

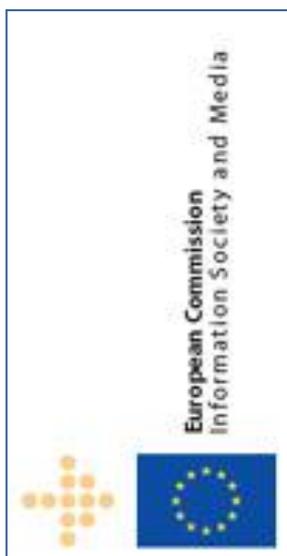


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GLOSSARY/ACRONYMS

ABBREVIATION	DEFINITION
AAG	Aquaculture Atlas Generation
AAPS	Aquaculture Atlas Production System
CBD	Convention on Biological Diversity
EEZ	Economic Exclusive Zones
EO	Earth Observation
GBIF	Global Biodiversity Information Facility
GIS	Geographic Information System
GSFM	Global Seafloor Geomorphic Features Map
IUCN	International Union for Conservation of Nature
MEOW	Marine Ecoregions Of the World
MPA	Marine Protected Areas
NASO	National Aquaculture Sector Overview
OBIS	Ocean Biogeographic Information System
PAIM	Protected Areas Impact Maps
UNEP	United Nations Environment Programme
VRE	Virtual Research Environment
WCMC	World Conservation Monitoring Center
WDPA	World Database on Protected Areas
WFS	Web Feature Service
WMS	Web Map Service
CMEMS	Copernicus Marine Environment Monitoring System

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DELIVERABLE SUMMARY

The deliverable D7.2 Blue Environment VRE Integrated Resources provides a description of the resources that are or will be exploited or reused in Blue Environment VREs. With the term resources, we refer to data sources, policies, guidelines, software and tools, etc. in the context of the Blue Environment VREs; in particular, as already described in deliverable D7.1, the Aquaculture Atlas Generation VRE and the Marine Protected Areas VRE. The document reports on the resources that have been integrated until the month M17 (January '17). The mentioned VREs were described in deliverable D7.1, where the design and the overall goals of the VREs were specified by pointing to a set of Wiki pages. Indeed, also Deliverable D7.2 was originally planned and implemented as a type “Other”; a living wiki page – which was in turn connected to several other wiki pages – that evolved with the development of Blue Environment resources. The rationale behind the wiki was to have flexibility in proposing new ideas, discuss potential development efforts, and report (intermediate) results. However, the overlap with the ticketing system, and the multitude of development activities, some of which stopped or completed in 2016, while other are not planned until 2018, led to fragmentation of the wiki in some parts.

Therefore in November 2016 it was decided that a deliverable of type “Report” had to be produced to summarize the information of the wiki pages in an organized fashion. This is the report that has been derived from the wiki pages, therefore in many sections, we report the links to the wiki pages where the reader can find more detailed (or in some cases more recent) information; the two sources are not synchronized.

The deliverable covers the first sixteen months of the project . An update to this deliverable will be D7.4 (Blue Environment VRE Integrated Resources: Revised Version) which is due for M27.

EXECUTIVE SUMMARY

Work Package 7's goal is to deliver services that serve the inventory of aquaculture farms, visualize the socio-economic performance of human activities in aquatic environments and facilitate the management of their spatial distribution in environmentally sustainable ways, consistently with the Ecosystem Approach.

This objective is met by developing two VREs:

- T7.1 the Aquaculture Atlas Generation (AAG) VRE;
- T7.2 the Protected Areas Impact Maps (PAIM) VRE.

Deliverable D7.2 describes the integrated resources of these VREs, focusing on the data and services to establish and manage them and the information related to their use.

The Use Cases related to AAG VRE refer to Aquaculture Mapping in two locations in Greece and in Indonesia. Both use cases mix data from satellites with data coming from other sources, in order to obtain a comprehensive analysis of aquaculture locations that will be added to the FAO NASO maps.

The general objective of the Use Cases related to PAIM VRE is to evidence the impact of human activities on protected areas and to extract specific management indicators. For this purpose, resources are required to perform an analysis of Marine Protected Areas coverage, the biodiversity (species occurrences) within them, along with statistics about regional fisheries and aquaculture production. The proposed Use Cases will be located at first in Caribbean and subsequently in an EU country and in Indonesia.

In this Deliverable, a generic interpretation applies for the term resources; it can include data sources, data collections, algorithms and models, software components and services, etc. The resources of the Blue Environment VREs are integrated and exposed through the VRE infrastructure for serving particular needs. However, they do not exist in isolation, and can be used in other VRE's, or in other instances of the same generic VRE, or be used outside a VRE. Of particular importance to this VRE is the use of large volumes of spatial data in an interoperable environment to extract spatial features from satellite imagery or base maps.

A set of resources has already been integrated for reaching the first milestone – the initial set-up and integration of the Blue Environment VREs - however more resources will be integrated during the VREs lifetime. In this deliverable we report all the integrated resources; including the ones that have already been integrated and the ones to be integrated. To this end we provide a detailed description of a potential exploitation plan of these resources in the BlueBRIDGE project wiki.

This deliverable was planned to be of type "Other" and it consists of a set of wiki pages, hosted by the BlueBRIDGE wiki **Error! Reference source not found..**

The wiki version of the deliverable can be accessed at

https://support.d4science.org/projects/bluebridge/wiki/Blue_Environment

For ease the reading and maintenance of the full version of the deliverable we classify resources in the following categories

- Data sources and data collections;
- Models and algorithms; e.g. to identify aquaculture cages or to extract spatial indicators;
- Software components; that contains tools that will facilitate the construction and maintenance of datasets. The integrated software components are either libraries or services that are ingested in the

infrastructure and will be exploited from the VREs with other components for delivering the desired VRE functionalities.

- Documentation and user guides; to manage the above resources, as well as for the corresponding processes and functionalities.

Most of the resources in the categories above can already be integrated in the infrastructure, however for some of them integration activities are still pending. For each resource we provide a detailed description about how it has been integrated (or will be integrated). After the resources have been integrated they can be exploited and combined with other integrated resources. This is a key advantage of the infrastructure, because through the integration of resources, Blue Environment VREs deliver high quality products that fulfil users' requirements. A detailed description of the above resources, as well as more information about their integration and exploitation details (and plans) can be found at the VRE wiki pages **Error! Reference source not found.****Error! Reference source not found.**

https://support.d4science.org/projects/bluebridge/wiki/T71_Aquaculture_Atlas_Generation_VRE

https://support.d4science.org/projects/bluebridge/wiki/T72_Protected_Area_Impact_Maps_VRE

1 INTRODUCTION

The deliverable D7.2 “Blue Environment VRE Integrated Resources”, provides a detailed description of the resources that are or are going to be exploited or reused in Blue Environment VREs. With the term resources, we refer to data sources, policies, guidelines, software and tools, etc. that are going to be exploited in the Blue Environment VREs; the Aquaculture Atlas Generation VRE and the Protected Areas Impact Maps VRE.

The Blue Environment VREs provide experts with a collaborative environment for the efficient development and sharing of aquaculture and environmental maps and indicators. Given the variety of data needs and requirements and the specifics of the community, it has been decided to set up several fine-grained VREs that will share a common layer of services in main VREs, but they will implement a different subset of algorithms in dedicated VREs. The main VREs are:

- the Aquaculture Atlas Generation VRE
https://support.d4science.org/projects/bluebridge/wiki/T71_Aquaculture_Atlas_Generation_VRE
- the Protected Area Impact Maps VRE
https://support.d4science.org/projects/bluebridge/wiki/T72_Protected_Area_Impact_Maps_VRE

The dedicated VREs, established as Virtual labs, each support a specific use case. The identified use cases are Aquaculture map of Greece, Aquaculture map of a section of Indonesia, Vulnerable Marine Ecosystems (VME) map of the Bahamas. Other VREs will be identified in the course of the project, and build on the successful features of their predecessors.

The document is organized as follows:

- Section **Error! Reference source not found.** is the introductory section of this deliverable.
- Section **Error! Reference source not found.** describes the two VRE’s from the perspective of the integrated resources; datasets and the data sources that are integrated as parts of the Blue Environment VREs.

At the end of most sections we report some hyperlinks pointing to particular BlueBRIDGE wiki pages. These pages contain more (and in many cases more up-to-date) information about the section.

2 INTEGRATED RESOURCES

2.1 AQUACULTURE ATLAS GENERATION VRE

2.1.1 DATA SETS

2.1.1.1 FAO INPUT DATASETS

FAO is reviewing its NASO maps production and presentation work-flow, and until a workplan has been provided, the datasets that will be used as input for the AAPS VRE will be the NASO maps that are provided as geocoded excel files, describing farm locations as precise coordinate points, with a list of attributes for each location providing information on farm type, activity, and species cultured amongst others.

2.1.1.2 SPATIAL DATASETS

The first version of the AAPS uses very high resolution basemaps from Bing Aerial Maps, Google Earth, or Here We Go. At this stage, the decision on which of these basemaps to adopt has not been finalized as it depends on licencing issues. In particular the partnership between FAO and Google Earth Engine Outreach for the free use of satellite data is being considered. All these basemaps are accessible via WMS protocol. In the case of Bing Aerial basemap and metadata, they are accessible via Bing Maps REST services.

Later versions of the AAPS will use Copernicus data (Sentinel series) through gateways of the Copernicus EU/ESA SciHUB platform (<https://scihub.copernicus.eu/>). Data covering the Regions of Interest are automatically downloaded based on adapted query. A tool to query the Sentinel data from ESA scihub or apihub, or the Greek mirror site is used. The results can be retrieved in meta4 or (geo)CSV format. This tool is not aimed at downloading the products directly: a batch downloader manager (for instance aria2 or wget) shall be used on the results of queries (see <https://scihub.copernicus.eu/userguide/5APIsAndBatchScripting>). This tool is using the OpenSearch API of the apihub (alternatively the scihub).

2.1.1.3 CLS OUTPUT DATASETS

As output, a database of aquaculture features are disseminated via the VRE. This database should:

- include the contours associated to each aquaculture feature (fish cages, shrimp pond);
- include a set of attributes (following a reference ontology) with hierarchical information (link between farm and fish cages for example);
- enable spatial query, and be easily used by WMS.

From these requirements, 2 solutions were investigated:

- PostGIS geographic server is a spatial database extender for PostgreSQL object-relational database. It adds support for geographic objects allowing location queries to be run in SQL. This DB type enables to store large volume of geographic data, and multiple-user access with various tools for integrated and efficient geographic processing. However, this type of database requires the set up of dedicated server.
- Geographic files such as Spatialite or shapefile. These data files enable to save geographic data of medium volume, while having a large set of geographic tools. The main difference between Spatialite and shapefile is the capacity for the former to use multiple tables which is of very high importance to track links between features. For instance, the use case in Greece has shown the necessity to track the links between individual fish cages and fish farms (and vice versa).

The need to manage complex relations between objects would make the Spatialite preferable. Nevertheless, the BlueBRIDGE e-Infrastructure fosters the use of OGC standards and remotely accessible formats. Spatialite does not meet these requirements, thus its use is going to be evaluated and possibly the tables and their links will be transformed into OGC standard representations (e.g. WMS layers).

Two examples of geospatial tables with their associated features are given in the following:

```
farm_columns= [ Column("id", Integer, primary_key=True),
                Column('internal_id', Unicode),
                Column('design', Unicode),
                Column('material', Unicode),
                Column('feed_system', Unicode),
                Column('status', Unicode),
                Column('species', Unicode),
                Column('confidence', Integer),
                Column('start_date', DateTime),
                Column('end_date', DateTime),
                Column('bbox', Geometry(4326)),
                Column('centroid', Geometry(4326)),
                Column('total_surface', Float)]

cage_columns = [Column("id", Integer, primary_key=True),
                Column("shape", String),
                Column('farm_id', Integer, nullable=False),
                Column('area', Float),
                Column('geometry', Geometry(4326), nullable=False, index=True),
                ForeignKeyConstraint(['farm_id'], ['farm.id'])
                ]
```

2.1.1.4 AAPS OUTPUT DATASETS FOR FAO

As of January 2017, the development of a new NASO maps infrastructure in FAO has not commenced, and there are no requirements known for the exchange of output datasets with FAO. FAO relies on an OGC based Spatial Data Infrastructure, and the output datasets can be stored in an infrastructure based network of Geoservers, managed by a Geonetwork catalogue to make them discoverable to FAO. However, the specifications for metadata and data are not provided by the responsible department yet. These are very likely to be very to previous data resources shared with FAO (VME-DB, Species maps) and BlueBRIDGE can rely on these to ensure the AAPS output will be compliant with FAO requirements.

2.1.2 SERVICES, TOOLS AND SOFTWARE

The AAPS service relies on two toolboxes:

- ACUITY GIS
- EODA web GIS

ACUITY GIS

The toolset developed by CLS further refines an existing imagery analysis tool that was developed to detect vessels from radar imagery. The tool procedure is as follow :

- the ingestion of data (for instance from Copernicus source, upload of WMS basemap layer, upload of pre-existing aquaculture maps – FAO source);

- the selection of an Area of Interest given by pre-existing aquaculture maps. This selection is done via the drawing of a polygon by an operator (see figure 1)
- run the automatic algorithm of aquaculture feature detection. For the algorithm developed for the Greece use case, round and square fish cages are to be detected (see Figure 2)

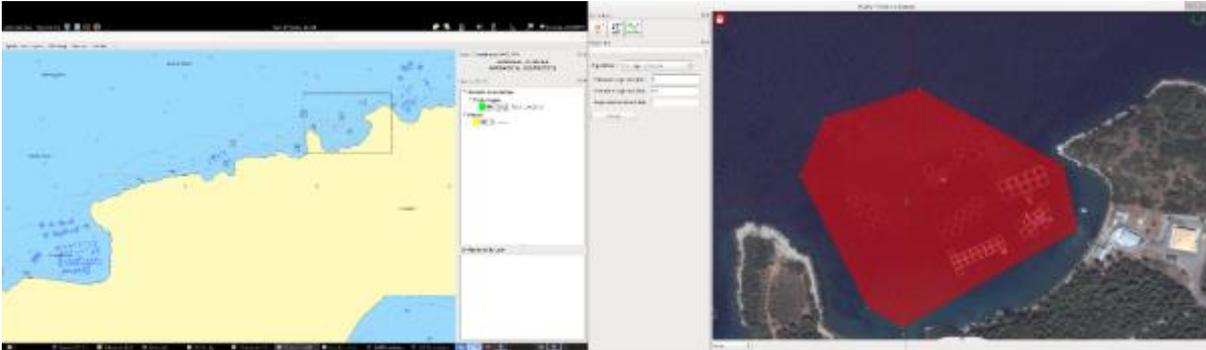


Figure 1: Select an area of interest to detect farms

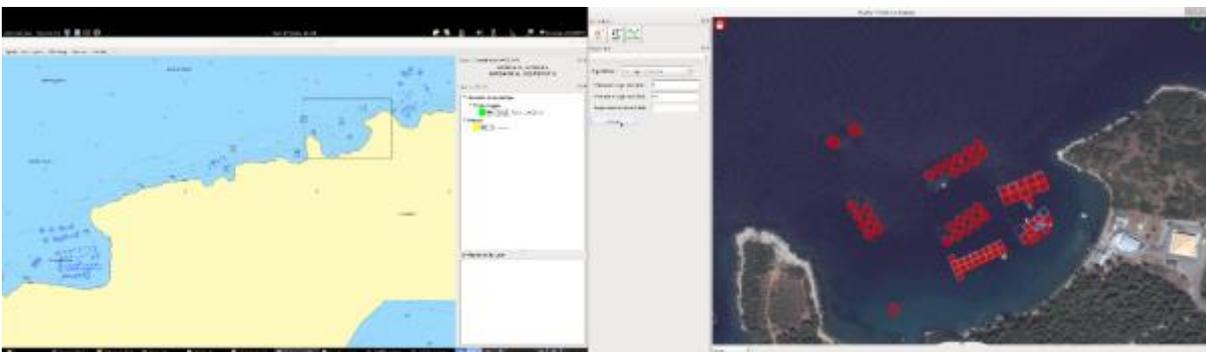


Figure 2: result of automated detection

- After the automated detection of features, a manual phase for correction, confirmation and validation follows. The user can draw more precise boundaries, change the sizes, add manually detected areas, describe cage typology, and group cages by farm. The tool can compute total farm size and count number of cages.

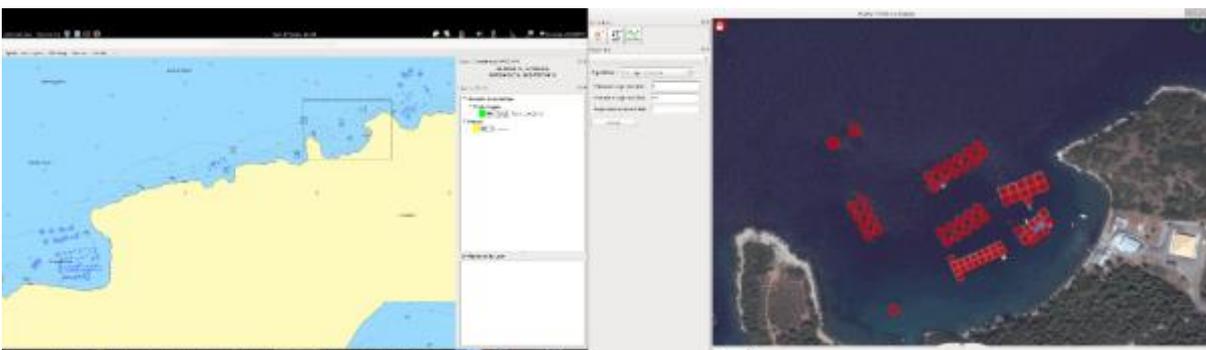


Figure 3: Manual editing of detected features

- Once ready with describing the aquaculture features in an image, the results can be stored using the aforementioned ontology, i.e. as reference vocabulary in the form of a formalized description of the identified features. This includes the actual or supposed dates of when the image was taken, and depending on data availability, this can result in a time series of aquaculture development.

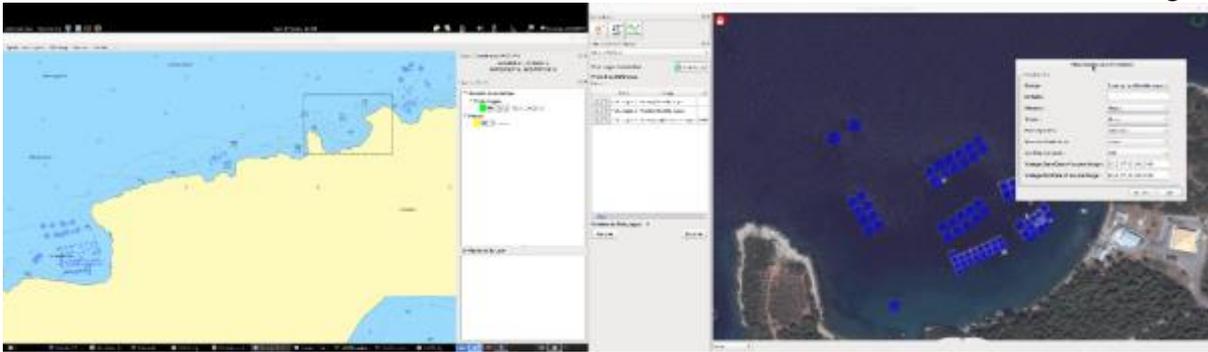


Figure 4: Export of detected features using an ontology

EODA web GIS

In the world of the geospatial data management and dissemination, international groups are currently working on specifications and implementations of interoperable interfaces¹, especially the Open Geospatial Consortium (OGC²) and International Standard Organization (ISO³). The CLS EODA platform uses notably OGC and ISO standards, which are now internationally recognized. It ensures the cost-effective and efficient communication involving the geospatial products between EODA platform and VRE infrastructure. Meanwhile, data volumes are particularly important for Earth Observation imageries, and should not be duplicated unnecessarily. As an illustration, one single Sentinel-1 image can be in the order of 1GB. That is why only useful EO data covering the AOI and of interest for the use case will be downloaded from the EU (see Subsection 2.1.1.2). This is handled by EODA system which has already the capability to query, ingest, and made available for visualisation EO data.

The standards used to implement the EODA web GIS include notably:

- The format of the catalogue metadata: ISO 19115 specifications, and its implementation ISO 19139 XML schema
- The inventory and viewing service for the EO and aquaculture features datasets: OGC [Web Map Service](#) (WMS)

All the data associated to a use case will be grouped together, and the EODA will offer to users a single entry point and standardized interfaces to access information and data (aquaculture features broadcasted by WMS from the VRE infrastructure, Sentinel-1 and Sentinel-2 data). For the AAPS VRE, EODA has been updated to ingest and visualize Sentinel-2 Copernicus data. As the VRE infrastructure will broadcast the WMS layer associated to the detected aquaculture features (provided by ACUITY), EODA will directly display this layer.

It will allow users to discover, view and access the AAPS geographic data in an integrated way.

¹ Interoperability is the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units.

² OGC: Open Geospatial Consortium. The Open Geospatial Consortium, Inc. (OGC) is a non-profit membership organisation to address interoperability among systems that process geo-referenced data, and between these systems and mainstream computing systems. OGC has about two hundred and twenty members from public and private organisations around the World.

³ ISO: International Standard Organization ISO/TC 211 is one of a number of Technical Committees enveloped within the International Standards' Organisation (ISO), and was formed for the development of standardisation in the field of digital Geographic Information. TC 211 aims "to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the earth. These standards may specify, for Geographic Information, methods, tools and services for data management (including definition and description), acquiring, processing, analysing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations".

D4Science Copernicus Service

D4Science will provide biotic and abiotic geospatial data from the Copernicus Marine Environment Monitoring Service (CMEMS). CMEMS provides APIs to search and download the hosted data through the “Motu” web Service. Motu is a high-efficiency service that manages the heterogeneity between the data of different CMEMS providers. In particular, Motu handles, extracts and transforms oceanographic huge volumes of data without performance collapse. Interaction with Motu is supported mainly through an open-source Python 2.7 client (<https://github.com/clstoulouse/motu#ClientsAPI>), which enables extracting and downloading data through a python command line.

Since the Motu client requires many parameters to identify a CMEMS product to download, D4Science will use a batch downloading system after a request has been sent from a BlueBRIDGE community member. In particular, the Workflow to obtain a CMEMS product requires (i) a community member to open a request to get a CMEMS product in a selected region, using the D4Science ticketing system, (ii) D4Science WP9 staff to run a batch downloading script for the product, (iii) publish the product in the D4Science SDI, (iv) make the output products available to other VREs (e.g. the Protected Area Impact Maps VRE). Up to now, a set of 307 products have been extracted from CMEMS (and other EO providers) and made available to the VRE, which include global and regional distributions of biotic and abiotic environmental features. The full list is available as an excel file in the VRE⁴ and can be browsed using the GeoExplorer web application, available in the VRE. These product are also available to all the applications running in the VRE.

AAPS-Map web interface

The **AAPS-Map** will be a web interface available in the VRE developed by FAO and integrated through WP9. It will share features with the MPA-Map; a prime example of infrastructure tools re-use. The tool will visualize CLS output, allow for editing of features, and generate output as FAO NASO Maps. It will also allow to report on the clustering of these features in farms or production units, relative to a target region of interest (e.g. a Province), and compute overall statistics (if a map is changed, recompute total area by feature etc.). The web application will have three main features. A **Data explorer map** which allows users to visualize data produced by the the CLS algorithm and edit features and to re-run the computation of statistics. It will also allow to overlay relevant layers, such as the FAO NASO maps, selected environmental and socio-economic maps, and species distribution maps. An **Overall Statistics** page will include tables and charts with results from the algorithm (i.e. Aquaculture features only). A **Report** page will show details of the spatial distribution of aquaculture features relative to other layers in the target region of analysis. A first working version of the web interface is being discussed, and will be gradually integrated in the AAPS VRE (with a planned first working prototype before summer). After a review and validation process of the interface and algorithm by users, changes and additional capacities will be added until the project closure.

2.1.3 MODELS/ALGORITHMS

A specific model for the fish cages/farms in Greece has been applied. It is described above, and may be subject to modifications. It is integrated in the EODA portal, and available through the CLS portal.

A similar model is being developed for Indonesia, but the specifications are still being developed, and the integrated resources cannot yet be identified. The algorithm will have to be adapted considerably, since in

⁴ <http://data.d4science.org/QUtqOE5PNnRKSWpldjJVR2gxMkRpUS9jSVBvcFNKSTRHbWJQNStISON6Yz0>

In addition to cages, other features have to be identified such as seaweed parcels and coastal ponds. This will require an extensive period of testing, and validation by experts with good knowledge of the local situation.

The intersection algorithm produced in the context of the PAIM VRE will be proposed also here in the AAPS-Map viewer. In addition, the Map viewer will require an interactive feature that re-computes the spatial features coverage after a feature is added / edited or removed. It will be made available through DataMiner.

2.1.4 USER GUIDES

The VRE incorporates user guidance through help features. Since the tool will mainly be used by geospatial data experts, advanced user interactions are not required.

This VRE shall be activated by specific request via the VRE platform. Internal modules such as the annotation ACUITY platform are to be run by CLS. As such, no user guide has been produced at this stage. However, online demonstration might be made available for VRE users.

For what concerns the AAP-WebViewer (and editor) specifications are not produced, and the resources cannot yet be specified. These are very likely to be similar to the MPA map viewer.

2.1.5 USAGE/LICENSING

The usage of these resources and toolboxes is illustrated in Figure 5.

Detection algorithms are implemented in ACUITY toolbox. ACUITY is only used by CLS analysts to generate the new value added aquaculture products stored in EODA and in the AAPS VRE.

During the project, registered external users and internal users (all project partners) have then access to the new aquaculture products and ancillary information. These data fall under the BlueBRIDGE Terms of Use and Licenses.

They are also granted an access and licence to a specific BlueBRIDGE instance of the EODA Web viewer to cover the identified use cases.

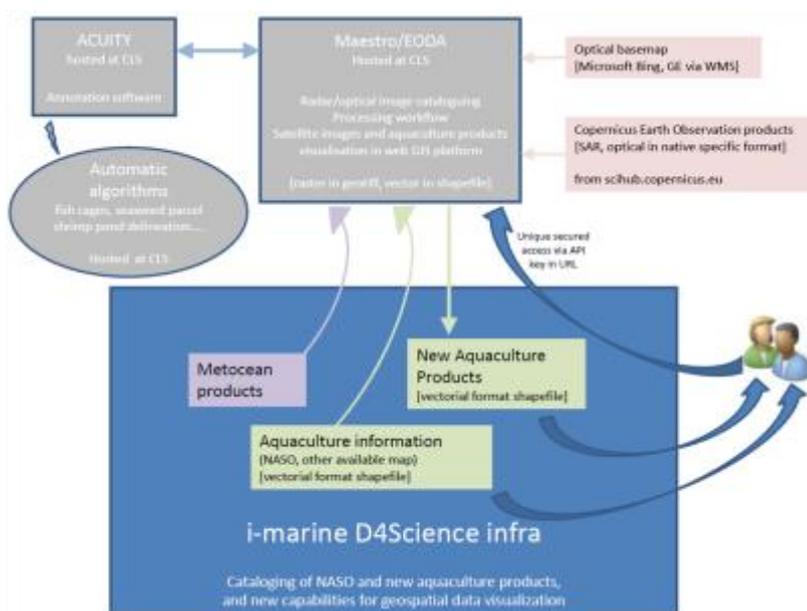


Figure 5: AAPS workflow and usage

At the end of the project CLS and D4Science will attempt to sign a MoU for the exploitation of this service.

This will rely a minima on the following requirements :

- Minimum duration of D4Science , MAESTRO availability and licence grant.
- Conditions of usage of CLS resources (e.g. algorithm and ACUITY toolbox, analyst work) to generate new or refined aquaculture products.

All other data and tooling come fall under the BlueBRIDGE Terms of Use and Licenses.

2.2 PROTECTED AREA IMPACT MAPS VRE

2.2.1 DATA SETS

The following data sets have been incorporated into the Protected Area Impact Maps VRE.

<p>Economic Exclusive Zones Boundaries. Version 9 http://www.marineregions.org/downloads.php</p>	<p>Global scale spatial dataset of the Exclusive Economic Zones. It includes disputed territories. After download, the dataset was modified in ArcGIS with the addition of a polygon for international waters beyond the EEZ.</p>	<p>The latest version (v.9) of the EEZ dataset has been integrated in the VRE. It is used both by the graphical interface as well as the intersect algorithm for this VRE.</p>
<p>Marine Ecoregions and Pelagic Provinces of the World (MEOW, PPOW). January 2016. Accessed at: http://data.unep-wcmc.org/datasets/38</p>	<p>This dataset combines two separately published datasets: the “Marine Ecoregions Of the World” (MEOW; 2007) and the “Pelagic Provinces Of the World” (PPOW; 2012). The MEOW dataset shows a biogeographic classification of the world’s coastal and continental shelf waters. The PPOW dataset shows a biogeographic classification of the surface pelagic (i.e. epipelagic) waters of the world’s oceans.</p>	<p>This dataset has been integrated in the VRE. It is used both by the graphical user interface and the intersect algorithm.</p>
<p>World Database on Protected Areas (WDPA) December 2016. Accessed at: https://www.protectedplanet.net/</p>	<p>Global scale spatial dataset of protected areas managed by UNEP-WCMC. After download, the dataset was modified in ArcGIS before used in the VRE. Modifications include deleting all protected areas that are not marine using information in the attribute table (MARINE = 0). The data is then intersected with the EEZ datalayer creating one output and with the</p>	<p>The November 2016 version of the WDPA has been integrated in the VRE. It is used in the reporting section of the graphical user interface and is a key dataset used by the intersect algorithm. A new version of the dataset (from January 2017) and prepared by JRC will be integrated in the VRE by the end of March 2017.</p>

ECOREGION datalayer creating another output. The intersect step removes any segment of the marine protected areas that are outside of the EEZ or the Ecoregion limits (e.g. some protected areas cover both marine and terrestrial ground). The two outputs are finally dissolved so that separate polygons of a same marine protected area in a unique EEZ or Ecoregion are joined together.

Global Seafloor Geomorphic Data. March 2014. Accessed at: http://www.bluehabitats.org/?page_id=58

The Global Seafloor Geomorphic Features Map (GSFM) has 29 geomorphic feature types. Only 20 are kept in the VRE, these include: shelf, slope, abyss, hadal, seamounts, guyots, canyons, ridges, plateaus, spreading ridges, rift valleys, glacial troughs, shelf valleys, trenches, troughs, terraces, fans, rises, bridges, escarpments.

All geomorphic features datasets have been integrated in this VRE. They are part of the graphical user interface as well as the intersect algorithm.

Global distribution of Seagrass. Version 4.0. 2016. Accessed at: <http://data.unep-wcmc.org/datasets/7>

This global scale spatial dataset shows the distribution of seagrass. It is compiled by UNEP-WCMC. (Integration in the VRE in progress)

This dataset has been uploaded to the geoserver. Because of its complexity, it has not yet been integrated in the intersect algorithm and graphical user interface. GRID-Arendal is working with FAO to find the best solution to fully integrate this dataset in the VRE and its services.

Global Distribution of Mangroves USGS version 1.3. Accessed at: <http://data.unep-wcmc.org/datasets/4>

This dataset shows the global distribution of mangrove forests, derived from earth observation satellite imagery. The dataset was created using Global Land Survey (GLS) data and the Landsat archive. (Integration in the VRE in progress)

This dataset has been uploaded to the geoserver. Because of its complexity, it has not yet been integrated in the intersect algorithm and graphical user interface. GRID-Arendal is working with FAO to find the best solution to fully integrate this dataset in the VRE and its services.

Global Distribution of Coral Reefs. Accessed at: <http://data.unep-wcmc.org/datasets/1>

This dataset shows the global distribution of coral reefs in tropical and subtropical regions. This dataset was compiled from a number of sources by UNEP World Conservation Monitoring Centre (UNEP-WCMC) and

This dataset has been uploaded to the geoserver. Because of its complexity, it has not yet been integrated in the intersect algorithm and graphical user interface. GRID-Arendal is working with FAO to find the best solution to

2.2.2 SERVICES, TOOLS AND SOFTWARE

The following are the services, tools and software used by and incorporated into the Protected Area Impact Maps VRE.

GeoServer is open source server installed on D4Science to host and share geospatial data. All the spatial data visualized and analyzed in the Protected Area Impact Maps VRE is stored on the GeoServer. See previous section (2.2.1 Data Sets) which outlines the specific spatial datasets used by this VRE. In the future, we may decide to access the UNEP WCMC data for mangroves, seagrass and coral reefs directly from their infrastructure as a WFS. A direct access to their data would ensure that our service is more sustainable as it would use the most up-to-date data, and any changes to the original data will directly be reflected in the outputs the VRE provides. A WFS is not yet available, but discussions with UNEP WCMC regarding this specific request are in motion.

GeoNetwork is a catalog application to manage spatially referenced resources. Data layers uploaded to GeoServer have metadata stored on the GeoNetwork. This metadata is used by other elements of the VRE. In the web-app developed for the VRE (described below) for example, metadata for each geomorphic feature is integrated in the reporting section.

The **MPA-Map** is a web interface available in the VRE that is developed by GRID-Arendal and FAO. It is a tool to visualize marine features such as geomorphic features and to report on the presence of these features in marine managed areas (e.g. Marine Protected Areas) relative to a target region of interest (e.g. Exclusive Economic Zone). The web application has three main features. A **Data explorer map** (Figure 5) which allows users to visualize data used by the algorithm and select a target region of interest on which to run the algorithm. A **Results** (Figure 6) page that includes tables and charts displaying data results from the algorithm. A **Report** (Figure 7) page that shows, in details, the spatial distribution of features relative to each marine managed area in the target region of analysis. A first working version of the web interface is in its final stage of development and will be integrated in the Protected Area Impact Map VRE when ready. After a review process of the interface and algorithm by users, changes and additional capacities will be added (e.g. user capacity to upload own unique or network of marine managed areas to report on).

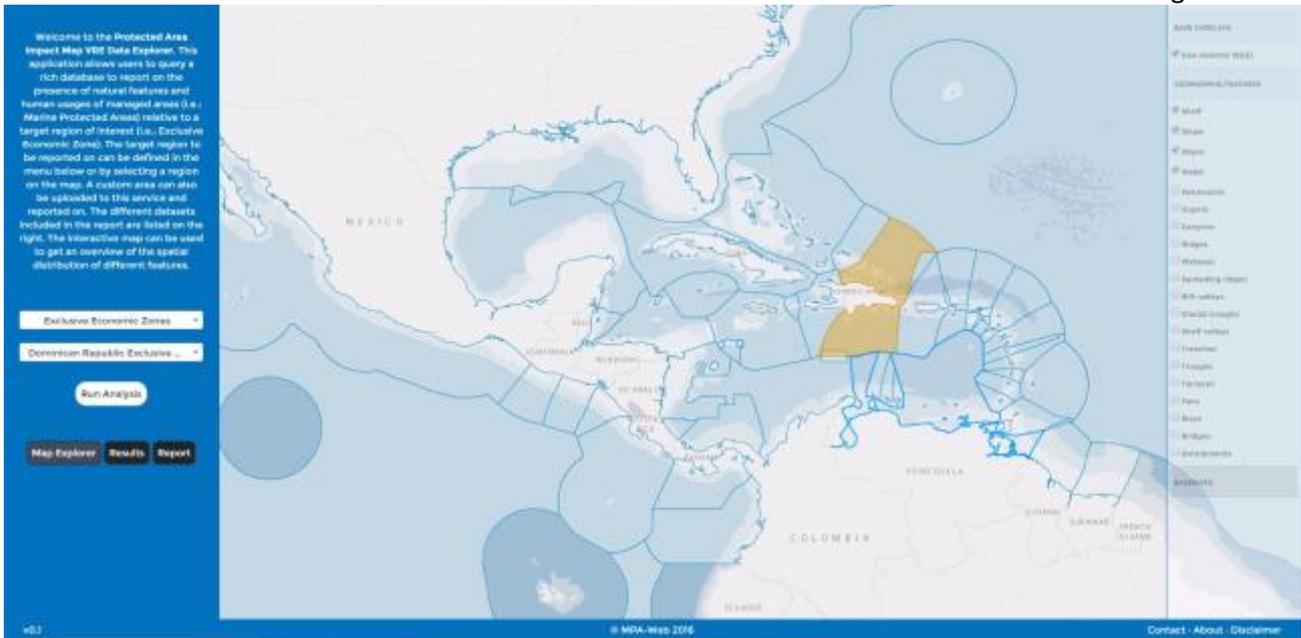


Figure 6: Screen capture of the Map Explorer in the MPA-Map web interface (in development). Here, the user can view features included in the algorithm, select an EEZ or Ecoregion, and Run the Analysis.



Figure 7: Screen capture of the Results section in the MPA-Map web interface (in development).

Here, the user can visualize results from the algorithm after an analysis is performed (Figure 1.). At the top, a searchable table reports on the area in km² of features in Marine Protected Areas. The table can be toggled to % to show the percent of features in an MPA relative to the total area of the feature in the target region. At the bottom, a chart compares the area of features in the target region versus the area of features in all MPAs in the target region.



Figure 8: Screen capture of the Report section in the MPA-Map web interface (in development).

After selecting an MPA in the Results page, a Report section is compiled which integrates information on the features present in the MPA with maps showing their spatial distribution in the MPA. This section will also show metadata information for each feature.

2.2.3 MODELS/ALGORITHMS

2.2.3.1 INTERSECTION ALGORITHM

MPA-Map web interface. The algorithm takes an ID input value defining either an EEZ or Ecoregion of interest. The algorithm uses this information to fetch geospatial data of features and protected areas located in the target region, and intersects features with protected areas in this region. It then compiles a report in tabular format with information on the area of each feature in each protected areas and in the target region as a whole. If used in DataMiner, the output from the algorithm is a .csv file with a list of MPAs and the area in m² of features reported (e.g. geomorphic features) in each MPA. The area in m² of features in the target region (an EEZ or ECOREGION) and in all the MPAs in the target region is also included.

The algorithm uses the [RfigisGeo](#) package developed by Emmanuel Blondel for FAO to compute the intersects and calculate area.

2.2.4 USER GUIDES

User Guides are yet to be developed for the Protected Area Impact Maps VRE. These guides will be developed in the first quarter of 2017.

2.2.5 USAGE/LICENSING

The following table contains the usage and licencing for data incorporated into the Protected Area Impact Maps VRE.

Economic Exclusive Zones Boundaries. Version 9 (EEZ) October 2016. Accessed at: <http://www.marineregions.org/downloads.php>

Usage Restrictions:

<http://www.marineregions.org/disclaimer.php>

Marine Ecoregions and Pelagic Provinces of the World (MEOW, PPOW). January 2016. Accessed at:

<http://data.unep-wcmc.org/datasets/38>

Usage Restrictions: https://www.unep-wcmc.org/policies/general-data-license-excluding-wdpa#data_policy

World Database on Protected Areas (WDPA) December 2016. Accessed at: <https://www.protectedplanet.net/>

Usage Restrictions :

<https://www.protectedplanet.net/c/terms-and-conditions>

Global Seafloor Geomorphic Data. March 2014.

Accessed at: http://www.bluehabitats.org/?page_id=58

Usage Restrictions:

<https://creativecommons.org/licenses/by/4.0/>

Global distribution of Seagrass. Version 4.0. 2016.

Accessed at: <http://data.unep-wcmc.org/datasets/7>

Usage Restriction: https://www.unep-wcmc.org/policies/general-data-license-excluding-wdpa#data_policy

Global Distribution of Mangroves USGS version 1.3.

Accessed at: <http://data.unep-wcmc.org/datasets/4>

Usage Restriction: https://www.unep-wcmc.org/policies/general-data-license-excluding-wdpa#data_policy

Global Distribution of Coral Reefs. Accessed at:

<http://data.unep-wcmc.org/datasets/1>

Usage Restriction: https://www.unep-wcmc.org/policies/general-data-license-excluding-wdpa#data_policy

Attributions: Claus S., N. De Hauwere, B. Vanhoorne, F. Souza Dias, P. Oset García, F. Hernandez, and J. Mees (Flanders Marine Institute) (2017). MarineRegions.org. Accessed at <http://www.marineregions.org> on 2017-01-24.

Attributions: The Nature Conservancy (2012). Marine Ecoregions and Pelagic Provinces of the World. GIS layers developed by The Nature Conservancy with multiple partners, combined from Spalding et al. (2007) and Spalding et al. (2012). Cambridge (UK): The Nature Conservancy. DOIs: 10.1641/B570707; 10.1016/j.ocecoaman.2011.12.016. Data URL: <http://data.unep-wcmc.org/datasets/38>

Attributions: IUCN and UNEP-WCMC (year), The World Database on Protected Areas (WDPA) [On-line], [insert month/year of the version downloaded], Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net.

Attributions: Seafloor Geomorphic Features Map by [Harris, P.T., Macmillan-Lawler, M., Rupp, J. and Baker, E.K. 2014. Geomorphology of the oceans](#). Marine Geology, 352: 4-2

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UNEP-WCMC, WorldFish Centre, WRI, TNC (2010). Global distribution of warm-water coral reefs, compiled from multiple sources including the Millennium Coral Reef Mapping Project. Version 1.3. Includes contributions from IMaRS-USF and IRD (2005), IMaRS-USF (2005) and Spalding et al. (2001). Cambridge (UK): UNEP World Conservation Monitoring Centre. URL: <http://data.unep-wcmc.org/datasets/1>

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- [2] gCube wiki: https://wiki.gcube-system.org/gcube/About_gCube
- [3] BlueBRIDGE support portal: <https://support.d4science.org/projects/bluebridge>