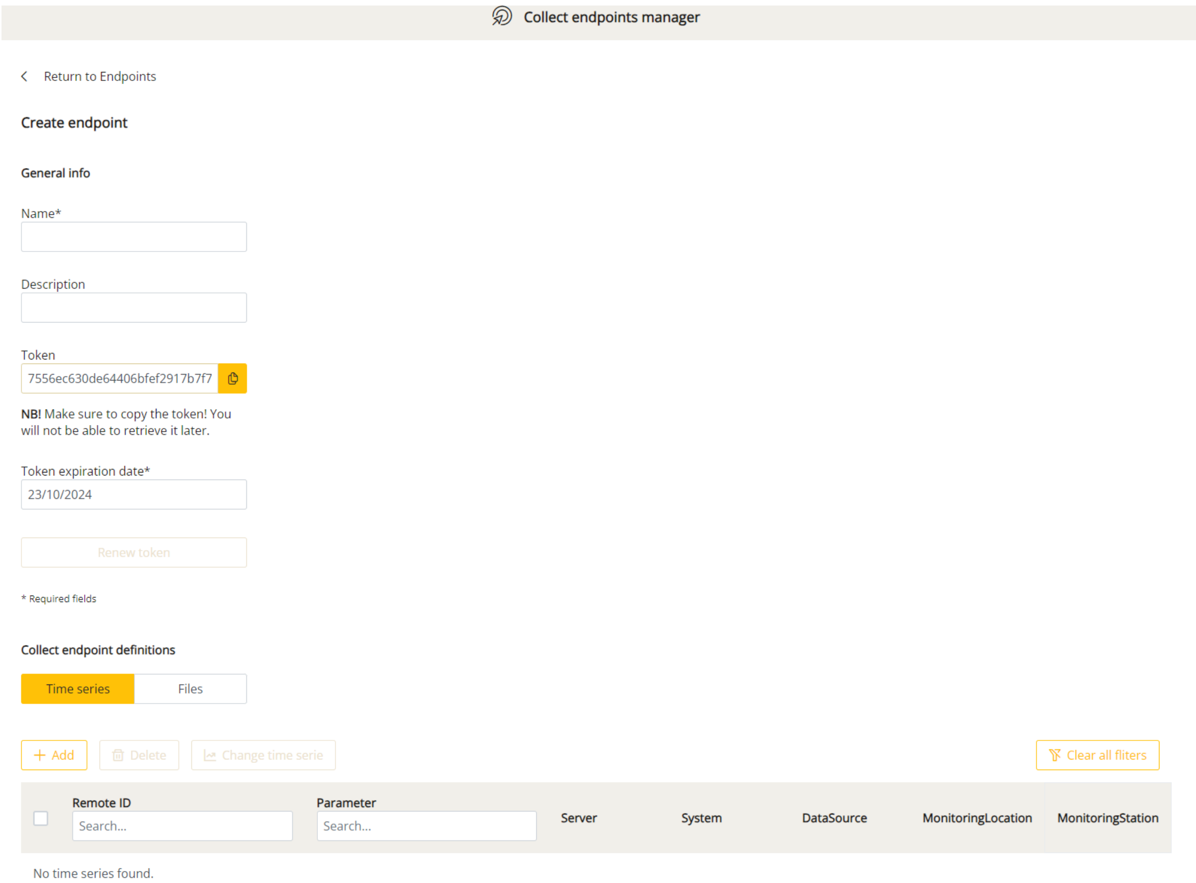

Figure 6. Key management in the platform back office.

By employing such security measures, the HiSea platform ensures that the push data acquisition process is efficient and highly secure. This approach guarantees stakeholders can trust the data they access, fostering confidence in the platform's capabilities and insights.

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The combination of pull and push data acquisition methods underscores the platform's adaptability. Whether it's periodic datasets that need scheduled downloads or continuous data streams that require real-time integration, the HiSea platform can handle it. This dual approach ensures comprehensive data coverage and enhances the platform's capability to provide timely and actionable insights.

3.3 Metadata

The process of uploading data requires the association of a minimum information describing the dataset (metadata). Two options are available for this: either the data owners fulfill the table presented in Figure 7 (and then the HiSea support team will upload it in the platform), or they may fill this data directly in the platform trough an online form (Figure 8).

Metadata

Designation		Data request
Description		Current speed and direction extracted from the operational model MOHID
Provider		HIDROMOD, LDA
Provider contact		hidromod@hidromod.com
Measures/Forecast		Forecast
Product Type		Timeseries
		Forecast from numerical model
Processing level		None
Variables		Current speed [m/s]
		Current direction [degrees]
Temporal resolution		10 mins.
Time span		19/11/2021 00:00 to 24/06/2024 23:00 (UTC +00:00)
Equipment		Non aplicable
Station		Data extraction points in the navigation channel of the Port of Aveiro bar.
Coordinates (Decimal Degrees)	**P5A**	Longitude: -8.761125; Latitude: 40.64218;
	P6	Longitude: --8.747834; Latitude: 40.64533;
	P7	Longitude: -8.737986; Latitude: 40.64713;
	P8	Longitude: -8.728013; Latitude: 40.65522;
	P9	Longitude: -8.72434; Latitude: 40.66423;
	P10	Longitude: -8.719346; Latitude: 40.65934;
	P11	Longitude: -8.690209; Latitude: 40.63846;
Altitude		Non aplicable
Coordinate System		WGS 84
Observations		The generated current intensity values represent the average in the water column of the velocities in each cell of the 2D model. Compared to measurements/observations, the model can underestimate the predicted data by around 20%.

Figure 7. Table available to provide information about the dataset.

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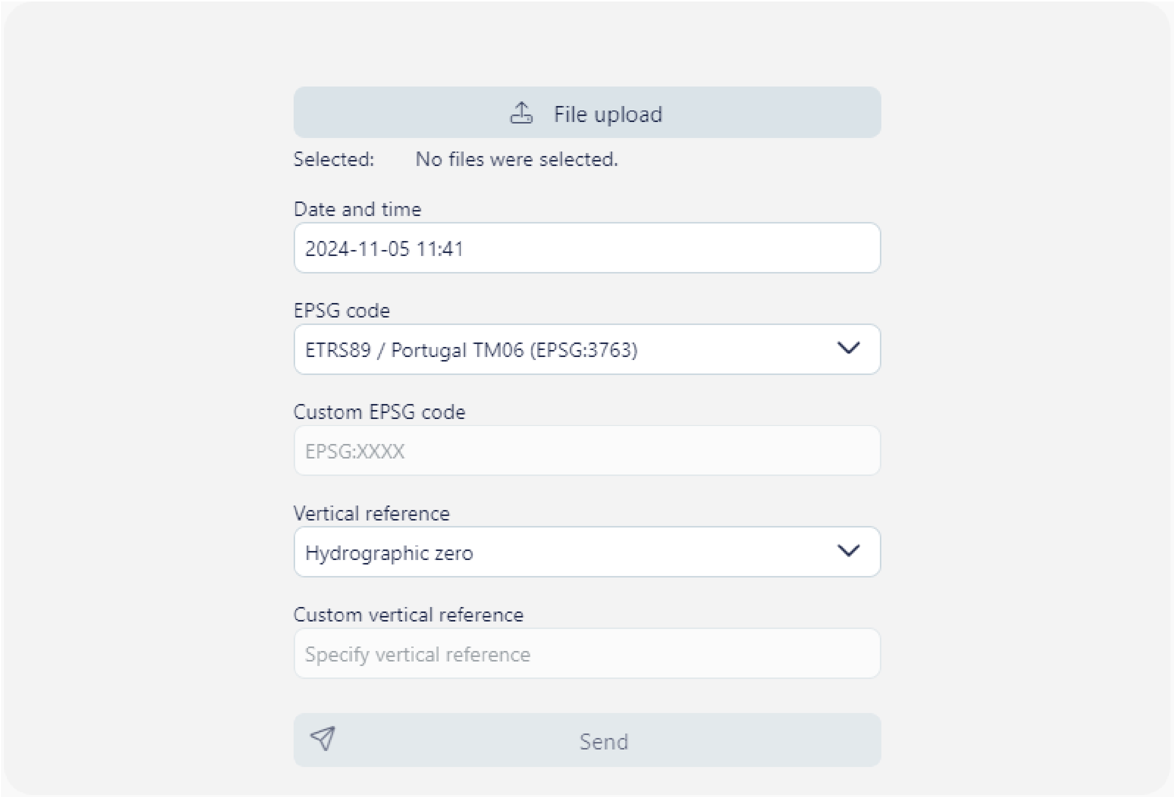

Figure 8. Online form available to provide the required metadata.

However, the metadata associated with a dataset may include quite detailed information. To keep this task as simple as possible, a minimum amount of information has been selected and must be provided. These include:

3.3.1 Identification of the dataset provider

- Name of the institution:
- Description of the institution:
- Website URL:
- Logo URL:
- Point of contact:
    - Name
    - E-mail
    - Phone Number

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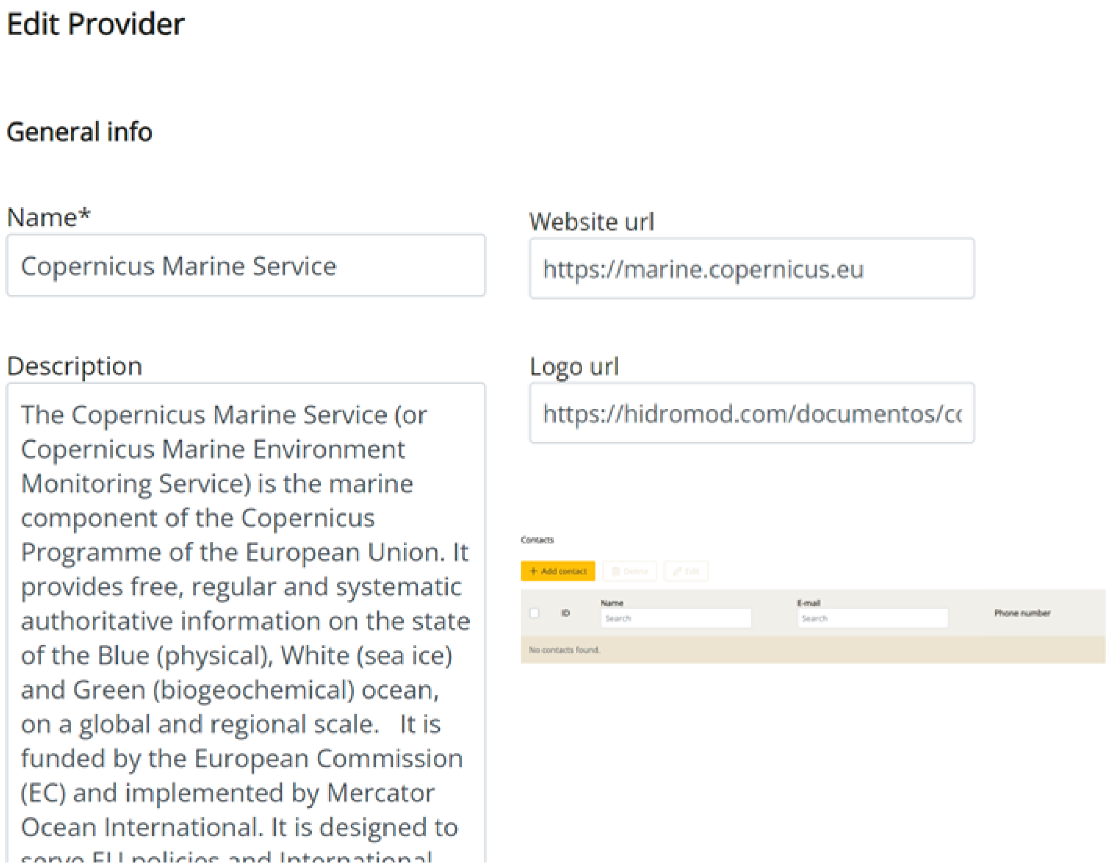

Figure 9. Information to be provided describing the data provider.

3.3.2 Details on the dataset

- Parameter name:
- DOI:
- Description of the dataset
  - Resolution**:**
    - Timestep
    - X, Y, Z resolution (m or deg)
    - X, Y, Z tiles
  - Location**:**
    - Name
    - Coordinates (GeoJSON)

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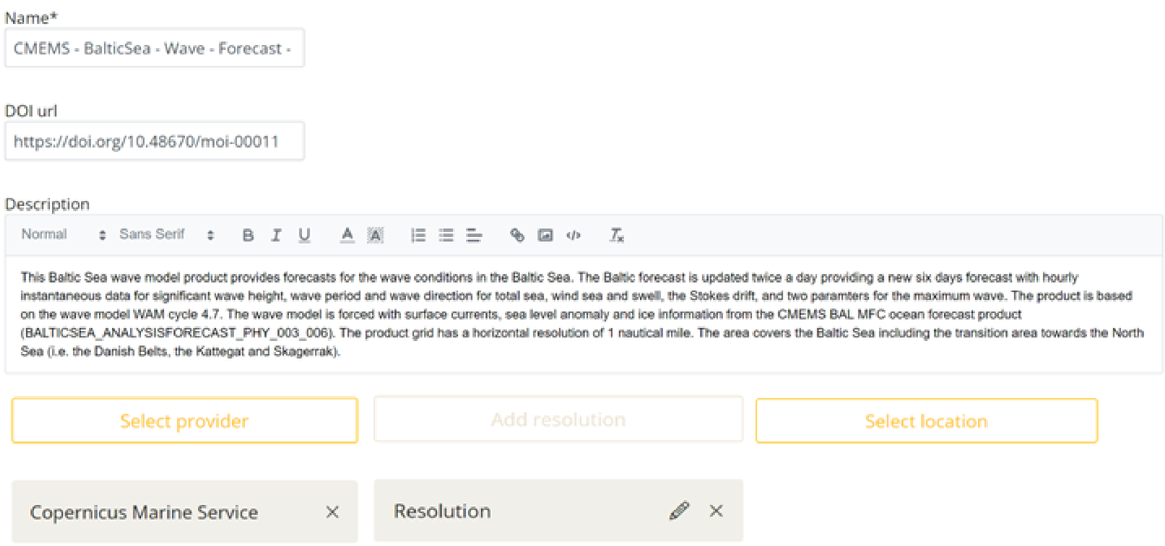

Figure 10. Information to be provided describing the dataset.

3.3.3 Details on the parameter

- Name:
- Translations
- Description:
- Parameter URL: https://vocab.seadatanet.org/p01-facet-search
- Unit:
- Translations
- Unit URL:https://vocab.seadatanet.org/v_bodc_vocab_v2

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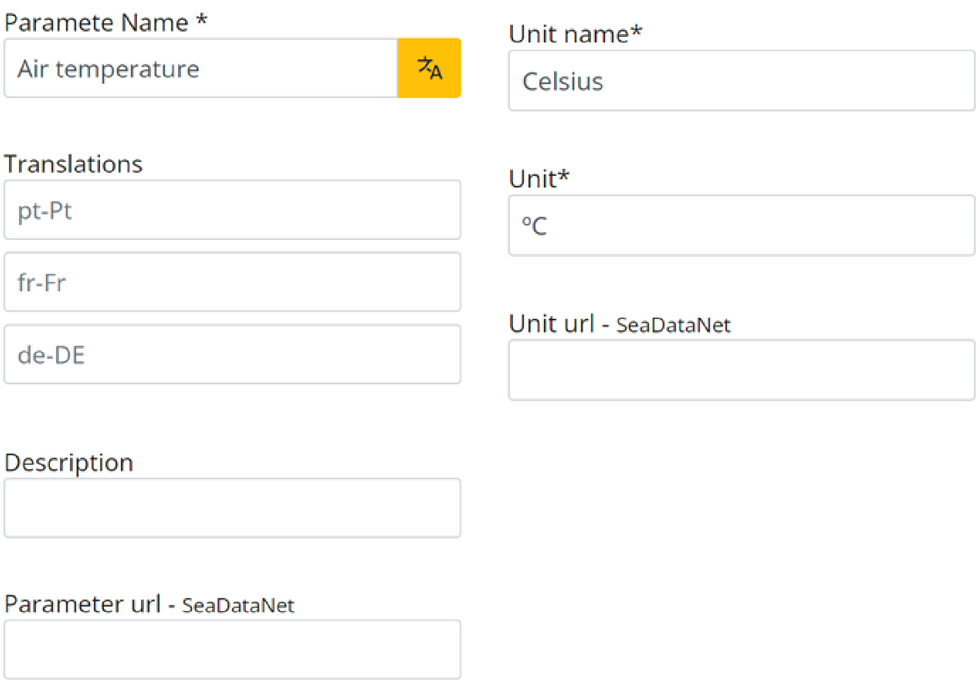

Figure 11. Information to be provided describing the parameter.

A summary of each dataset metadata is available from the platform dashboards (Figure 12).

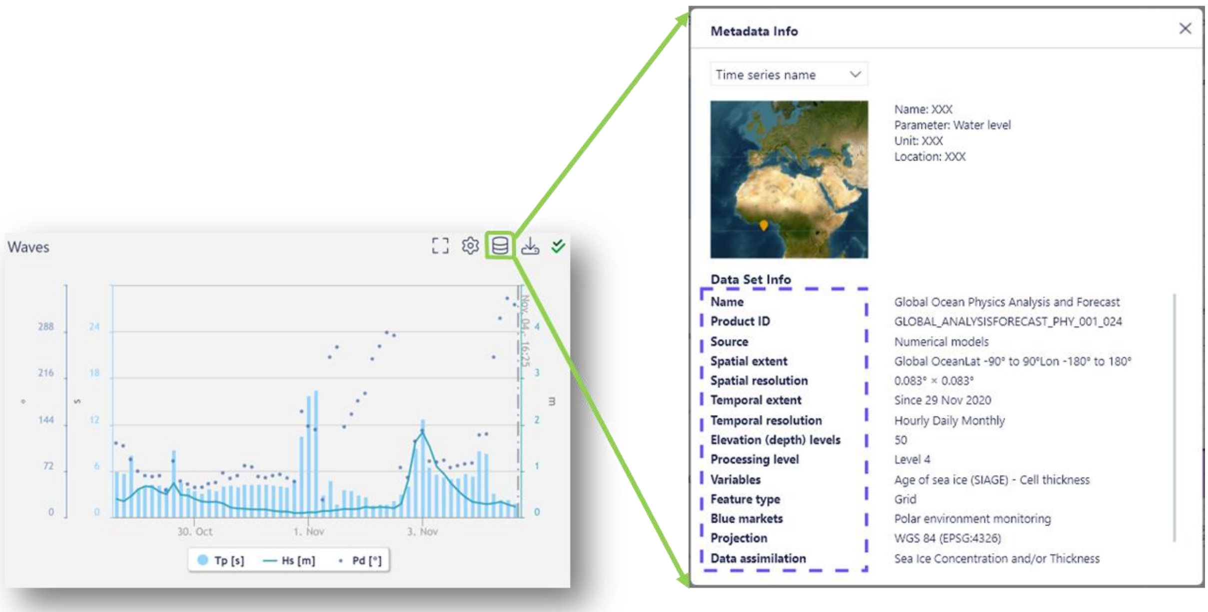

Figure 12. Summary of metadata available in the dashboards.

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3.4 Data required and being collected by the pilots

3.4.1 German pilots

The German offshore pilots in the Baltic and North Seas are situated next to the offshore research platform FINO2 and FINO3 within and between wind parks. A variety of parameters measured at these platforms are open for public access. This monitoring network is complemented with buoys and other stations within the North and Baltic Seas, some of which are very close to the research platforms (e.g., North Sea buoy II and III: DWR, depth 20-40 meter). Those measurement systems gather information about many parameters that are relevant for the ULTFARMS pilots such as:

- Significant wave height
- maximum wave height
- wavelength
- wave periodicity

Additional meteorological sensors at the research platforms deliver open access data, which is used for this project such as water temperature, salinity and oxygen saturation (FINO2/3, Northsea buoy 2/3). Many of the in-situ sensors continuously gathered data at a high-resolution interval. This information can be taken as a baseline for comparison with upscaled satellite data, but also provide an invaluable complementation of "real data" for a modelling approach, intending to improve predictions.

For the oceanographic data available, there are three data platforms that collect information. The individual websites "FINO2, 3", "MARNET" and "SEASTATE/INSITU". SEASTATE and INSITU are the current versions that hope to standardize and collect all data. However, these servers are in their infancy and under construction. A data platform that gathers all provided as raw data from the BSH and other resources to ultimately presents real-time insights in a user-friendly interface would therefore be of great value for the implementation phase for daily decisions. The HiSea platform is therefore one spearheading opportunity to this situation.

Additionally needed parameters have to be obtained by individual in situ sensors, e.g., attached to the aquaculture systems. One example is the use of the new created habitat by an underwater camera to monitor also growth of the cultured species. The aim is to transfer data from sensors attached to the aquaculture units to a receiver at an offshore structure capable to store the data and transmit it onshore. In the case of the German pilots the offshore platforms FINO2 and FINO3 will provide this stepstone of the data flow system.

At the FINO 3 research platform a probe will be installed to provide the following aquaculture-relevant measurement data via remote monitoring:

- total chlorophyll
- concentration of green algae
- concentration of cyanobacteria
- concentration of diatoms/dinoflagellates
- concentration of cryptophytes
- fingerprints of classes/species
- turbidity

Other relevant data is also collected on both pilots, such as light intensity and water temperature.

3.4.2 Danish pilots

The Danish pilots would be interested in data streams relating to metocean conditions (meteorology and oceanography variables) and water quality data.

- **Metocean** data of interest are:
  - Wind
  - Waves (height & period)
  - Current velocity
  - Potential Energy Anomaly
- **Water quality** data include:
  - Chlorophyll-a,
  - Nitrates
  - Salinity
  - Temperature
  - Dissolved oxygen

Currently, the pilot uses in-situ sensors, but they are not set up for remote transmission. However, during the monitoring period, data is collected approx. every 5-8 weeks after which data is available for uploading to the HiSea platform.

In situ collected data includes CTD data from two depths (at the bottom and at 5 meters depth) on the pilot site Anholt where the aquaculture structures are positioned. The CTDs measure salinity, temperature, dissolved oxygen, pH and chlorophyll-a. In addition, there are light loggers that measure photosynthetically active radiation (PAR) at the same depths.

The pilot also collects ADCP data at the sea bottom (15 meters depth) that will be available from the platform.

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3.4.3 Belgian pilot

The Belgian pilot, located in the offshore wind farm of Belwind, demonstrates the challenges of offshore data monitoring in a high-energy environment. While the ideal scenario would involve integrating advanced in situ sensors capable of transmitting real-time data on forces acting on the longlines (e.g., wave impact sensors), we had to rely solely on existing measurement buoys and weather forecast systems.

The measurement buoys in the vicinity of the pilot site may provide essential data for forecasting the feasibility of working within the wind farm. These Waverider buoys measure key wave spectral parameters, including (comparable to the German pilot):

- Significant wave height
- Wave period
- Mean wave direction
- Directional spreading
- Optionally surface current speed and direction

Weather forecasts, particularly for wind waves and swell, are followed closely to determine safe operating windows, as vessel days involve significant costs. Accurate predictions are critical to ensure both safety and cost-efficiency for offshore operations.

However, the lack of in situ sensors transmitting real-time data limits our ability to monitor forces directly on the structures. A "deploy-and-forget" may be a wiser option for this high-energy offshore environment, avoiding the need for manual retrieval of sensors, which can be logistically challenging and prone to loss or damage, as observed in earlier projects like Edulis. Despite these limitations, we aim to optimize planning and scheduling by leveraging the data and forecasts currently available.

3.4.4 Dutch pilot

Currently, the Dutch pilot is partly in operation (end of 2024). The platform has been installed in 2024 and the plan is to have a running pilot (5 x 200 m lines) platform by mid-2024. In situ sensors and data collected at the Dutch pilot location that could be linked to the HiSea platform are:

- GPS position of the pilot installation
- Load cells (forces on the lines) and GNSS receiver within the mussel line system (UGENT)
- Temperature, chlorophyll and suspended matter (data collected offline, downloaded every 3 months)
- Mussel biomass and biodiversity, seafloor biodiversity

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- Surveillance cameras: presence of birds (data not collected within ULTFARMS project, but a separate project)
- Acoustic data: presence of fish (data not collected within ULTFARMS project, but a separate project)

OOS envisions a real-time transmission of sensor data from the cultivation platform to shore.

3.5 Data already available and foreseen to be available on the platform

With six real-life ocean multi-use pilot sites under the ULTFARMS project, the team will collect a vast amount of data and indicators. The HiSea platform, with its robust architecture, serves as the backbone for this data integration. It accommodates data from global datasets and allows for their downscaling per pilot. The platform's plugin architecture ensures flexibility in handling various data formats and protocols, making it a comprehensive data aggregation and processing solution.

The consortium has already configured the platform with the public datasets detailed in Table 2 to Table 5 for the six pilot areas. Tables 6 to 10 also provide information about the local collected data to be uploaded to the platform, and the foreseen timeline for integration of pilot data.

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Table 2: Public data available for the German pilots.

Pilots	Variables Types	Provider	Name	Source Link	OBSERVATION / MODELS	TEMPORAL RESOLUTION	UPDATE FREQUENCY	SPATIAL RESOLUTION
Germany	Hydrodynamic	CMEMS	FORECAST	Link	numerical-model	hourly; daily-mean; 15-min	daily (12h)	0.014° x 0.03°
Germany	Hydrodynamic	CMEMS	FORECAST	Link	numerical-model	daily mean (24 levels)	daily (12h)	0.111° x 0.067°
Germany		CMEMS	OBSERVAT	Link	Observations	instantaneous	daily	
	Flow			Link	River flow	instantaneous	daily	Point
	Hydrodynamic			Link	Tide gauge station	instantaneous	daily	Point
	Waves			Link	fixed buoys,MO, fixed obse	instantaneous	daily	Point
Germany	Waves	CMEMS	FORECAST	Link	numerical-model	hourly	daily (12h)	0.014° x 0.03°
Germany	Biogeochemistry	CMEMS	FORECAST	Link	numerical-model	daily mean	daily (12h)	0.111° × 0.067°
Germany	Chlorophyll	CMEMS	L3_NRT_O	Link	Satellite observations	daily mean	daily(18:00)	0.3km × 0.3km
Germany	Chlorophyll	CMEMS	L4_NRT_O	Link	Satellite observations	daily mean	daily (20:00)	1km × 1km
Germany	SST	CMEMS	L4_NRT_O	Link	Satellite observations	daily mean	daily (12:00)	0.02° × 0.02°
Germany	SST	CMEMS	L4_NRT_O	Link	Satellite observations	daily mean	daily (08:00; 12:00 UTC)	0.05° × 0.05°
Germany	Meteorology	DWD	ICON 7 km		numerical-model	hourly	daily (00h, 12h)	7 km x 7 km
Germany	Meteorology	DWD	ICON 3 km		numerical-model	hourly	daily (00h, 12h)	3 km x 3 km
Germany	Meteorology	NOAA	GFS 25 km		numerical-model	hourly	daily (00h, 06h, 12h, 18h	25 km x 25 km
Germany	Meteorology	METAR	Airport		Observations	instantaneous	instantaneous	Point
			Westerlar	Link	Observations	instantaneous	instantaneous	Point
			Esbjerg Ai	Link	Observations	instantaneous	instantaneous	Point
Germany	Hydrodynamic	GLOSS	Cuxhaven	Link	Tide gauge station	instantaneous	instantaneous	Point
Germany	Hydrodynamic	GLOSS	Helgoland	Link	Tide gauge station	instantaneous	instantaneous	Point
Germany	Hydrodynamic	GLOSS	Hörnum	Link	Tide gauge station	instantaneous	instantaneous	Point
Germany	Hydrodynamic	GLOSS	Borkum Fi	Link	Tide gauge station	instantaneous	instantaneous	Point
Germany		EMODNET	Hoernum	Link	Tide gauge station (Sea Leve	instantaneous	instantaneous	Point
Germany		EMODNET	Radar Stat	Link	Radar Station (Currents)	instantaneous	instantaneous	Point
Germany		EMODNET	NOO	Link	MO (Water Temperature,Wa	instantaneous	instantaneous	Point
Germany		EMODNET	Butendiek	Link	MO (Waves)	instantaneous	instantaneous	Point
Germany		EMODNET	FINO3WR	Link	MO (Water Temperature,Wa	instantaneous	instantaneous	Point
Germany		EMODNET	NsbIII	Link	MO (Atmospheric,Water cor	instantaneous	instantaneous	Point
Germany		EMODNET	NsbII	Link	MO (Atmospheric,Water cor	instantaneous	instantaneous	Point

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Table 3: Public data available for the Dutch pilot.

Pilots	Variables Types	Provider	Name	Source Link	OBSERVATION / MODELS	TEMPORAL RESOLUTION	UPDATE FREQUENCY	SPATIAL RESOLUTION
Netherlands	Hydrodynamic	CMEMS	FORECAST_PHY_004_013	Link	numerical-model	hourly; daily-mean; 15-min (33 levels)	daily (12h)	0.014° x 0.03°
Netherlands	Hydrodynamic	CMEMS	FORECAST_PHY_LR_004_001	Link	numerical-model	daily mean (24 levels)	daily (12h)	0.111° x 0.067°
Netherlands		CMEMS	OBSERVATIONS_013_036	Link	Observations	instantaneous	daily	
Netherlands	Flow			Link	River flow	instantaneous	daily	Point
Netherlands	Hydrodynamic			Link	Tide gauge station	instantaneous	daily	Point
Netherlands	Waves			Link	fixed buoys,MO, fixed observations	instantaneous	daily	Point
Netherlands	Waves	CMEMS	FORECAST_WAV_004_014	Link	numerical-model	hourly	daily (12h)	0.014° x 0.03°
Netherlands	Biogeochemistry	CMEMS	FORECAST_BGC_004_002	Link	numerical-model	daily mean	daily (12h)	0.111° × 0.067°
Netherlands	Chlorophyll	CMEMS	L3_NRT_OBSERVATIONS_009_036	Link	Satellite observations	daily mean	daily(18:00)	0.3km × 0.3km
Netherlands	Chlorophyll	CMEMS	L4_NRT_OBSERVATIONS_009_037	Link	Satellite observations	daily mean	daily (20:00)	1km × 1km
Netherlands	SST	CMEMS	L4_NRT_OBSERVATIONS_010_025	Link	Satellite observations	daily mean	daily (12:00)	0.02° × 0.02°
Netherlands	SST	CMEMS	L4_NRT_OBSERVATIONS_010_001	Link	Satellite observations	daily mean	daily (08:00; 12:00 UTC)	0.05° × 0.05°
Netherlands	Meteorology	DWD	ICON 7 km		numerical-model	hourly	daily (00h, 12h)	7 km x 7 km
Netherlands	Meteorology	DWD	ICON 3 km		numerical-model	hourly	daily (00h, 12h)	3 km x 3 km
Netherlands	Meteorology	NOAA	GFS 25 km		numerical-model	hourly	daily (00h, 06h, 12h, 18h)	25 km x 25 km
Netherlands	Meteorology	METAR	Airport		Observations	instantaneous	instantaneous	Point
			Goeree Le, Netherlands	Link		instantaneous	instantaneous	Point
			Euro, Netherlands	Link		instantaneous	instantaneous	Point
			P11-b, Netherlands	Link		instantaneous	instantaneous	Point
			Hoorn-a, Netherlands	Link		instantaneous	instantaneous	Point
			K14-fa-1c, Netherlands	Link		instantaneous	instantaneous	Point
			K13-a, Netherlands	Link		instantaneous	instantaneous	Point
Netherlands		GLOSS	Hoek van Holland	Link	Tide gauge station	instantaneous	instantaneous	Point
Netherlands		GLOSS	Scheveningen	Link	Tide gauge station	instantaneous	instantaneous	Point
Netherlands		GLOSS	Europlatform	Link	Tide gauge station	instantaneous	instantaneous	Point
Netherlands		EMODNET	IJmondstroompaal	Link	MO (Currents)	instantaneous	instantaneous	Point
Netherlands		EMODNET	Ijmuiden	Link	Mooring time serie (Sea Level,Water	instantaneous	instantaneous	Point
Netherlands		EMODNET	MATROOS - Monster	Link	Radar (Currents)	instantaneous	instantaneous	Point
Netherlands		EMODNET	HoekVanHollandNAP	Link	MO (Water salinity ,Water Temperature)	instantaneous	instantaneous	Point
Netherlands		EMODNET	EurogeulE13	Link	MO (Waves)	instantaneous	instantaneous	Point
Netherlands		EMODNET	Europlatform	Link	MO (Sea Level,Water Temperature,Waves,Winds)	instantaneous	instantaneous	Point
Netherlands		EMODNET	IJmuidenMunitiestort	Link	MO (Water Temperature,Waves)	instantaneous	instantaneous	Point

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Table 4: Public data available for the Belgian pilot.

Pilots	Variables Types	Provider	Name	Source Link	OBSERVATION / MODELS	TEMPORAL RESOLUTION	UPDATE FREQUENCY	SPATIAL RESOLUTION
Belgium	Hydrodynamic	CMEMS	FORECAST_PHY_004_013	Link	numerical-model	hourly; daily-mean; 15-min (33 levels)	daily (12h)	0.014° x 0.03°
Belgium	Hydrodynamic	CMEMS	FORECAST_PHY_LR_004_001	Link	numerical-model	daily mean (24 levels)	daily (12h)	0.111° x 0.067°
Belgium		CMEMS	OBSERVATIONS_013_036	Link	Observations	instantaneous	daily	
Belgium	Flow			Link	River flow	instantaneous	daily	Point
Belgium	Hydrodynamic			Link	Tide gauge station	instantaneous	daily	Point
Belgium	Waves			Link	fixed buoys,MO, fixed observations	instantaneous	daily	Point
Belgium	Waves	CMEMS	FORECAST_WAV_004_014	Link	numerical-model	hourly	daily (12h)	0.014° x 0.03°
Belgium	Biogeochemistry	CMEMS	FORECAST_BGC_004_002	Link	numerical-model	daily mean	daily (12h)	0.111° × 0.067°
Belgium	Chlorophyll	CMEMS	L3_NRT_OBSERVATIONS_009_036	Link	Satellite observations	daily mean	daily(18:00)	0.3km × 0.3km
Belgium	Chlorophyll	CMEMS	L4_NRT_OBSERVATIONS_009_037	Link	Satellite observations	daily mean	daily (20:00)	1km × 1km
Belgium	SST	CMEMS	L4_NRT_OBSERVATIONS_010_025	Link	Satellite observations	daily mean	daily (12:00)	0.02° × 0.02°
Belgium	SST	CMEMS	L4_NRT_OBSERVATIONS_010_001	Link	Satellite observations	daily mean	daily (08:00; 12:00 UTC)	0.05° × 0.05°
Belgium	Meteorology	DWD	ICON 7 km		numerical-model	hourly	daily (00h, 12h)	7 km x 7 km
Belgium	Meteorology	DWD	ICON 3 km		numerical-model	hourly	daily (00h, 12h)	3 km x 3 km
Belgium	Meteorology	NOAA	GFS 25 km		numerical-model	hourly	daily (00h, 06h, 12h, 18h)	25 km x 25 km
Belgium	Meteorology	METAR	Airport		Observations	instantaneous	instantaneous	Point
			Ostend–Bruges International	Link	Observations	instantaneous	instantaneous	Point
			Koksijde Air Base	Link	Observations	instantaneous	instantaneous	Point
Belgium		GLOSS	Ostend	Link	Observations	instantaneous	instantaneous	Point
Belgium		GLOSS	Vlakte v/d Raan	Link	Observations	instantaneous	instantaneous	Point
Belgium		GLOSS	Breskens Handelshaven	Link	Observations	instantaneous	instantaneous	Point
Belgium		EMODNET	Westhinder	Link	MO (Sea Level,Water Temperature,Waves,Winds)	instantaneous	instantaneous	Point
Belgium		EMODNET	Kwintebank	Link	MO (Water Temperature,Waves)	instantaneous	instantaneous	Point
Belgium		EMODNET	OostendNorth	Link	MO (Water Temperature,Waves)	instantaneous	instantaneous	Point
Belgium		EMODNET	Wandelaar	Link	MO (Water Temperature,Waves,Winds)	instantaneous	instantaneous	Point
Belgium		EMODNET	WandelaarTG	Link	MO (Sea Level,Winds)	instantaneous	instantaneous	Point
Belgium		EMODNET	ScheurWielingenTG	Link	MO (Sea Level,Winds)	instantaneous	instantaneous	Point
Belgium		EMODNET	ThorntonbankSouth	Link	MO (Water Temperature,Waves)	instantaneous	instantaneous	Point

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Table 5: Public data available for the Danish pilot.

Pilots	Variables Types	Provider	Name	Source Link	OBSERVATION / MODELS	TEMPORAL RESOLUTION	UPDATE FREQUENCY	SPATIAL RESOLUTION
nmark	Hydrodynamic	CMEMS	FORECAST_PHY_003_006	Link	numerical-model	hourly; daily-mean; 15-min (33 levels)	daily (12h)	2 km x 2 km
nmark		CMEMS	OBSERVATIONS_013_036	Link	Observations	instantaneous	daily	
	Flow			Link	River flow	instantaneous	daily	Point
	Hydrodynamic			Link	Tide gauge station	instantaneous	daily	Point
	Waves			Link	fixed buoys,MO, fixed observations	instantaneous	daily	Point
nmark	Waves	CMEMS	FORECAST_WAV_003_010	Link	numerical-model	hourly	daily (12h)	2km × 2km
nmark	Biogeochemistry	CMEMS	FORECAST_BGC_003_007	Link	numerical-model	daily mean	daily (12h)	2km × 2km
nmark	Chlorophyll	CMEMS	L3_NRT_OBSERVATIONS_009_036	Link	Satellite observations	daily mean	daily(18:00)	0.3km × 0.3km
nmark	SST	CMEMS	L4_NRT_OBSERVATIONS_010_025	Link	Satellite observations	daily mean	daily (12:00)	0.02° × 0.02°
nmark	SST	CMEMS	L4_NRT_OBSERVATIONS_010_001	Link	Satellite observations	daily mean	daily (08:00; 12:00 UTC)	0.05° × 0.05°
nmark	Meteorology	DWD	ICON 7 km		numerical-model	hourly	daily (00h, 12h)	7 km x 7 km
nmark	Meteorology	DWD	ICON 3 km		numerical-model	hourly	daily (00h, 12h)	3 km x 3 km
nmark	Meteorology	NOAA	GFS 25 km		numerical-model	hourly	daily (00h, 06h, 12h, 18h)	25 km x 25 km
nmark	Meteorology	METAR	Airport		Observations	instantaneous	instantaneous	Point
			Copenhagen Airport	Link	Observations	instantaneous	instantaneous	Point
nmark		EMODNET	Kobenhavn	Link	MO (Sea Level,Water Temperature)	instantaneous	instantaneous	Point
nmark		EMODNET	Flinten7BS	Link	MO (Currents,Water conductivity/ BioGeoChemical,Water salinity ,Water Temperature)	instantaneous	instantaneous	Point
nmark		EMODNET	DrogdenCU	Link	MO (Currents)	instantaneous	instantaneous	Point
nmark		EMODNET	Ale	Link	MO (Atmospheric,Water Temperature,Winds)	instantaneous	instantaneous	Point

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Table 6: Data foreseen to be available for the German pilots. The intended start date refers to the project month when the data upload to the platform is planned, with Month 1 (M1) corresponding to the start of the project in January 2023.

Location	**Sensor/ Instrument**	**Parameter**	**Intended Start**	**Intended Interval**	**Upload latest**
FINO 2	Light & Temp. Sensor	Water temperature [°C]	M24	monthly**	M41
		Light [Lux]	M24	monthly**	M41
	Camera	Image	M24	monthly**	M41
		Temperature [°C]	M24	monthly**	M41
		Light [Lux]	M24	monthly**	M41
FINO 3	Light & Temp. Sensor	Water temperature [°C]	M36	monthly**	M41
		Light [Lux]	M36	monthly**	M41
	PhycoProbe	total chlorophyll [μg chl-a/l]	M27*	monthly**	M41
		concentration of green algae [μg chl-a/l]			
		concentration of cyanobacteria [μg chl-a/l]			
		concentration of diatoms/brown algae [μg chl-a/l]			
		concentration of cryptophytes [μg chl-a/l]			
		fingerprints of classes/species, also user-defined (e.g. Planktothrix rubescens) [μg chl-a/l]			
		yellow substances			
		depth			
		turbidity			
	WebCam	Image	M24	monthly**	M41
Nearshore	Manual measurement	Algae length [mm]	M24	monthly**	M41

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	water quality probe	temperature			
		pH			
		oxidation reduction potential			
		electrical conductivity			
		turbidity			
		dissolved oxygen			
		TDS total dissolved solid			
		salinity			
		seawater specific gravity			
Public available data	FINO 2 & 3	Max. Wave height [m]	Established	Online Access provided	M41
		Significant wave height [m]			
		Wave length [m]			
		Wave periodicity [s]			

*planned, depending on installation date
**collected data packages, ends after deinstallation

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Table 7: Data foreseen to be available for the Danish pilots.

Sensor/Instrument	Parameter	Intended start	Intended interval
CTD loggers (5 m depth and 14 m depth)	Salinity	M24*	Every 2 months; sensor deployed on 27-09-2023
	Temperature		
	Dissolved Oxygen		
	pH		
	Chlorophyll-a		
PAR loggers (5 m depth and 14 m depth)	Light (surface irradiance, attenuation coefficient)	M24*	Every 2 months; sensor deployed on 27-09-2023
ADCP (sea bottom, 15 m depth)	Currents (speed and direction)	M24**	Instrument retrieved on 27-08-2024

*Periods of missing data are present due to dead battery/fouling.
** Raw data available; data not treated.

Table 8. Data foreseen to be available for the Belgian pilot.

Sensor/Instrument	**Parameter**	**Intended start**	**Intended interval**
Manual measurement	Oyster growth	M29	One-time measurement; Line detached, retrieved July 2023
	Seaweed growth (length)	M36	One-time measurement; Line removed Nov. 2024
Load cells (forces on the lines) and GNSS receiver within the mussel line system (with Dutch pilot)	Force on lines	M25	Every 3 months; deployed on 7-11-2024

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Table 9: Data foreseen to be available for the Dutch pilot.

Sensor/Instrument	Parameter	Intended start	Intended interval
GPS position of the pilot installation	position	M25	Every 3 months; deployed on 7-11-2024
Load cells (forces on the lines) and GNSS receiver within the mussel line system (with Belgian pilot)	Force on lines	M25	Every 3 months; deployed on 7-11-2024
Infinity sensor CLW ACLWC-USB/CARD/CAD (JFE Advantech Co.)	Temperature	M26	Every 3 months; deployed on 8-5-2024, sensor lost and new one installed 12-12-2024
Infinity sensor CLW ACLWC-USB/CARD/CAD (JFE Advantech Co.)	Suspended matter	M26	Every 3 months; deployed on 8-5-2024, sensor lost and new one installed 12-12-2024
Infinity sensor CLW ACLWC-USB/CARD/CAD (JFE Advantech Co.)	Fluorescence	M26	Every 3 months; deployed on 8-5-2024, sensor lost and new one installed 12-12-2024

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Table 10. Sensor and instrument specifications for the Dutch pilot monitoring.

■ **Sensor specifications**

Parameter	Chlorophyll	Turbidity	Temperature
Principle	Fluorescent measurement	Backscattering	Thermistor
Range	0 to 400ppb (Uranine reference)	0 to 1,000FTU (Formazin reference)	-3 to 45ºC
Resolution	0.01ppb	0.03FTU	0.001ºC
Accuracy	Non-linearity±1%FS (0 to 200ppb)	±0.3FTU or 2%	±0.02℃ (3 to 31ºC)

■ **Instrument specifications**

	Data logger version	Digital output version
Model designation	ACLW2-USB	ACLW2-CAR/CAD
Memory medium	miniSD card	-
Data capacity	1GB provided as standard (miniSD card)	-
AD converter	16 bit digital conversion	-
Measuring mode	Continuous mode, Burst mode	-
Measuring interval	0.1 to 1.0 s (0.1 s increment), 1 to 600 s (1 s increment)	-
Burst sampling interval	1 to 1,440 min (1 min increment)	-
No. of samples	1 to 18,000	-
Battery	CR-V3 lithium / 3.3Ah (four maximum)	-
Communication	USB 2.0 (ver. 1.1 compatible)	CAR: RS-232C, CAD: RS-485
Current consumption	90mA	30mA
Housing material	Titanium (grade 2)	Titanium (grade 2)
Dimensions	Φ70mm×232mm	Φ70mm×173mm
Weight	Approx. 1.3kg in air, 0.6kg in water	Approx. 1.0kg in air, 0.5kg in water
Depth rating	200m depth equivalent	200m depth equivalent

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4. Services

The HiSea platform offers the possibility of running analytical services adaptable and scalable, ensuring stakeholders receive accurate, timely, and actionable insights. Central to these services is the robust plugin architecture, which allows for developing calculation workers tailored to specific analytical needs.

4.1 Calculation Services

The platform's plugin architecture enables the creation of specialized calculation workers. These workers can handle various tasks, from intricate hydrodynamic models to straightforward calculations on existing datasets. Whether it's executing complex models, custom satellite imagery processing, or basic data manipulations, the architecture supports it all.

The platform seamlessly integrates new analytical methods or tools using a modular approach with plugins. It also means the HiSea platform remains agile and ready to incorporate advancements as analytical demands evolve.

These calculation workers truly showcase their deployment flexibility. The platform can dispatch them to cloud environments for tasks that demand significant computational power or scale them up quickly. The platform supports deployment in local environments for tasks that prioritize data privacy, lower latency, or integration with on-premises systems.

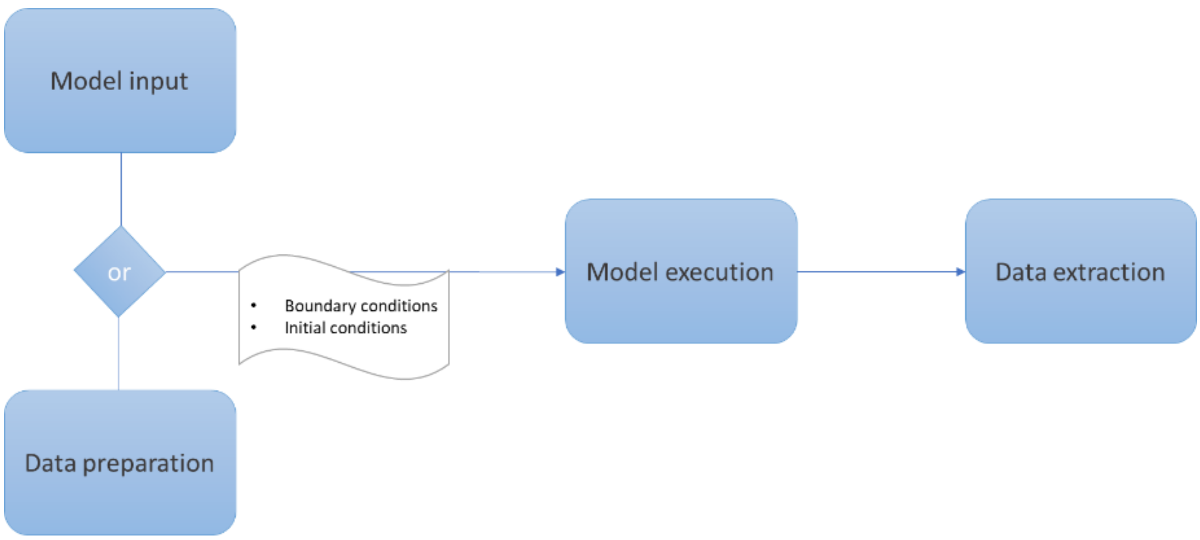

Figure 13. Calculation execution workflow.

This deployment flexibility ensures efficient handling of varying workloads. Whether addressing a surge in data processing needs or managing routine tasks,

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the platform scales its resources accordingly, ensuring timely processing and optimal resource utilization.

4.2 Calculation Workloads

The platform has two kinds of calculation workloads: scheduled and on-demand.

1. Scheduled Executions:
   a. Description: These are calculation workloads that the platform has pre-configured to run automatically at specified intervals. They operate in the background, performing specific analytical tasks regularly without user intervention.
   b. Example: A prime example of a scheduled execution is the regular processing of a nested hydrodynamic model. The platform might set this model to run every few hours or days, updating itself with the latest hydrodynamic data.
   c. Benefits: Scheduled executions ensure consistency in data processing, reduce manual intervention and guarantee that specific analytical tasks are always up to date.
2. On-Demand Calculations:
   a. Description: Contrary to scheduled executions, on-demand calculations are initiated by the user as and when needed. These calculations allow users to input specific parameters or conditions, tailoring the analysis to their immediate requirements.
   b. Example: A user might want to determine the number of periods a particular site has met ocean conditions that fit within specific criteria. They could specify constraints such as waves below a certain height and wind speeds below a certain threshold.
   c. Benefits: On-demand calculations allow users to get insights tailored to their needs. They can adjust parameters, ensuring the analysis is relevant and actionable.

By combining the plugin architecture's adaptability with the calculation workers' scalability and the calculation flexibility, the HiSea platform offers a comprehensive solution for data analysis for the ULTFARMS project.

4.3 Alert and Notification Services

The HiSea platform's alert system, recognizing the diverse needs of stakeholders, offers a range of functionalities to ensure timely and relevant alerts. This system is a testament to the platform's adaptability and user-centric design. Alerts and notifications services allow users to:

1. Combine Multiple Data Sources:

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Users have the flexibility to combine multiple data sources when setting up alerts. Such combinations can include a mix of modelled data, such as predictions for waves or tides and real-time sensor measurements. By integrating various data sources, the platform provides a comprehensive view of the conditions and bases alerts on a holistic understanding of the environment.

2. Implement flexible Thresholds:

   The platform designs the alert system to accommodate both fixed and variable thresholds. Users can set static limits, such as a specific wave height, or opt for limits that change over time, adapting to seasonal variations or distinct operational phases.

3. Persistency in Alerts:

   Understanding that not all conditions warrant immediate alerts, the platform introduces the concept of persistence. Alarms can trigger only when specific requirements persist for a defined duration. For instance, a warning for high waves might only activate if the wave height remains above the threshold for more than an hour. Such a setup ensures that transient spikes or anomalies don't trigger unnecessary alerts, directing attention to sustained conditions that might pose genuine risks.

4. Notification Mechanisms:

   Once an alert is triggered, the platform ensures timely notifications through various channels. These can range from traditional methods like sending emails to more instant modes like WhatsApp messages. Certain alerts can even initiate specific actions within the platform, such as starting calculation workloads. This proactive approach ensures that stakeholders are informed of potential issues and can take immediate action if necessary.

The HiSea platform ensures stakeholders receive timely and relevant announcements by offering a versatile approach to alerts and notifications. Whether monitoring for potential risks, providing optimal operational conditions or initiating specific platform actions, the alert system supports informed decision-making.

4.4 Desired services from project partners and pilots

4.4.1 German pilots

One of the desired features for this pilot is the integration of PhycoProbe for detection of harmful algae blooms (HAB), to set up an early warning system for the detection of a potential risk of accumulation of micro-algae toxins by mussels.

Explanation and background: Within the marine ecosystem, there are naturally occurring molecules that are potentially harmful to human health. Often produced by microalgae (e.g., Dinoflagellates) or certain bacteria (Cyanobacteria), these compounds are often extremely stable and can, based on the feeding strategy, accumulate in certain organisms (e.g., mussels). If contaminated organisms are consumed by humans, they can cause a variety of reactions commonly known as "Shellfish poisoning" and are classified depending on their harm (ASP, DSP, NSP and PSP). Toxic microalgae in low concentration pose no threat to human health, however, blooming events that are fueled by excess nutrients can lead to dangerous levels very quickly, a scenario that is only amplified by climate change. This poses a potential challenge for the aquaculture industry. As of today, the state-of-the-art monitoring approach for harmful algae blooms (HABs), are the analysis of either water samples for Chlorophyll a, the determination of the concentration of certain microalgae, the tracing of the level of contamination within bioaccumulated biomass (e.g., accumulation of domoic acid in mussel) or remote sensing of proxies (chlorophyll-a) via satellite imaging. However, all these strategies are either indirect and conflicted with a variance or require intense sampling and laboratory effort. In addition to that, the harsh conditions at offshore sites limit the operational windows for vessels to investigate these reoccurring blooming events and the seasonal succession of the phytoplankton present in the water column at a particular position.

For this reason, the German pilots aim to establish in close cooperation with BBE Moldaenke a novel sensor, the "bbe fluorometer", at the aquaculture site that aims to track fluorometric data related to the succession of phytoplankton.

Dinoflagellates often produce toxins which are enriched in phytoplankton filtrating organisms like shellfish. For product safety in offshore farming and especially to prevent shellfish poisoning in offshore farmed mussels it is necessary to detect dinoflagellates and especially discriminate dinoflagellates from diatoms on site. For that, the discrimination of the microalgae phyla diatoms and dinoflagellates need to be discriminated to gain on site insights into the development of HABs.

To achieve a proper determination and discrimination the bbe fluorometer needs to be equipped with an additional fingerprint. In a first attempt in the laboratory dinoflagellate and diatom cultures of several different species are cultivated and later utilized to achieve class specific fluorometric fingerprints for both classes. Laboratory testing showed that discriminating between diatoms and dinoflagellates is possible.

In a second attempt, field samples have been analysed for diatoms and dinoflagellates microscopically and with the bbe fluorometer. It was possible to show that the microscopically observed diatoms and dinoflagellates could be discriminated by the bbe fluorometer successfully. According to the results from laboratory and field sample testing it could be stated that discriminating between dinoflagellates and diatoms would also work in the field online. For this the monitoring buoy at the offshore aquaculture testing site close to FINO3 will be equipped with a bbe PhycoProbe provided with fingerprints for chlorophytes, cyanobacteria, diatoms, dinoflagellates and cryptophytes. Data will be collected continuously and sent to FINO 3 via LoRaWAN.

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Other wished-for services include a model for Harmful Algal Bloom detection and forecasting capabilities to find windows of operation.

4.4.2 Danish pilots

As for previous pilots, there is interest in integration of remote-sensing models for harmful algal bloom detection.

4.4.3 Belgian pilot

For the Belgian pilot, several data-driven services would have significantly enhanced our ability to manage operations in the high-energy offshore environment of the Belgian North Sea. One key improvement would have been the integration of models to predict the potential location of lost objects. Using data on currents, wave action, and object characteristics such as size, weight and buoyancy, these models could provide probabilistic drift paths and settlement zones. This would have minimized the search area for lost equipment, saving valuable time and reducing operational costs.

Enhanced detection systems driven by data would also have greatly improved equipment recovery. Advanced sensors with longer-lasting signals, wider detection radii, and the ability to transmit real-time data could have made it easier to locate submerged or buried equipment. For example, when objects like cages detached from longlines and became buried in sand, having robust, data-enabled tracking systems would have allowed for more efficient and reliable recovery.

Another crucial enhancement would have been access to detailed seabed data. Real-time mapping of sediment composition, density, and the type of sediment present at greater depths (beyond the surface 2-meter layer) could have significantly improved decision-making for anchor installation and removal. This data would have enabled better anticipation of challenges, such as determining whether sandy or muddy conditions necessitated specific tools or techniques for decommissioning. Such insights would have streamlined operations, minimized delays, and reduced the risk of unforeseen complications.

Real-time current monitoring and drift prediction models would also have added significant value. Combining data from sensors and environmental models could provide precise insights into the movement of drifting objects. This would have made it easier to respond quickly and recover equipment more effectively, particularly in the dynamic conditions of the Belgian North Sea.

Finally, having data on the forces acting on longline structures would have improved their stability and durability. Sensors measuring stress, tension, and wave impact could provide actionable insights into structural integrity. Analyzing such data during the pilot would have allowed for design optimizations and maintenance scheduling, reducing risks of equipment failure.

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Hence, these data-driven services and tools could address critical gaps in monitoring, decision-making, and operational efficiency. While the pilot relied on existing systems and methodologies, integrating these advanced data solutions could have significantly enhanced the outcomes. These could provide a more robust framework for future offshore projects.

4.4.4 Dutch pilot

At the moment, no additional services are identified by this pilot. This could evolve as the running pilot plan goes into operation (planned for 2025).

5. Cost-effectiveness

The ULTFARMS project aims to use the HiSea data platform to integrate OWF and LTA monitoring and operational activities in a single interface with warnings, alerts, operation automatization, and data visualization to enhance the synergies of multiple activities.

The monitoring strategy has several benefits for the cost-effectiveness of both OWF and LTA operations, such as reducing the operational costs of LTA by providing alerts and warnings for detecting risks (e.g., strong winds, low or high-water temperatures, changes of production parameters) and optimizing the LTA operations. For example, the HiSea platform can help LTA producers to determine the best time for installation, harvesting, and maintenance of their farms, as well as to adjust their production parameters according to the environmental conditions.

This strategy also enhances the synergies of OWF and LTA by providing a single interface for monitoring and operational activities. This can facilitate the coordination and communication between OWF and LTA operators, as well as the sharing of resources and infrastructure. For instance, the HiSea platform can help OWF and LTA operators to plan their activities in a way that minimizes conflicts and maximizes mutual benefits.

Finally, this method can support the licensing and regulatory compliance of OWF and LTA by providing reliable data on the environmental impact and performance of their activities. The HiSea platform can help OWF and LTA operators to demonstrate their adherence to EU regulations and national mandates, as well as to provide references for future multi-use projects. This can improve the trust and acceptance of OWF and LTA among stakeholders and authorities, as well as reduce the administrative costs and delays of obtaining permits.

Therefore, the proposed monitoring strategy for ULTFARMS is expected to improve the cost-effectiveness of OWF and LTA activities by reducing operational costs, enhancing synergies, and supporting licensing and regulatory compliance. The monitoring strategy will also provide valuable data and information for interested stakeholders, such as researchers, policymakers, and consumers, who can access the HiSea platform and benefit from its services.

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6. Manuals and training materials

A comprehensive set of training materials are available to ensure that all stakeholders can effectively use the HiSea platform, and get the most benefit of the platform's capabilities. These materials are available for download/visualization on the platform site (https://ultfarms.hidromod.com/) and include a user manual and video tutorials explaining the process of how to upload, download and visualize data. While the manuals and training materials are primarily designed for online use, a current version of the documentation is included as an annex to this deliverable (Annex 1). It provides a technical description of the HiSea platform components and step-by-step guidance on creating dashboards, including details on the different types of widgets and their configuration.

In any case, a close collaboration with the different pilots to help them using the platform and answering their questions, is assured from the platform support and maintenance team.

7. Summary and conclusions

This deliverable reported on Task 6.2 of ULTFARMS: "Integration of monitoring technologies & data-base management and Services". The objective of this task is to offer a service that integrates advanced monitoring technologies and database management for effective monitoring and decision support for offshore aquaculture farms. To achieve these purposes, an IT platform developed in the framework of the previous H2020 EU HiSea project, capable of properly managing different types of data, models and algorithms, and publish/distribute information in fitted to use forms, has been chosen for the project.

The strength of this platform is that it helps with data visualization but is also able to integrate data from multiple sources and can be adapted for the needs of the pilots and integrate local datasets. The proposed approach aims to refine management practices for LTA, monitor equipment, structures, and biomass, and optimize daily operations, thereby reducing production risks. Overall, it can be a powerful tool for decision making in the project.

The HiSea platform will be further adapted and improved based on the needs of the ULTFARMS pilots. The consortium has already configured the platform with a wide range of public datasets for the pilot locations. Moreover, one of the planned improvements is for the pilots to be able to integrate additional data flows, for instance through in situ sensors collecting meteorological, water quality data, or underwater cameras that will monitor aquaculture species growth and suitability.

Another major objective is to introduce new services that support daily decision-making and future planning. For example, both the German and Danish pilots are interested in the integration of sensors or models that can detect harmful algal blooms. This capability would allow to establish an early warning system to

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identify potential risks due to the accumulation of micro-algae toxins in mussels. Moreover, in the event of lost gear or objects, the pilots would find it highly beneficial to integrate models that can forecast the potential location radius based on factors such as ocean currents. This feature would largely improve their ability to deal with these incidents.

The use of this monitoring framework is expected to enhance the cost-effectiveness of LTA and OWF operations. It will reduce operational costs through warnings and alerts for risks like strong winds and temperature changes, thereby optimizing the LTA operations (installation, harvesting, maintenance). With a single interface for monitoring and operational activities of both OWF and LTA, the synergies between the two activities will increase, potentially leading to shared resources and infrastructure, which can reduce overall costs. The monitoring strategy will also provide reliable data on environmental impacts and performance of their activities. This can reduce administrative costs and facilitate future licensing procedures. Additionally, the strategy provides valuable data for a wide range of stakeholders, further increasing its cost-effectiveness beyond the consortium.

In conclusion, the HiSea platform, with its emphasis on modularity, user customization, and real-time responsiveness, has the potential to significantly enhance the effectiveness of the project. As the project evolves, the platform's features are expected to drive insights and support a data-driven approach to decision-making.

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Annex 1: HiSea Platform documentation

Table of Contents

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1. Introduction

The documentation is divided into two main sections:

Dashboard: This section provides information on creating dashboards, including the various functionalities and capabilities available within the platform.

Widgets: This section details the different types of widgets and how to configure them.

2. Dashboard

The HiSea Platform uses dashboards to display data, providing a flexible layout that enhances data visualization. This section explains how to create a dashboard, considering the various types and available options.

For more information:

- On how to create a dashboard, refer to Create a Dashboard section.
- On how to use workloads in your dashboard, refer to Workloads section.
- On how to use multiple locations in your dashboard, refer to Dynamic Dashboard section.
- On how to define a single date or time span for all the widgets in your dashboard, refer to Single Date section.
- On how to set up the widgets in the dashboard, refer to Structure section.

2.1 Create a Dashboard

Create a new dashboard:

1. Navigate to the project where you want the dashboard to be located.
2. In the top navigation bar, locate the 'Settings' button and click on it.
3. From the popup menu, select the 'Manage Dashboards' option.
4. In the Dashboard Manager, you will see a table displaying all existing dashboards. If the project is new and no dashboards are listed, this is completely normal—you'll create dashboards and populate the table shortly.
5. Click the 'Create Dashboard' button located above this table to proceed to the dashboard creation page.

Define the general settings for your dashboard:

1. Choose whether the dashboard will contain a single widget or multiple widgets.
2. Provide a name and description for the dashboard.

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Build the dashboard:

1. Start adding widgets to the newly created dashboard by clicking the '+Add Widget' button.

For more information on dashboard structure, refer to Structure section. For detailed instructions on creating widgets, refer to the Widgets section.

Additional settings are available under Dashboard Definitions general settings. These include:

1. Use Workloads: Allows you to select a workload to associate with the dashboard.
   For more information, refer to the Workloads section.
2. Dynamic Dashboard: Enables the selection of multiple locations, with information dynamically updating based on the selected location. Widgets are configured once for several locations, and they display data corresponding to the selected location. When the location changes, the information updates automatically. Further details can be found in the Dynamic Dashboard section.
3. One Common Date for All Widgets: Lets you select a common date or time span for all widgets on the dashboard. More information is available in the Single Date section.
4. Use the Dashboard to Display an External Page: Available only for single-widget dashboards, this option allows you to set an external page as the entire dashboard display.

2.2 Structure

To edit the structure of your dashboard:

1. In the Dashboard Manager, locate the 'Structure' tab—it's the last option among the manager's tabs. Open the tab.
2. If there are no widgets in the dashboard, you will need to create them:
   • Click the '+Add Widget' button located in the top navigation bar of the Dashboard Manager.
   • A popup with the Widget Wizard will open, allowing you to set up your widget.
   • Once the widget is set up, click the 'Save' button. The widget will then be automatically added to the dashboard.
3. Now adjust the size of the widget as needed.
4. Repeat the process of adding and adjusting widgets to optimize the readability of your dashboard.

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2.3 Workload

What is a Workload?

A workload defines a scheduled or on-demand task for data processing, downloading, or presenting a product. It ensures that you have the necessary inputs and/or results to populate the widgets on your dashboard effectively.

To create a dashboard that utilizes a workload:

1. Make sure you are in the 'Dashboard Definitions' tab in the Dashboard Manager.
2. Enable the 'Use Workloads' toggle button.
3. Once activated, click on the newly enabled 'Dashboard Workload' tab.
4. Click the 'Select a workload' button.
5. In the popup window, select the desired workload from the table of available workloads.
6. Click the '+Add' button located above the table. The popup will close automatically, and the selected workload's name will appear in the workload definitions.

When configuring widgets:

- You will now have access to the workload's inputs and results.

Note: Date selection for the dashboard is not possible when using a workload, as the dashboard will adhere to the time settings defined in the workload.

2.4 Dynamic Dashboard

To create a dynamic dashboard:

1. Make sure you are in the 'Dashboard Definitions' tab in the Dashboard Manager.
2. Enable the 'Dynamic Dashboard' toggle button.
3. Click on the newly enabled 'Dynamic Dashboard Settings' tab.
4. Click the 'Pick Locations' button (the steps are identical for layers).
5. In the popup window, select the desired locations and add them by clicking the 'Ok' button. The popup will close automatically, and the number of selected locations will display.
6. Click the 'Create map with locations' button to add a map displaying the selected data (optional).
7. The map will be added automatically to the dashboard as a widget.

8. Navigate to the 'Structure' tab and adjust the map widget to fit your dashboard.

2.5 Single Date

If you want all the widgets on your dashboard to share the same date or time span:

1. Make sure you are in the 'Dashboard Definitions' tab in the Dashboard Manager.
2. Enable the 'One common date for all widgets' toggle button.
3. Click on the newly enabled 'Time Period' tab.
4. Define the start and end dates, as well as the dashboard refresh interval.

3. Widgets

The HiSea Platform offers a wide variety of widgets to provide maximum flexibility in data display. In this section, you will learn about the functionality of these widgets and how to configure them.

This section is divided into two main sections:

- Basic Configuration: Provides general information on widget setup and configuration.
- Widgets in Depth: Offers detailed information about each specific widget.

3.1 Basic Configuration

This section provides general information on widget setup and configuration.

For more information:

- On how to create a widget, refer to Create a Widget section
- On how to select time series, refer to Time Series Selection section.
- On how to define time series details, refer to Time Series Settings section.
- On how to define time series aggregation, refer to Time Series Aggregation section.
- On how to set up a date or time span, refer to Date Selection section.

3.1.1 Create a Widget

This section explains how to create a widget.

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1. Ensure you are in the Dashboard Manager, as widgets belong to dashboards.
2. For more information on how to create a dashboard, refer to the Create a Dashboard section.
3. Click the '+Add Widget' button located in the top navigation bar of the Dashboard Manager. This will open the Widget Wizard, a popup with all the necessary tools to create a widget.
4. Enter the widget's name and a short description.
5. Assign an ordinal number to the widget. This is important for mobile dashboard displays, as widgets will appear in the order of their ordinal numbers.
6. Use the checkboxes to select the type of information you want the widget to display.
7. Choose the widget type. There are multiple type groups available, such as charts and maps/diagrams. Explore all the options available.
8. For more details on each widget, refer to the Widgets in Depth section.
9. Add notes about the widget. These notes will be displayed on the reverse side of the widget and can include text, images, links, etc.
10. If you are using notes, check the 'Add widget information to the bar' checkbox located in the General info.

3.1.2 Time Series Selection

When the selected widget type requires a time series selection:

1. The 'Time series' step will become visible among the steps at the top of the Widget Wizard, go to this step.
2. In the 'Time series' step, you will find a table displaying all available time series.
3. Select one or multiple time series from the table.
4. The selected time series will be listed on the right side of the table.
5. Ensure that the time series you need are included in this list.
6. To remove unwanted time series, either click the bin button next to the series in the list or deselect it in the table.

3.1.3 Time Series Settings

When the selected widget type requires a time series selection, and you have already chosen the series you wish to use, you need to define the series details.

Define time series details:

1. Go to the 'Details' step at the top of the Widget Wizard and find the 'Time Series Settings' tab. Open this tab.
2. First, define the color palette for your widget. The selected color palette will be available when assigning colors.
3. Review the list of all selected time series. Adjust the name that will display in the widget. Depending on the widget type, a suitable data representation (such as lines, dots, areas, bars, or shapes) will be automatically assigned. For each type of data representation, configure the available settings:
    - Lines: Adjust the line color, type and weight.
    - Dots: Modify the dot type, size and color.
    - Areas, Columns, and Shapes: Customize the color.

Explore the available options to ensure all settings are correctly configured for your needs.

3.1.4 Time Series Aggregation

When the selected widget type requires a time series selection, and you have already chosen the series, you may also want to define the series aggregation.

Define time series aggregation:

1. Go to the 'Details' step at the top of the Widget Wizard and find the 'Time Series Aggregation' tab. Open this tab.
2. You will see a list of all selected time series.
3. For each time series, select the desired aggregation type and period.

3.1.5 Date Selection

Many widgets require a date or time span to be set up.

To configure the date:

1. Go to the 'Details' step at the top of the Widget Wizard, find the 'Date Selection' tab and open it.
2. Depending on the widget, provide either:
    1. Start and End Date (for example, for time series widgets).
    2. Reference Date (for single value widgets).
    3. Each date selector provides the following options:
        - Real Time: The selected period is always relative to the current moment.
        - Fixed Time: A specific date and time.

- Other: Allows selection of flexible time spans relative to days, weeks, months, etc.

Note: If using a workloads dashboard or the dashboard is set to 'One common date for all widgets', the date selection will be disabled in the Widget Wizard. In these cases, the dates are pre-selected either in the workload settings or in the dashboard settings.

3.2 Widgets in Depth

This section provides detailed information about each specific widget, organized by widget type groups as they appear in the tabs of the Widget Wizard.

3.2.1 Charts

This section is dedicated to all kinds of charts.

3.2.1.1 Chart Basic Configuration

To define the appearance of a chart:

1. Go to the 'Details' step at the top of the Widget Wizard.
2. Find the 'Chart Settings' tab and open it. You will see three sections within this tab:
    - General Settings:
        - ✓ Select from a series of checkboxes to define what information will be displayed (e.g., current date line, legend).
        - ✓ Define the X-axis color in this section.
    - Vertical Axis for Selected Unit:
        - ✓ Configure the Y-axis settings here, such as:
        - ✓ Minimum and maximum values (which specify the height of the chart).
        - ✓ Axis colors and styles.
    - Horizontal Plot Bands and Lines (only for selected chart types):
        - ✓ Define horizontal plot bands and lines in this section.
        - ✓ This feature is useful when adding an extra line or range to the chart for better visual analysis.

3.2.1.2 Line Chart

What is a Line Chart?

It is a type of chart that displays information as a series of data points connected by straight line segments. Line charts are ideal for visualizing continuous data, such as:

- ✓ Temperature
- ✓ Water flows
- ✓ Wind speed
- ✓ Precipitation rate
- ✓ Other similar continuous properties

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Configure time series:
    - Refer to Time Series Settings section.
5. Define time series aggregation (if necessary, optional):
    - Refer to Time Series Aggregation section.
6. Define chart details:
    - Refer to the Chart Basic Configuration section.

3.2.1.3 Column Chart

What is a Column Chart?

A Column Chart represents categorical data using rectangular bars, with each bar's height proportional to the values they represent. This chart type is ideal for displaying accumulated properties such as:

- ✓ Precipitation volume
- ✓ Irrigation volume
- ✓ Other cumulative data

The Column Chart displays data in a vertical format. If you're looking for horizontal data representation, consider using the Bar Chart widget instead.

How to set up:

1. Create a widget:

- Refer to Create a Widget section.

2. Select time series:
   - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
4. Configure time series:
   - Refer to Time Series Settings section.
5. Define time series aggregation (if necessary, optional):
   - Refer to Time Series Aggregation section.
6. Define chart details:
   - Refer to the Chart Basic Configuration section.

3.2.1.4 Mixed Chart

What is a Mixed Chart?

A Mixed Chart is a powerful tool that allows you to combine different types of data representation within a single chart. A common use case is combining a column representation with a line dataset, allowing for diverse and flexible data visualizations.

The following data representation types can be used within a mixed chart:

- ✓ Line
- ✓ Column
- ✓ Area
- ✓ Dots

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select time series:
   - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
4. Configure time series:
   - Refer to Time Series Settings section.
5. Define time series aggregation (if necessary, optional):

- Refer to Time Series Aggregation section.

6. Define chart details:
    - Refer to the Chart Basic Configuration section.

3.2.1.5 Pie Chart

What is a Pie Chart?

When it comes to statistical types of graphs, a Pie Chart and Donut Chart hold a significant place. These charts display data in a 'pie-slice' format, visually representing numerical proportions. The Pie Chart breaks down a group into smaller pieces, illustrating part-whole relationships, while the Donut Chart serves a similar function but with a hollow center, offering a more flexible and modern design for statistical visualization.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Configure time series:
    - Refer to Time Series Settings section.
5. Define chart details:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Pie Chart Settings' tab and open it.
    - Decide whether to show the legend using the checkbox.
    - Define the size of the inner circle (for doughnut charts).

3.2.1.6 Pyramid Chart

What is a Pyramid Chart?

A simple and intuitive chart used for representing data organized in a hierarchical structure. As the name suggests, this chart has a pyramid or triangular shape. The pyramid is divided into levels, each representing a different stage or category in a progressive order. It's ideal for illustrating proportions within a hierarchy, with the largest category at the base and progressively smaller categories toward the top.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select time series:
   - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
4. Configure time series:
   - Refer to Time Series Settings section.

3.2.1.7 Bar Chart

What is a Bar Chart?

A Bar Charts represent categorical data using horizontal rectangular bars, where the length of each bar is proportional to the value it represents. This widget displays the data in a horizontal bar chart format.

If you're looking for vertical data representation, check out the Column Chart widget instead.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select time series:
   - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
4. Configure time series:
   - Refer to Time Series Settings section.

3.2.1.8 Candlestick Chart

What is a Candlestick Chart?

A Candlestick Chart is the best chart to display time series variations within a given interval. It visually presents the start and end values of the interval, along with the minimum and maximum values within that period, making it ideal for analysing fluctuations or ranges in data over time.

How to set up:

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1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Configure time series:
    - Refer to Time Series Settings section.
5. Define time series aggregation (if necessary, optional):
    - Refer to Time Series Aggregation section.
6. Define chart details:
    - Refer to the Chart Basic Configuration section.

3.2.1.9 Scatter Chart

What is a Scatter Chart?

A Scatter Chart widget, like any scatter plot, displays the relationship between two or more variables. It is a highly powerful chart type that helps users quickly identify relationships or trends. One common use case is comparing modelled and measured values.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Configure time series:
    - Refer to Time Series Settings section.
5. Define time series aggregation (if necessary, optional):
    - Refer to Time Series Aggregation section.
6. Define chart details:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Scatter Chart Settings' tab and open it.

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- You will see three sections within this tab: General Settings, X Axis, and Y Axis.
    - In General Settings, define the appearance of the chart, including dot size and colors.
    - In X Axis and Y Axis, define the specifications for each axis.

3.2.1.10 Homologous Periods Chart

What is a Homologous Periods Chart?

A Homologous Periods Chart allows the reproduction of a single time series across different time intervals. It is a valuable tool for comparing values over specific periods, such as by years or weeks, to easily observe trends or patterns.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Configure time series:
    - Refer to Time Series Settings section.
4. Define chart details:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Homologous Chart Settings' tab and open it.
    - You will see three sections within this tab: General Settings, X Axis, and Start of Each Period.
        - In General Settings, define the chart type, duration, and interval.
        - In the Y Axis, define the axis specifications.
        - In the Start of Each Period, set the start date for each time period.

3.2.1.11 Bar Range Chart

What is a Bar Range Chart?

A Bar Range Chart is a visual tool used to display and analyse the range of data for different categories along a horizontal axis. Each category, represented on the Y-

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axis, is associated with a bar that shows the minimum and maximum values for that category along the X-axis.

This type of chart is ideal for examining the variability or spread of data over a specific range, such as speeds or temperatures. For example, a Bar Range Chart could illustrate how speed varies across different locations (e.g., Location A, Location B, Location C) over a period of time, helping to analyse fluctuations and patterns.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Define chart details:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Chart Settings' tab and open it.
    - You will see two sections within this tab: General Settings and Colors Settings.
        - In General Settings, define the overall appearance of the chart.
        - In Colors Settings, define the colors for the bars in the chart, following the provided instructions.

3.2.2 Map & Diagram

This section is dedicated to all kinds of widgets related to maps and diagrams.

3.2.2.1 Map

What is a Map Widget?

A Map Widget is a tool used to display data on a map, with the ability to showcase simple maps or incorporate complex data, such as time series, grids, locations, or alarms.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.

4. Define map settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Map Settings' tab and open it.
    - You will see two sections: General Settings and Background Layers.
        - In General Settings, define what you want to display on the map and how the map will appear.
        - In Background Layers, select the layers you want to be available in the map. These layers can be toggled in the widget but must be selected here first.
5. Define layers settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Layers Settings' tab and open it.
    - In the 'Manage Layers' section, you can add custom layers to your map. You can add as many as necessary but keep the number reasonable. Let's create one layer together:
6. Click the 'Layer Type' button and select the type of layer that suits your needs. For this example, we will create a 'Time Series Layer.'
7. Once the 'Time Series Layer' is selected from the dropdown, it will be automatically added to the 'Existing Layers' list, and a new section with layer settings will appear on the right.
8. Carefully review all the settings to ensure they are configured according to your needs. Make sure to select the data for the layer—in the case of the 'Time Series Layer,' click the 'Select Time Series' button. A popup will appear, allowing you to choose the data you wish to use. The selected time series will be displayed below the button, and you can delete them if needed. Each layer type will have a different set of settings.
9. You can add multiple layers; all added layers will be displayed in the 'Existing Layers' list. To edit a specific layer, simply click its name on the list, and the editor for that layer will open on the right.
10. If you wish to delete a layer, select it from the 'Existing Layers' list and click the 'Delete Layer' button located above the list.
11. You can also control the order in which layers appear on the map. To change the order, select the layer you wish to move and use the arrows located to the left of the 'Existing Layers' list.

3.2.2.2 Process Flow

What is a Process Flow?

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A Process Flow is a versatile widget that allows the creation of various schemes or workflows. These schemes can be connected to a model, enabling interaction with other widgets on the dashboard.

Key features of the Process Flow Widget:

- ✓ Customizable Schemes: You can design any kind of process or scheme to suit your needs.
- ✓ Model Connectivity: The scheme can be linked to a model, making it responsive to other elements on the dashboard.
- ✓ Interactive Functionality: When specific objects within the scheme are clicked, actions like selecting a corresponding option from a dropdown in another widget can be triggered, enhancing user interaction and integration across the dashboard.

This flexibility makes the Process Flow Widget a powerful tool for visualizing and controlling complex workflows and models.

How to set up:

1. Create a widget:
   - Refer to <u>Create a Widget</u> section.
2. Select time series:
   - Refer to <u>Time Series Selection</u> section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to <u>Date Selection</u> section.
4. Define the process flow settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Process Flow Settings' tab and open it.
   - You will see two sections: Diagram settings (on the left) and Preview (on the right). In Diagram settings, you define the process flow, while the preview allows you to view it in real-time. There are two ways to create a process flow:
     - Using a pre-defined JSON file: If you have a ready JSON file with the scheme definition, simply paste it into the text field.
     - Using the Editor: If the scheme is not yet created, use the Editor by clicking the 'Edit' button. The Editor allows you to add text, shapes, images, schemes, tables, etc. The time series selected in Step 2 are available in the editor for use.

Once you complete the configuration, you can view and interact with the process flow in the Preview section.

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3.2.3 Workload

This section is dedicated to all kinds of widgets related to workloads.

3.2.3.1 Under Keel Clearance Calculator

What is a Under Keel Clearance Calculator?

A Under Keel Clearance (UKC) Calculator is a tool designed to calculate the safe timetable and route for a ship's passage, ensuring there is adequate clearance between the keel (the bottom of the ship) and the seabed.

This widget can be used on its own, but it is recommended to pair it with additional widgets like the UKC Inputs/Results Table or the Time Span Table. When used together, the calculator provides a comprehensive and easy-to-use set of information based on the calculations, ensuring safe navigation for vessels.

How to set up:

1. Ensure you're in a Workloads Dashboard:
    - If you need more information on Workloads Dashboards, refer to Workloads section.
2. Create a widget:
    - Refer to Create a Widget section.
3. Define calculator settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Calculator Settings' tab and open it.
    - Select and configure the settings that suit your specific requirements for the Under Keel Clearance Calculator.

3.2.3.2 Under Keel Clearance Inputs Table

What is a Under Keel Clearance Inputs Table?

A UKC Inputs Table Widget complements the Under Keel Clearance (UKC) Calculator.

It provides a clear and comprehensive display of the inputs used in the UKC Calculator, making it easier for users to review and manage the data involved in keel clearance calculations.

For further details, please refer to the Under Keel Clearance Calculator section.

How to set up:

1. Ensure you're in a Workloads Dashboard:

- If you need more information on Workloads Dashboards, refer to Workloads section.

2. Ensure you are using an Under Keel Clearance Calculator:
   - Verify that the UKC Calculator is present in the dashboard you're editing. To do that go to 'Structure' tab in the Dashboard Manager and look for the calculator widget.
3. Create a widget:
   - Refer to Create a Widget section.

3.2.3.3 Under Keel Clearance Results Table

What is a Under Keel Clearance Results Table?

A UKC Results Table Widget is designed to complement the Under Keel Clearance (UKC) Calculator.

It displays the results generated by the UKC Calculator in a clear and comprehensive manner, making it easy for users to interpret and understand the outputs.

For further details, please refer to the Under Keel Clearance Calculator section.

How to set up:

1. Ensure you're in a Workloads Dashboard:
   - If you need more information on Workloads Dashboards, refer to Workloads section.
2. Ensure you are using an Under Keel Clearance Calculator:
   - Verify that the UKC Calculator is present in the dashboard you're editing. To do that go to 'Structure' tab in the Dashboard Manager and look for the calculator widget.
3. Create a widget:
   - Refer to Create a Widget section.
4. Define table's settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Under Keel Clearance Results Table Settings' tab and open it.
   - Select which parameters you wish to be displayed in the table.

3.2.4 Single value

This section is dedicated to all kinds of widgets displaying a single value.

3.2.4.1 Gauge

What is a Gauge?

A Gauge Widget displays a single value within a selected range. It serves as a simple status indicator, offering a clear and easy-to-read representation of a value's position relative to predefined alerting ranges.

This widget is particularly useful for tracking metrics where it's important to see how close a value is to critical thresholds.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Define gauge settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Gauge Settings' tab and open it. A preview will be displayed on the left side.
    - General Settings:
        - Select the gauge type: Arc, Linear, Radial, or Wind.
        - Define the widget's styles.
    - Labels:
        - Set minimum and maximum values.
        - Define the unit and additional label styles.
    - Main Ticks:
        - Define styles and frequency for the main ticks.
        - Optionally, disable ticks using the checkbox next to the section's name.
    - Secondary Ticks:
        - Define styles and frequency for secondary ticks.
        - Optionally, disable ticks using the checkbox.
    - Main Value Style:
        - Customize the appearance of the main annotation value.

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- Color Scales:
    - Set the gauge to change colors based on assigned values for clearer visualization.

3.2.4.2 Single Value

What is a Singe Value Widget?

A Single Value Widget is a simple, yet powerful tool used to display a single, bold piece of information prominently. It is ideal for presenting critical data points, such as alerts, performance metrics, or key indicators.

The widget allows customization of text and icon colors, making it highly effective for highlighting alerts or important updates in a clear and easily readable format.

For example, this widget can be used to show the current temperature, system status, or a specific KPI with visual cues to draw attention to critical values.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Define single value's settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Single Value Settings' tab and open it.
    - General Settings:
        - Select the single value type: Choose between Value or Date.
        - Define details such as Header text, number of decimal places, and units.
    - Main Value:
        - Customize the size and color of the main value.
        - The value color can be dynamically changed based on a value span, depending on predefined conditions.
    - Icon:
        - Decide if an icon should be displayed using the checkbox next to the "Icon" title.

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- Define the size, color, and type of the icon. You can also set the icon to change depending on the value span to reflect different statuses or conditions.

3.2.4.3 Level Description

What is a Level Description Widget?

A Level Description Widget displays the status of different alarm levels. It provides a compact and straightforward way to present critical information about the status of alarms on a dashboard, making it an ideal tool for situations where concise, easy-to-understand data is required.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
3. Define level description settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Level Description Settings' tab and open it.
   - Alarm Selection:
     - Choose the alarm you wish to monitor and display in the widget.
   - General Settings:
     - Configure how the data will be shown.
     - Select the Data Validity Period to determine how long the data remains valid. This is useful when working with real-time or time-sensitive information to avoid showing outdated data.
   - Style:
     - Customize the appearance of the widget, including text size and icon settings. You can choose to display or hide the icon depending on your needs.

3.2.5 Table

This section is dedicated to all kinds of table widgets.

3.2.5.1 Table

What is a Table widget?

A Table widget displays time series data in a table format.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select time series:
   - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
4. Configure time series:
   - Refer to Time Series Settings section.
5. Define table settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Table Settings' tab and open it.
   - For each selected time series, you can assign a level. If a level is selected, the table will display the level's name or description (depending on your preference) instead of the time series value. This feature allows for a more descriptive representation of the data.

3.2.5.2 Port Calls Table

What is a Port Calls Table widget?

A Port Calls Table widget displays port calls for a selected port in a table format.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
3. Define port calls table settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Table Settings' tab and open it.
   - Choose the port you want to display and select the type of calls from the dropdown. The available options are:
     - Arrivals/ Departures/Both

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- Select the columns you want to be visible in the table.

3.2.5.3 Alarms Table

What is a Alarms Table widget?

The Alarms Table widget is a powerful data visualization tool that helps track and analyse alarm-related data over time. It consists of two key sections:

1. Combined Hourly Values:
   - ✓ Displays the extreme (maximum or minimum) values for each hour of the day, providing an hourly breakdown of critical data points.
2. Daily Extremes:
   - ✓ Shows the extreme values for an entire day, helping users quickly identify the highest or lowest recorded values over a 24-hour period. This widget is particularly useful for monitoring alarm levels and understanding variations across time intervals, enhancing decision-making and situational awareness.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
   - Refer to Date Selection section.
3. Define table settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Alarms Table Settings' tab and open it.
   - Decide whether you want to display both combined values and daily extremes tables or just one of the two.
   - Select the alarms you want to display. You can reorder them as needed, adjust their names, and add icons if necessary.

3.2.5.4 Annotations Table

What is an Annotations Table widget?

The Annotations Table widget displays information about selected Annotation Group in in a table format.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.

2. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
3. Define table settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Annotations Settings' tab and open it.
    - Select the Annotation group you wish to display in the table.

3.2.5.5 Time Span Table

What is a Time Span Table Widget?

A Time Span Table Widget displays time intervals along with information about corresponding levels. It shows the start and end dates, duration, and level details, using either time series data or model-based information.

How to set up (Not Using Workloads):

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Define table settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Time Span Table Settings' tab and open it.
    - Choose the level set you want to use and set the max time for the bar representation based on your data. For example, if events are generally not longer than 8 hours, set the max time accordingly. The duration will still be shown as a value (e.g., 8h45m) even if it exceeds this limit.

How to set up (In Workloads Dashboard):

1. Create a widget:
    - Refer to Create a Widget section.
2. Select one of the following:
    - Time Series - Refer to Time Series Selection section.
    - Workload's Inputs - Follow the same logic as for time series.
    - Workload's Results - Follow the same logic as for time series.

3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Define table settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Time Span Table Settings' tab and open it.
    - Select the level set and define the max time for the bar representation, just like in the 'Not Using Workloads' setup.

3.2.5.6 Meteogram

What is a Meteogram widget?

A Meteogram widget is a graphical presentation of meteorological variables (observed or forecast) over time for a specific location.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select time series:
    - Refer to Time Series Selection section.
3. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
4. Configure time series:
    - Refer to Time Series Settings section.
    - Additional custom settings for this widget:
        - Is direction: Allows you to specify direction types (e.g., arrows) if needed.
        - Level set: Assigns the colors based on the level set.
        - Hide zeros: Option to exclude zero values from being shown in the table.
5. Define table settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Meteogram Settings' tab and open it.
    - Set the time step for the data (e.g., 1-hour or 3-hour intervals) based on your needs.

3.2.6 Other

This section is dedicated to all kinds of widgets.

3.2.6.1 PDF

What is a PDF widget?

A PDF widget is designed to display PDFs, allowing users to view either external PDF documents or internal report files directly within the dashboard.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Define PDF settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'PDF Settings' tab and open it.
   - In the General Settings section, choose whether you want to display an external PDF or an internal report:
     - External PDF: Enter the PDF's URL in the provided field.
     - Internal Report: Click the Select reports button. A popup will appear with all available reports. Select the report you want to display.

3.2.6.2 Notes

What is a Notes widget?

A Notes widget is ideal for adding static content to a dashboard. This content can include text, images, videos, links, and other multimedia, making it versatile for adding supplementary information, instructions, or visual elements.

How to set up:

1. Create a widget:
   - Refer to Create a Widget section.
2. Define notes settings:
   - Go to the 'Details' step at the top of the Widget Wizard.
   - Find the 'Notes Settings' tab and open it.
   - Add content using the Editor. You have various options available, such as:
     - Text: Insert plain or formatted text.

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- Images: Add images to enhance the visual appeal or provide visual aids.
- HTML Container: Insert custom HTML code for additional styling or content structuring.
- Videos: Embed video content from supported platforms. (Note: There is also a dedicated Video Player widget specifically designed for displaying video content. If your focus is on showcasing video files or streams, it may be better suited for your needs.)
- Links: Add hyperlinks to external or internal resources.

3.2.6.3 Reports

What is a Reports widget?

A Reports Widget is designed to list and provide access to reports issued within a specified period. These reports can be scheduled daily, weekly, monthly, or according to your preference. Users can download any report by clicking on the corresponding row in the table.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
3. Define PDF settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Reports Settings' tab and open it.
    - Define whether the date should be based on the report's values or the report creation date.
    - Click the Select reports button to open a popup displaying all available reports. Choose the reports you wish to display.

3.2.6.4 Image Slider

What is an Image Slider widget?

An Image Slider Widget displays a sequence of images along with their timeline, ideal for showing multiple images, such as those taken by an on-site camera.

How to set up:

1. Create a widget:

- Refer to Create a Widget section.

2. Select a date (if not using a Workload Dashboard or Single Date Dashboard):
    - Refer to Date Selection section.
3. Define PDF settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Image Slider Settings' tab and open it.
    - Choose which image you want to display first.
    - Set the transition interval between images.
    - Click the Select image button to open a popup showing all available images and select the desired image set.

3.2.6.5 Time Series Exporter

What is a Time Series Exporter widget?

A Time Series Exporter widget is designed to export time series data for further use outside the dashboard.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.

3.2.6.6 Video Player

What is a Video Player widget?

A Video Player widget displays videos directly on a dashboard.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Define player's settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Video Settings' tab and open it.
    - Provide a URL for the video that is suitable for website embedding.

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3.2.6.7 Website Viewer

What is a Website Viewer widget?

The Website Viewer widget embeds an external website directly on the dashboard. It's useful for integrating external resources, but caution is required as external sites might impact dashboard readability and need to be verified regularly.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Define viewer's settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Website Viewer Settings' tab and open it.
    - Enter the website URL.
    - Adjust the widget size appropriately to ensure the embedded website is displayed clearly on the dashboard.

3.2.6.8 Limits Calculator

What is a Limits Calculator widget?

A Limits Calculator widget is a map-based widget that visually displays layers showing whether specific variables fall within predefined limits. This tool allows users to easily understand how different conditions meet or exceed these limits.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Define calculator's settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Limits Calculator Settings' tab and open it.
    - Select a Base Project: Choose the project you want to work on or display. Each project will have a unique set of predefined variables.
    - Define Colors for Variables: Assign colors for each variable based on whether the value was below or above the defined limits, making it easy to differentiate and interpret data visually.

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3.2.6.9 Ship Viewer/Editor

What is a Ship Viewer/Editor widget?

The Ship Viewer/Editor widget is designed for viewing or editing ship information stored in the database. Users can access detailed information about ships and, depending on the settings, either view or modify this data.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Define viewer/editor settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'Ship Editor Settings' tab and open it.
    - Display as read-only (no editing allowed):
        - If checked: The widget will function as a Viewer. Users can view ship information but cannot make any modifications.
        - If unchecked: The widget will function as an Editor. Users can view and edit ship information, and they will have full permissions to modify ship details.

3.2.6.10 File Uploader

What is a File Uploader widget?

A File Uploader widget enables users to upload files directly to AquaSafe's database, facilitating data management and integration.

How to set up:

1. Create a widget:
    - Refer to Create a Widget section.
2. Define uploaders settings:
    - Go to the 'Details' step at the top of the Widget Wizard.
    - Find the 'File Uploader Settings' tab and open it.
    - Configure the necessary information for the Data Receiver Configuration.
      Please use the Backoffice application as a reference point.
    - Provide the information needed for a notification email that will be sent to Hidromod's team upon file upload.