
# HISEA DELIVERABLE 6.2

## REPORT ON SUSTAINABLE SUPPLY CHAIN

### WORK PACKAGE NUMBER: 6

### WORK PACKAGE TITLE: SERVICE OPERABILITY, VALIDATION, AND DEMONSTRATION

## HiSea Project Information

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|---|---|
| **Project full title** | High Resolution Copernicus-Based Information Services at Sea for Ports and Aquaculture |
| **Project acronym** | HiSea |
| **Grant agreement number** | 821934 |
| **Project coordinator** | Dr. Ghada El Serafy |
| **Project start date and duration** | 1st January 2019, 30 months |
| **Project website** | https://hiseaproject.com/ |

## Deliverable Information

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|---|---|
| **Work package number** | 6 |
| **Work package title** | Service Specification and User Requirements |
| **Deliverable number** | 6.2 |
| **Deliverable title** | Report on sustainable supply chain |

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| **Description** | The deliverable focuses on establishing the most operational supply chain in terms of data information flow through the platform. This deliverable will analyse the potential to improve the operational performance of algorithms and workflows to provide HiSea services as well as process and display data. It will generate operational components, which are required for the service provision, such as metadata sheets, quick looks, and quality descriptions. In order to make the service ready to be integrated into the client's workflows and day to day work activities, customized solutions to the platforms are provided. Further making sure that tools developed to integrate with client operation procedures, workflows and security requirements. Provide user administrative functions and organizations administrative functions. |
| **Lead beneficiary** | Deltares |
| **Lead Author(s)** | Sandra Gaytan Aguilar |
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## Approvals

| | Name | Organisation | Date | Signature (initials) |
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Contents



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# 1 Executive Summary

This document is the deliverable D6.2: 'Report on the sustainable supply chain' for the HiSea project. This deliverable describes the feasibility, efficacy, and improvements to the different modules of the sustainable supply chain. This document analyses the potential to improve the operational performance of algorithms and workflows to provide HiSea services as well as process and display data.

# 2 Introduction

HiSea aims to provide a set of services focused on different coastal user's needs (for example, navigation safety, ports operations, aquacultures, etc.) enabling exploitation of the added value of integrated Earth Observation (EO) technologies (satellite, airborne and ground based), Copernicus Marine Service and ICT to deliver customized and ready to use information. These services will provide an easy way to get in-situ data, local high-resolution forecasts, products and services (e.g. meteo-oceanographic conditions at specific locations, identification of optimum or critical working windows, support to sea pollution response actions, etc.) to a broad range of different users.

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# 3 Supply chain

The ***HiSea*** downstream service retrieves and pre-processes the Copernicus Service products, including model outputs, satellite imagery, and in-situ measurements. Complementary dataset and in-situ measurements are downloaded from external providers such as NOAA GFS data, Argo, EMODnet, etc. Near real-time data is locally acquired together with local high-resolution models forecasts. The schematization of the supply chain is presented in Figure 1. HiSea service provides an operational system for the demonstration services which produces enhanced information using data fusion algorithms. The data fusion algorithms will be used in order to interlace the various data sources into a comprehensive dataset which is both complete and more robust (accurate and reliable) than the individual datasets alone and more customized to the users' needs.

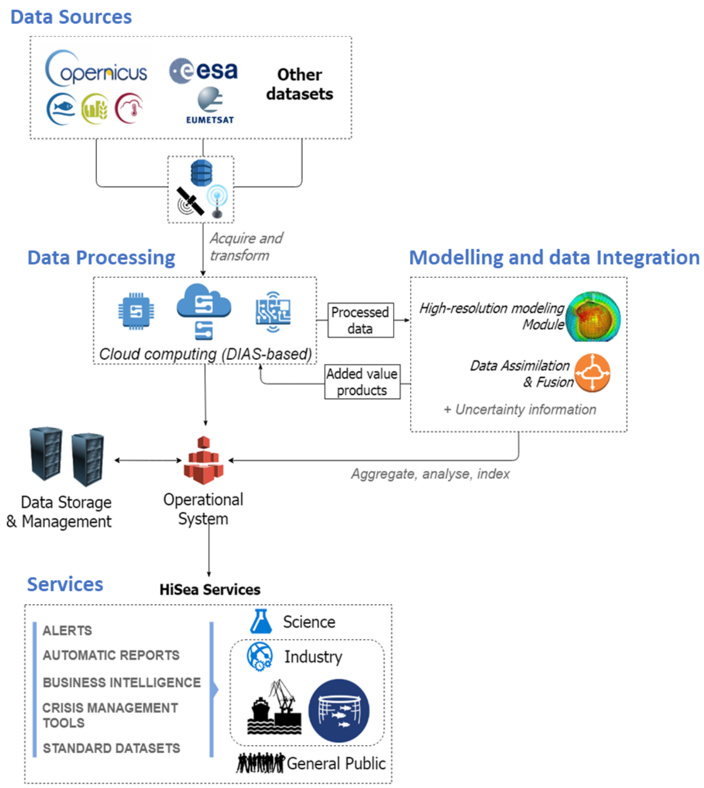


Figure 1 HiSea Supply chain

In the HiSea project, the supply chain risk environment is dynamic. The future might bring different threats and unexpected events. It is clear the Port and Aquaculture users rely on the availability of the service to plan activities and to make decisions. To map the nature of changing supply chain risks, we have identified the main components of our supply chain.

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In HiSea, a sustainable supply chain is defined as a process of providing services to the Ports and Aquaculture users in a way that fosters continuous and reliable water quality information, indicators and reports.

Sound asset management practices support sustainable service delivery by integrating user needs and an informed understanding of the trade-offs between risks and services. Figure 2 presents the HiSea service management process; it is the purpose and desired outcome. It also presents the reports, deliverables, and means of verification, validation, and monitoring.

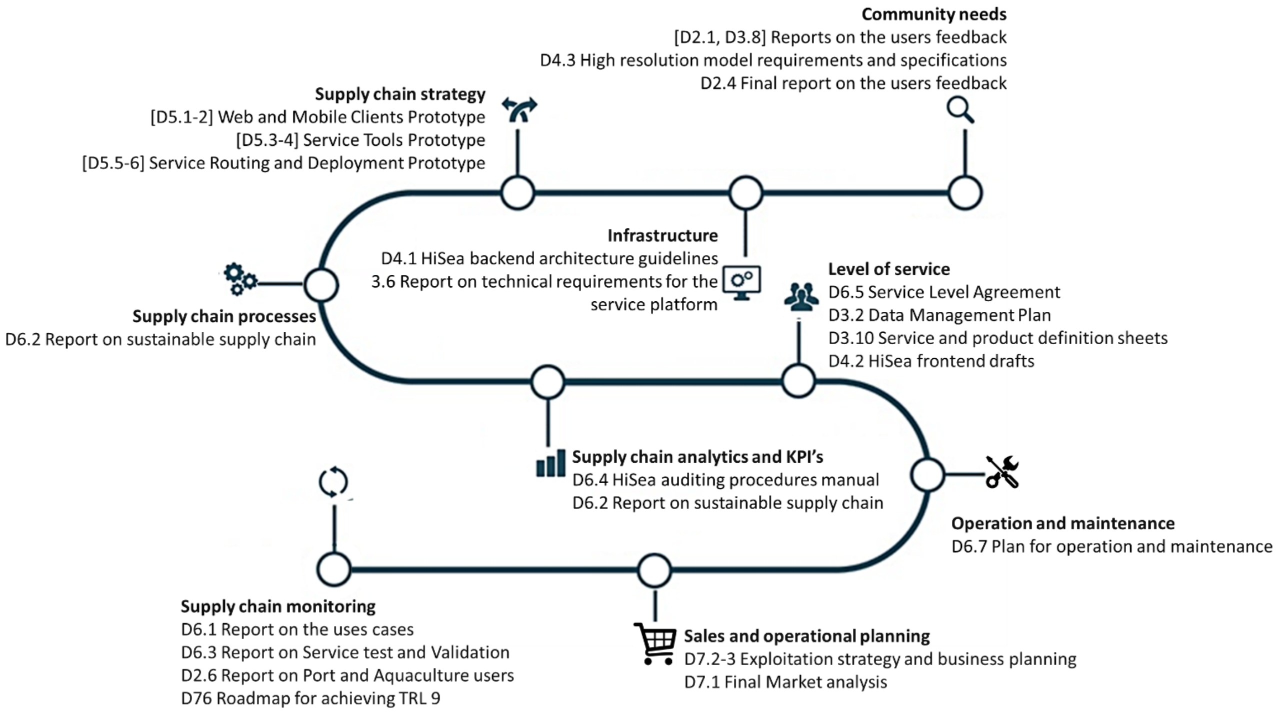


Figure 2 Supply chain optimization

For a sustainable supply chain, we have identified four core elements: the asset, the information (about the status and performance of the service), the consortium and the finances. All of these elements are addressed in the HiSea project at different phases of the project.

## 3.1 Assets

The assets include: back-end infrastructure, front-end infrastructure, numerical models, algorithms for pre/post-processing and data fusion. These assets will enable us to provide the HiSea services. Deliverable 3.10 presented a collection of product sheets that are included in the HiSea products portfolio. The product sheets summarize each HiSea product in terms of performance and other technical characteristics that are of interest to Ports and Aquaculture users of the system.

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## 3.2 Information

In order to have a sustainable supply chain, it is important to monitor and bring data about the assets and the performance while providing the service. This is done through the HiSea auditing procedures manual (D6.4). Information about the performance of the service is presented in the Report on Service test and validation (D6.3).

## 3.3 The consortium

The service supply chain is a consortium-wide responsibility. The importance of ensuring that people have the necessary knowledge, skills, and attitudes, along with enabling consortium processes and culture, cannot be overlooked. The roles and responsibilities will be stated in the cooperation agreement that will be drafted before starting to provide services. The cooperation agreement will address the following points:

- Partner's role in asset management and the actions that contribute to the desired service provision.
- Culture and consortium alignment that fosters teamwork and integration across disciplines.
- The partner's staff with the required knowledge and skills to develop, implement and maintain the HiSea platform.
- Commitment to the continuous improvement of the HiSea platform.

The HiSea level of service is a commitment to the port and aquaculture users. Therefore, based on the previously defined auditing procedures (Task 5.4), audits will be performed in order to assess the system reliability and to identify any problem that may affect the system. As a result of these audits, beyond the identification of the aspects that may need improvements, it will also be possible to get the information about the service level agreement (SLA) accomplishment. The ability to be able to commit to an agreed SLA with the clients, including quality, availability, and responsibilities, are critical for the success of the service.

Moreover, the D3.2 Data management plan, presents the minimum requirements in terms of metadata that need to be provided with the service, as well as a quality description of the service. In order to make the service ready to be integrated into client's workflows and day to day work activities, 2 workshops have been organized and reported in the Report on end-users' needs and requirements (D3.8)

## 3.4 Finance

To achieve sustainable service delivery, services need to be financially viable over the long term. Asset management requires the integration of technical information about services, risks, and information about costs and funding to inform decision-making.  Balancing costs and funding strategies is an iterative and ongoing process that begins with ensuring that the levels of service provided can be financially sustained. This information will be integrated into a financial plan (D7.2 Business Plan)

Another important aspect is the costs of operation and maintenance. D6.7 Plan for operation and maintenance will report the plan for the operation and maintenance of the services to be produced during the project's lifetime. It aims to ensure that the services are compliant with the H2020 Open Access policy and the recommendations of the Open Research Data Pilot. The plan will ensure effective implementation of the end-user services and will control its performance efficiency to achieve an economical, sustainable and reliable operation. Translating the user requirements and recommendations into specific guidelines that can be applied in the users' practices will contribute to optimised performance and reliability of the system.

Defining and reviewing each part of the supply chain is a set of ongoing activities that are applied, to some extent, in each stage of the process. Although these activities are ongoing and embedded in the overall process, their importance justifies dedicated consideration to ensure that they are central to the process. The following sections

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describe the work flows in the supply chain presented in Figure 1., addressing mainly access to the Data sources, Data Processing, High-resolution modelling, and the Front end.

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# 4 Data sources

## 4.1 Copernicus Marine Service

The data provided by Copernicus, with emphasis on Copernicus Marine, Land and Copernicus Climate has the potential to introduce relevant benefits in several sea related activities and sectors such as environment, maritime safety or resources management and it is therefore of major importance that a growing number of users may take advantage of it. HiSea will contribute to a wider use of this data, by providing added value in two ways: (1) processing it in a way that it can be delivered to users through a friendly process and in easy to use formats and (2) processing it in order to produce the tailored information that users require.

Copernicus Marine Service provides numerous products for the Global Oceans and the European Seas. The products include historical data, hindcast (reanalysis), near-real-time forecasts, and forecasts. The temporal resolutions vary from hourly and daily to monthly. Furthermore, fine, medium and coarse spatial resolution products are available. Certain CMEMS model products use data assimilation of Sea Surface Temperature, sea level, or Chlorophyll-*a* into the models. The processing level of CMEMS products ranges from L2 discrete (with quality control flags) through L3 gridded (data with gaps after validation) to the L4 grid (gap-free gridded data after validation). Models and observations (in-situ and satellite) are available covering different physical and water quality variables.

To facilitate and standardize access to data, the European Commission has deployed five cloud-based platforms providing centralized access to Copernicus data and information, as well as processing tools. These platforms are known as Data and Information Access Services, or DIAS.

DIAS is an excellent fit for hosting the HiSea services since it would allow access to Copernicus data without the burden of maintaining data on the platform. Most of the DIAS platforms provide access to information either via a network shared with a virtual machine (VM) running on their infrastructure or via data services hosted by the DIAS providers. More information and detailed comparison have been addressed in D3.1 “State of the Art” and D3.7 “Integration of external data Sources”.

## 4.2 Accessing other data sources

The main problem of accessing external sources is the diversity of transport protocols and file formats that exist. OGC standards such as sensor observation service (SOS) and Web coverage service (WCF) are still only partially adopted by most data providers.

Most gridded data are accessible via OPENDAP protocol; however, other formats such as time-series and even satellite images are usually more scattered regarding access protocols.

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# 5 Data Processing

## 5.1 Cloud computing

The operational cloud-based (DIAS-based) infrastructure: The information management software system will take care of all the necessary steps to import all the external data, prepare and run the high-resolution models and make the information available. The relevant data processing procedures include importing and preparing data, running models, publishing results, issuing reports and alerts. The extensive experience acquired with Hidromod's IWA awarded AQUASAFE and Delft FEWS platforms, in different operational services will assure a reliable starting point for the **HiSea** platform. These platforms will be adapted to fully run in a cloud environment such as DIAS.

The HISEA platform is a distributed platform that proposes several services to end-users to manage data across the Mediterranean Sea. The proposed services offer the end User many opportunities including:

- Discovering data and services from the HISEA catalog
- Viewing data and metadata
- Downloading raw and processed data
- Production of the dataset with processing queue for later analysis and download
- Processing data with different algorithms on-the-fly

A constraint of the HISEA platforms is that the needs of the end-users cannot be easily identified and it is anticipated that more users will come online as the project progresses. It is therefore essential that the platform and architecture are scalable and allow the flexibility to respond to change.

To respond to this scalability, platform components should have a high degree of independence and should be able to communicate asynchronously to each other.

As may be seen from the HISEA platform architecture and its main components, data from external providers (as EMODnet, CMEMS, SeaDataNet, and many others), as well as data collected by Observatory servers, comprised of data from on-site sensors, remote sensing data, and results of numerical models, will be included into the HISEA platform. More information has been presented and extended in D4.1 "HiSea backend architecture guidelines"

## 5.2 EO-derived information

Earth Observation ( remote sensing and model outputs) derived information processed by ARGANS-FR lean against different data **providers** such as Copernicus (Marine, atmosphere and climate change service), ACRI (Globcolour, remote sensing data from Modis, Viirs, Sentinel-2 and 3), spatial agencies or meteorological centres. Those data are daily accessed (or download) via different protocols like OPenDAP or FTP and then automatically treated by the ARGANS-FR platform.

Input data can be Model Outputs (i.e. form Copernicus) or Remote Sensing data (i.e. from ACRI database or spatial agency). All the data are processed on Linux computers by ARGANS-FR to extract the requested parameters on the

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area of interest. For remote sensing data, specifics algorithms can be applied to generate added-value products (i.e. ocean colour products, Harmful Algal Bloom detection, different indicators like environmental optimal area for a farming type). Quality control and mini alert can be associated with the resulting product. Temporal series can be extracted from different points corresponding to farm location.

The resulting products are stored in a "Files Data Base" in a different format (GTIFF, PNG, NetCDF, CSV) and the corresponding "Metadata" in a DataBase Server, whole will be accessed by HiSea platform via an API.

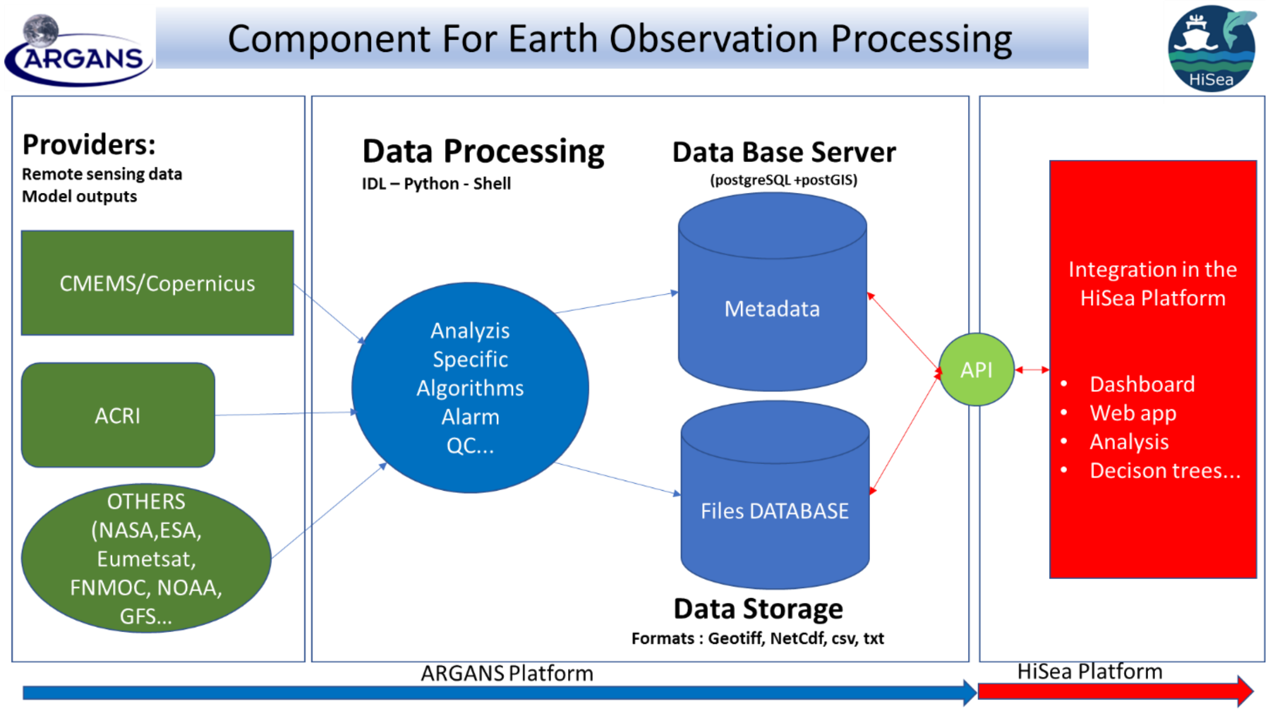


Figure 3: Component for Earth Observation processing.

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# 6 High-resolution modelling

The high-resolution models: Hydrodynamics, waves, and water quality models are capable of providing high-resolution forecasts. In the first development stage, the hydrodynamic models will rely on Delft3D and/or MOHID, the wave modelling will rely on SWAN and WaveWatch III and the meteorological information will be mostly acquired from external providers.

HiSea platform will make use of Delft FEWS or Hidromod's AQUASAFE systems to operationalize (daily automatically run) the high-resolution models. Both of them have the ability to link any type of model and data source and so additional models may also be considered whenever required.

## 6.1 Delft3D Flow Flexible Mesh

The modelling tool proposed for this research is Delft3D-FM modelling suite. The application of Delft3D for water systems diagnosis is widely accepted. This suite contains the popularly used unstructured hydrodynamic module called D-FLOW FM, and the ecological module D-Water Quality (DELWAQ). D-FLOW FM is a multi-dimensional i.e.; 1D, 2D and 3D hydrodynamic and transport simulation program. It calculates the unsteady flow and transport phenomenon that is resulted from tidal and meteorological forcing on structured or unstructured, boundary fitted grids. The D-FLOW FM offers an unstructured grid in the horizontal plane, which is an advantage while developing high-resolution models as it would offer greater accuracy of the coastal geometrical features. The flexible mesh term in the name refers to the feature, which allows the creation of unstructured grids made of triangles, quadrangles, pentagons, and hexagons. In 3D simulations, vertical grids are created in σ coordinate approach (D-FLOW-FM, 2019).

D-FLOW FM solves the Navier Stokes equation for an incompressible fluid. In 3D models, the vertical velocities are computed from the continuity equation. The set of partial differential equations in combination with an appropriate set of initial and boundary conditions is solved on an unstructured finite volume grid. The continuity equation is solved implicitly for all grid points in a single combined system. The time integration is prepared explicitly for part of the advection term and the subsequent dynamic time-step limitation is automatically fixed based on the Courant number criteria (D-FLOW-FM, 2019).

$$\frac{\partial h}{\partial t} + \frac{\partial Uh}{\partial x} + \frac{\partial Vh}{\partial y} = Q \quad (3.1)$$

$$Q = \int_0^h (q_{in} - q_{out})\, dz + P - E \quad (3.2)$$

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$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} - fv = -\frac{1}{\rho_0}\frac{\partial P}{\partial x} + F_x + \frac{\partial}{\partial z}\left(\nu_V\frac{\partial u}{\partial z}\right) + M_x \quad (3.3)$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z} + fu = -\frac{1}{\rho_0}\frac{\partial P}{\partial y} + F_y + \frac{\partial}{\partial z}\left(\nu_V\frac{\partial v}{\partial z}\right) + M_y \quad (3.4)$$

$$\frac{\partial h}{\partial t} + \frac{\partial uh}{\partial x} + \frac{\partial vh}{\partial y} + \frac{\partial w}{\partial z} = h\left(q_{in} - q_{out}\right) \quad (3.5)$$

Equation (3.1) is a depth-averaged continuity equation, where U and V are depth-averaged velocities. Q represents the contribution per unit area due to the discharge or withdrawal of water, precipitation and evaporation (equation 3.2). The momentum in x and y direction are given in equations (3.3) and (3.4), where $\mathbf{V}_V$ is the vertical eddy viscosity coefficient. Density variations are ignored, except in the baroclinic pressure terms, ∂P=∂x and ∂P=∂y denote the pressure gradients. The forces $F_x$ and $F_y$ in the momentum equations denote the unbalance of horizontal Reynolds stresses. $M_x$ and $M_y$ represent the contributions due to outside sources or sinks of momentum. The vertical velocity *w* in the adapting σ co-ordinate system is calculated from the continuity equation (3.5). At the surface, the effect of precipitation and evaporation is considered. The vertical velocity *w* is defined at the iso σ-surfaces. *w* is the vertical velocity relative to the moving σ-plane. It could be inferred as the velocity related to up or downwelling motions (D-FLOW-FM, 2019).

## 6.2 MOHID

MOHID is a modelling suite,  in some ways similar to Delft 3D, (developed jointly by HIDROMOD and the Environmental and Marine Investigation Centre of Instituto Superior Técnico, with smaller contributions from other teams) composed of several modules, capable of simulating different aspects such as Hydrodynamics, Sediment Transport, Water Quality and Ecology, Soil Water Drainage and Oil Spillage. MOHID system was applied successfully in several environments worldwide, from oceanic to coastal areas, estuaries, lakes and reservoirs and watersheds, both in the framework of engineering and R&D&I projects.

In the framework of HiSea, MOHID will be available to perform high-resolution simulations as part of the HiSea services.

## 6.3 D-Water Quality

D-Water Quality or DELWAQ allows building the water quality models for different water systems including fresh, brackish and saline conditions. This can be coupled to the hydrodynamic model from Delft3D-FLOW. DELWAQ is flexible enough to be built on 1D, 2D or 3D structured or unstructured grids. This module simulates the state variable of interest which could be a naturally present substance or property of the water, polluting substance or the aquatic organism. These substances could enter the model area through the boundaries of lateral flows. The movement and dispersion in time are in accordance with the flow or the currents in the water that is described under the

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hydrodynamic model (D-FLOW FM). They show their intrinsic properties such as decay or interaction with other substances, mainly caused by the microbial organisms or the phytoplankton or such aquatic organisms. This could be described as a chemical process. Another transforming process is physically occurring at the water-atmosphere interface. These are dependent upon factors such as temperature and other meteorological forces like solar radiation and wind velocity. Table refers to the state variables, process and the respective forcing functions that are part of eutrophication or the HABs (DELWAQ, 2019).

Table 1: Pollution problems and their associated state variables, process and forcing functions (Source: DELWAQ 2019)

| Pollution problem | State variables | Important processes | Forcing functions |
|---|---|---|---|
| Oxygen deficiency | Biochemical oxygen demand (BOD), Dissolved Oxygen (DO) | Mineralisation of the organics consuming the oxygen, reaeration | Water temperature, wind speed, flow velocity |
| Eutrophication | Algae biomass, inorganic nutrients ($NH_4$, $NO_3$, $PO_4$, Si), BOD | Mineralisation of the organics consuming the oxygen, settling, growth, and mortality of the algae | Solar radiation, water temperature |

The transport of the substances is described by the advection-dispersion equation (3.6). The change in the substance concentration is governed by this equation which considered advection transport and the dispersion transport along with other sources and sinks. A wide range of numerical schemes is available to compute the transport part of the equation, the selection of which depends on the model discretisation, geometries of both steady and unsteady cases (Lorinc Mészáros, 2018).

$$\frac{\partial C}{\partial t} = -u\frac{\partial C}{\partial x} - v\frac{\partial C}{\partial y} - w\frac{\partial C}{\partial z} + \frac{\partial}{\partial x}\left(D_x\frac{\partial C}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_y\frac{\partial C}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_z\frac{\partial C}{\partial z}\right) + S + P \qquad (3.6)$$

Where C is concentration of the state variable, (*u,v,w*) is velocity components, ($D_x$, $D_y$, $D_z$ ) is dispersion tenor components, (*x, y, z*) is coordinates, S is source or sink due to loads and boundaries, P is source or sink due to processes, t is time.

DELWAQ enables research with its features of ecological process and will work in tandem with the hydrodynamic model D-FLOW FM.

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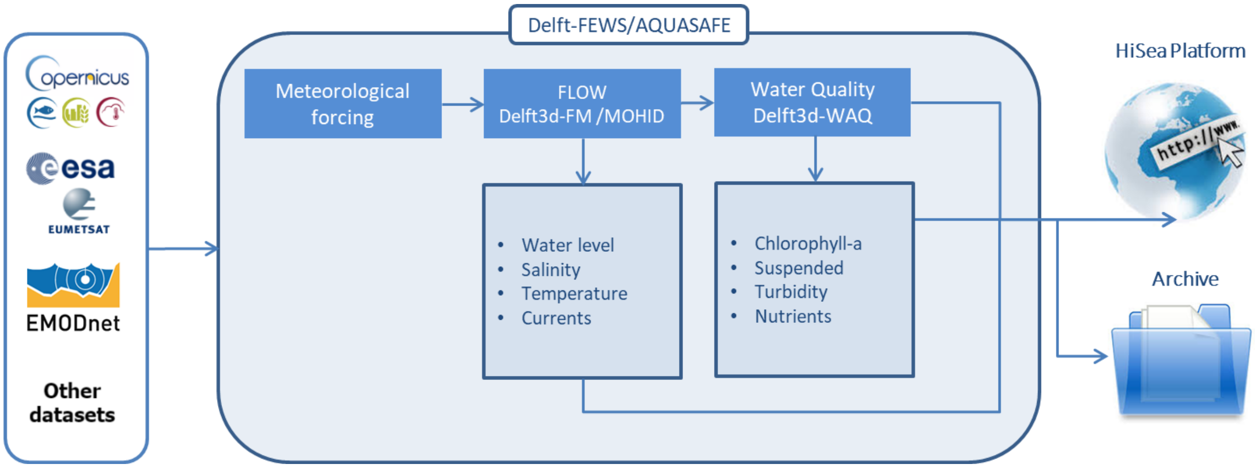


Figure 4 schematization of the modelling workflow.

## 6.4 Data assimilation and fusion

The data science component includes data assimilation and data integration. Data assimilation and fusion will make use of the various Copernicus Service products and external datasets, including model outputs, satellite imagery and in-situ measurements for the merging of these datasets. The combination of the above mentioned different types of sources and format of data will be done to gain a lower detection error probability and higher reliability and therefore a more complete global information of the case study.

The main tasks to be executed in the data integration phase are data preparation (caching and pre-fetching), data harmonization, standardization, assimilation, and fusion. Data fusion algorithms need to be used in order to interlace the various data sources into a comprehensive dataset which is both completer and more robust than the individual datasets alone. Dealing with a huge amount of data, data needs to be processed and saved in an efficient way, removing unnecessary auxiliary data. Thus, firstly data can be validated for information utility (e.g. in the case of remote sensing acquired data, excessive cloud cover resulting in no pixel information) and then filtered. Furthermore, datasets are inspected for existing errors or correlations with each other by using statistical metrics.

While merging different datasets, it is necessary to establish that the set of data over time refers to the same object. The clustering algorithm as the nearest neighbour and the K-means will be used to overcome such issues. Moreover, data will be formatted into a common form and aligned in the time and in the spatial domain. The assessment of the data also leads to determine classification's impact on the propagation and compounding of errors. Such errors can then be determined by a comparative analysis of the fused datasets with in-situ monitoring stations. It is proposed that effective fusion of the data products examined will be conducted in a manner so that the various classifications, complementary, redundant, and cooperative, of data, are all assessed to determine the classification's impact on the propagation and compounding of error.

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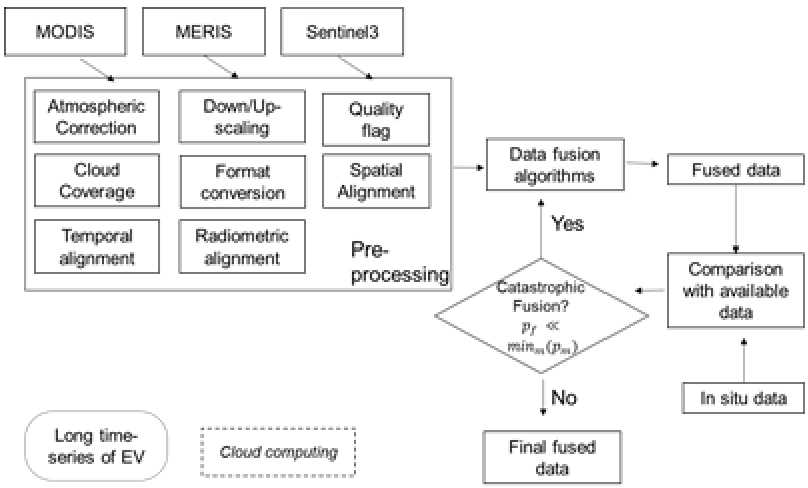
The use of Data Assimilation (DA) has a positive impact on reducing errors and uncertainty improving water quality prediction. DA combined model outcomes with in-situ measurements to produce an optimal estimate of the evolving state of the system better than the one obtained by using EO or model data alone. Nowadays, DA use spans a wide range of fields such as operational weather and ocean forecasting, seasonal weather forecasting, global climate datasets as it provides real-time monitoring and short-term information.

Among others, the main benefits of DA are quality control, a combination of data, errors in data and in the model, filling in data poor regions, designing an observational system, maintaining consistency, estimating unobserved quantities. Within the HiSea services, data assimilation methods will be used for automatic calibration of the models and state updates. Estimation and calibration methods such as Shuffled Complex Evolution (SCE), Simplex, or Conjugate Gradients help to find an optimal solution to parameterization problems. Among the most used DA methods, the Ensemble Kalman Filter (EnKF), will be applied to the hydrodynamic model via a step-wise assimilation process of selected data products (eg. chlorophyll-a concentrations). This will mostly depend on the data availability, with considerations on the spatial and temporal resolution of said data sets, as well as the primary objective functions of the model outputs and how such variables can relate to the automated calibration or active state updating of modelling exercises.

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# 7 Frontend

The service frontend (e.g. desktop, web, mobile) is a key component of any service. Through the frontend, users have access to the service. Therefore, the level of acceptance of the service by the user is closely related to the service's capacity to properly answer the user's questions and the user's ability to employ the service easily and effectively. D4.2 "HiSea frontend drafts" describes some HiSea service mock-ups, such as web and mobile clients, to enable an informed exchange of ideas with different potential users, creating a first draft of the user interface (UI), namely, how the HiSea services will look to the end-user. The frond-end focuses on 3 components

**Visualization and apps**

The service allows users to browse the data using an app, define reports and dashboards which provide graphical views on the data including charts and maps. Users may subscribe to updated and customized reports which provide a combination of graphical and text elements.

**Crowdsourcing**

The provision of mobile crowdsourcing information is an increasingly popular mechanism to share information resulting from personal experiences and observations that may be of interest if adequately harvested. This kind of information may be quite useful in preventing accidents or taking preventive actions in case some qualitative abnormal incidents that may impact the business have been reported.

**The support to clients and auditing system**

Continuous monitoring of the proper execution of the different service chain components, assessment of system performance in terms of the internal tasks and of the services delivered to the client, production of regular models validation reports, etc.

A summary of the port and aquaculture application is presented below. More detailed information can be found in "D4.2 HiSea frontend drafts" and in "D3.6 Report on technical requirements for the service platform"

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Table 2: Port and Aquaculture application requirements

| | Id | Application domain | Detail | Goal / Requirement |
|---|---|---|---|---|
| Ports | 1 | Area control and monitoring | Water quality | Facilitate regulation compliance |
| | | | | Continuous measurements |
| | | | | Identify areas with specific water parameters. |
| | | | | Facilitate regulation compliance |
| | | | | Continuous measurements |
| | | | Material transport (sediments) | Internal and external port waters |
| | 2 | Early warning systems | Water quality and Oil spills | Identify oil spills |
| | | | | Personalized alarms for abnormal water quality parameters |
| | 3 | Modeling | Water trajectory models | Foresee oil and other contaminant spill movements. |
| | | | Identify the location of contaminating sources | After contamination is detected, perform reverse tracking to its source location. |
| | | | Forecasting Water quality parameters | |
| Aquaculture | 1 | Water quality for aquaculture | Water quality revolves around water temperature and oxygen. Currents and winds are good indicators of oxygen renewal | Hight resolution |
| | | | | Historical data |
| | | | | Forecast and alerts |
| | | | | Correlate to feeding levels |
| | 2 | Harvesting with vessels | Winds and currents determine the timing of harvesting using ships. Forecasting winds and currents would allow scheduling this activity so that the weather conditions would not negatively affect the supply chain | Schedule harvesting. |

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# 8 Conclusion

This report has presented an overview of the supply chain. All of the building blocks for a sustainable supply chain in the HiSea project have been tested within the project or in the framework of other projects. Moreover, the knowledge and experience of the consortium partners, guarantee that the services delivered by the HiSea platform can be sustainable within the HiSea context.

Reporting demonstrates measurable progress in implementing the process and achieving sustainable service delivery. Along with this deliverable, additional reports on the progress on the implementation have been delivered.

Asset management is an important part of overall sustainable service delivery. Importantly, Asset management also must develop a set of performance measures and processes for reporting in a way that best support effective communication by the consortium and achievement of the HiSea goals. This set of indicators will be reported in D6.4: (HiSea auditing procedures manual), where the appropriate auditing procedures aiming to keep a continuous verification of the service quality will be defined. These auditing procedures will take into account specific requirements to improve the quality of the services following three steps: 1) procedures; 2) indicators for each procedure and 3) quantification of each indicator.

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