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JERICO-S3 DELIVERABLE

Joint European Research Infrastructure for Coastal Observatories
Science, Services, Sustainability

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1.EXECUTIVE SUMMARY

This deliverable reports on the availability of data from the five Integrated Regional Sites (IRS) within JERICO-S3. Each IRS also assessed the Findability and Accessibility attributes of FAIR (Findable, Accessible, Interoperable, and Reusable) for two platforms. Overviews of regional data handling, gaps that need to be addressed, and a future outlook is also provided for each IRS. Recommendations related to data handling and accessibility from the regional perspective are provided for consideration by WP6 on improving data management and WP9 on improving the flow of data to regional stakeholders/users. This includes the potential utility of setting common guidelines for each IRS and considering what data products, in addition to the products generated for a primarily research focus, can be of use for regional stakeholders/users.

2.INTRODUCTION

Integrated Regional Sites (IRS) within the JERICO-S3 project play an important role in harmonising and coordinating coastal observing at a regional level. This regional approach, as detailed in Deliverables 3.1 and 3.2, enables "local" scale development between countries that are adjacent to coastal ocean water masses since coastal ocean physical, chemical, and biological processes do not stop at political borders. At the same time, some regions have specific key scientific challenges (KSCs), research foci, and user/stakeholder challenges, so some degree of granularity beyond pan-European is required. Five IRSs were established at the beginning of the project: Northern Adriatic-IRS (NA-IRS), Iberian Atlantic Margin-IRS (IAM-IRS), Bay of Biscay-IRS (BoB-IRS), Kattegat-Skagerrak-Eastern North Sea-IRS (KASKEN-IRS), and Norwegian Sea-IRS (NS-IRS).

Each IRS has developed a roadmap tool to direct developments and progress. A specific objective in the roadmap tool is focused interoperability and harmonisation. Included in this objective is a topic related to increasing interoperability and availability of data from each region. The intentions that motivate this topic centre around the importance of having a regional grasp of how data flows, is quality controlled, accessed, and ultimately made available to researchers, stakeholders, and other important users in the region. Each region could have a different approach to this depending on what data types are collected and the existing data infrastructures. For example, some IRSs have a strong focus on biological observations involving imagery that might require specialised databases or libraries. Other IRSs have a strong focus on large networks of sensors for physical oceanographic variables for operational forecasting, and therefore require a different approach to validating, cataloguing, and storing data on a real-time basis.

This Deliverable is a report of recommendations from the five IRSs regarding how data handling and accessibility can be improved within JERICO-S3 with respect to general guidelines related to data handling from WP6: Data management and user interaction and services provided in WP9: A sustainable JERICO-RI. This required assessing the degree of data availability and accessibility for each IRS, and also discussing with each IRS the limitations and gaps that remain to be addressed. The assessment was performed for each IRS (presented in the Main Report as subsections). The first assessment activity was to evaluate the availability of data from each platform type (fixed platform, FerryBox, HF radar, etc.) and for each partner institute that is presently operating the platform type

at the institutional, national, regional, and European levels. The second assessment activity was to select two platforms from each IRS and evaluate the Findability and Accessibility attributes for FAIR (Findable, Accessible, Interoperable, and Reusable). The final assessment activity was to present "novel data handling" or "success" stories from each IRS related to data handling and availability, as well as discussion of gaps related to the topic and the future perspective from a regional perspective. The last subsection of the main report comprises a summary of recommendations to WP6 and WP9 based on the assessment of data handling and availability with IRSs.

3.MAIN REPORT

The following subsections present self-assessments and self-evaluations from individual IRSs. Meetings were held with each IRS lead to discuss the content and meaning of the assessments, which was then followed up by consultation with other partners in each IRS. The first type of assessment was for overall data availability (Yes, No, Partially, Unknown, Not relevant) categorised by platform type and partner at the institutional, national, regional, and European levels. In this case, data availability was loosely defined as whether or not data from platforms/partners are viewable, downloadable, or otherwise accessed by external users, including cataloguing databases that provided direct links to the data (e.g., national database with direct link to institutional server where data could be accessed). For regional level availability, any multi-national (but not European level) databases/portals were considered (e.g., Regional Ocean Observing Systems within the European Global Ocean Observing System framework). European level databases/portals include, but are not limited to, Copernicus Marine Environment Monitoring Services (CMEMS), European Marine Observation and Data Network (EMODnet), Pan-European Infrastructure for Ocean and Marine Data Management (SeaDataNet), or International Council for the Exploration of the Sea (ICES).

A second type of assessment involved evaluating the Findability and Accessibility attributes for FAIR for two specific observing platforms from each IRS - which are directly linked to the availability and accessibility topics that are the focus of this Deliverable. We used the same criteria implemented in Deliverable 6.7 on evaluation of FAIRness related to the JERICO-RI Data Management Policy. Deliverable 6.7 used definitions and questions related to the degree to which data met FAIR principles from the GO-FAIR office (www.go-fair.org) which has developed a set of 14 principles to determine the level of FAIRness of data. We used the same assessment choices of Yes, No, Partially, Unknown. Eight of the 14 principles apply to Findability and Accessibility:

Findable

- F1. (Meta)data are assigned a globally unique and persistent identifier
- F2. Data are described with rich metadata (defined by R1 below)
- F3. Metadata clearly and explicitly include the identifier of the data they describe
- F4. (Meta)data are registered or indexed in a searchable resource

Accessible

- A1. (Meta)data are retrievable by their identifier using a standardised communications protocol
- A1.1 The protocol is open, free, and universally implementable

- A1.2 The protocol allows for an authentication and authorisation procedure, where necessary
- A2. Metadata are accessible, even when the data are no longer available

The third type of assessment was to present novel data handling or success stories related to data handling in the region, as well as what the future vision was for data availability and accessibility at the regional level, and what gaps remain towards accomplishing this future vision and what recommendations can be provided to WP6 on improving data management and WP9 on improving the flow of data to regional stakeholders/users.

3.1. Northern Adriatic IRS

Partners: Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy; Consiglio Nazionale delle Ricerce (CNR), Italy; Ruder Boscovic Institute (IRB), Zagreb, Croatia, Center for marine Research (CIM) Croatia

3.1.1. Data availability/accessibility

Data availability and accessibility for NA-IRS platforms are indicated in Table 1 based on platform type and partners for JERICO-RI observation platforms listed in Table 1 of Deliverable JERICO-S3 D3.1: "Initial analysis and summary of region-specific and region-wide monitoring strategies, and regional sustainability plans" (https://www.jerico-ri.eu/download/jerico-s3_deliverables/D3.1_JERICO-S3_DELIVERABLE_finalV22july21_compressed.pdf).

IRB fixed platform CIM ODAS I and CIM ODAS II are multiparametric buoys that acquire physical, chemical and biological oceanographic data as well as meteorological data in near real time to the institutional database of the Center for marine research in Rovinj, Croatia. The resulting datasets are further integrated with datasets of vessel based and manual sampling. Data and respective metadata are stored together. Parts of the data are aggregated further into a national database (publicly accessible) for MSFD related reporting (https://vrtlac.izor.hr/ords/roscop/pocetna; http://faust.izor.hr/nmon/pocetna).

Vessel based sampling along a grid across the northeastern Adriatic also results in molecular inventories in the form of metabarcodes, biodiversity datasets and metatranscriptomes, which are aggregated in international and publicly available/searchable databases like GBIF (www.gbif.org), NCBI (www.ncbi.nlm.nih.gov), Genbank (https://www.ncbi.nlm.nih.gov/genbank/) and UNI-EUK (https://www.ebi.ac.uk/ena/browser/home). Metadata is embedded in the datasets and unified across the respective databases. An Erddap network for coastal observations around the Adriatic Sea was set up during the Interreg ITA-HR project AdriaClim.

CNR fixed platforms (AA Aqua Alta Ptf, S1-GB and PALOMA are multiparametric observational sites that acquire physical, chemical and biological oceanographic data as well as meteorological data in near real time and send them to the institutional database. From there then the data are sent to the following aggregators:

- AA (Aqua Alta ptf): Data are available at the SWE service of the LTER site, https://deims.org/758087d7-231f-4f07-bd7e-6922e0c283fd
- S1-GB: Data partially available through EMODNET Chemistry, visualised in near real-time on an internet site, http://s1.bo.ismar.cnr.it/perl/s1_home.pl
- PALOMA: Data partially available through ICOS data portal, https://meta.icos-cp.eu/resources/stations/OS_PALOMA and contribute to the SOCAT data product (https://www.socat.info/index.php/data-access/). QA/QC, according to SOCAT protocols, are applied in delayed mode.

OGS fixed platforms (MAMBO 1-2-3-4 and DWRG 1-2-3) are multiparametric observational sites that acquire physical, chemical and biological oceanographic data as well as meteorological data in near real time and send them to the OGS institutional database NODC. The NODC is also the Italian **N**ational **O**ceanographic **D**ata **C**enter (https://nodc.ogs.it). From NODC data are sent in near real-time to several European aggregators: SeaDataNet, EMODnet physics and chemistry, ICOS.
For data collected by OGS fixed Platform in NA-IRS, NODC has developed an ERDDAP based data provider where data set can be searched and retrieved. Based on this ERDDAP data provider NODC has developed a web portal: https://nodc.ogs.it/geoportal/.
The following type of findability and access is provided at the various levels:

1. FTP Folder/Google Drive (raw - restricted access)
2. Database PostgresSQL (normalised DB - restricted access)
3. ERDDAP webservice (https://nodc.ogs.it/erddap/index.html - FAIR)

More information available at: https://nodc.ogs.it/data/datapolicy
Regarding QC/QA performed, more information available at: https://www.seadatanet.org/content/download/596/file/SeaDataNet_QC_procedures_V2_%28May_2010%29.pdf

OGS HF Radar are managed in cooperation with the Slovenian National Institute of Marine Biology. Raw data acquired in near real-time are sent to the OGS and NIB local database. Current maps are elaborated in near real-time and made accessible on OGS - NODC web portal: https://nodc.ogs.it/geoportal/.

Regarding OGS manual sampling (C1), data are monthly collected on C1 site and the resulting data sets are integrated into NODC database in delay mode. Then they are sent to European aggregators like LTER.

Table 1. Data availability/accessibility in the NA-IRS by platform type/partner.

Platform type	Partner	European	Regional	National	Institutional
Fixed platform (AA Aqua Alta Ptf, S1-GB, PALOMA)	CNR	Yes	Partial	No	Yes
Fixed platform (MAMBO 1-2-3-4, DWRG 1-2-3	OGS	Yes	No	Yes	Yes
Fixed platform (CIM ODAS I and CIM ODAS II)	IRB	No	No	Partial	Yes

Manual sampling (AA Aqua Alta Ptf, S1-GB, PALOMA)	CNR	Partial	No	No	Yes
Manual sampling (C1)	OGS	Partial	No	Partial	Yes
Manual sampling	IRB	No	Unknown	Partial	Yes
HF Radar	OGS	No	No	Yes	Yes

3.1.2. Findability and Accessibility evaluation of specific platforms

Evaluation of Findability and Accessibility attributes for four platform types are provided below. Information related to fixed platforms of OGS is presented in Table 2, fixed platforms of CNR in Table 3, fixed platforms of IRB in Table 4, and manual sampling by OGS in Table 5.

Table 2. Findability and Accessibility evaluation for OGS fixed platforms.

Northern Adriatic IRS - Fixed platform of OGS (MAMBO and DWRG)		
	F and A Self-assessment	**Comment**
F1.	Yes	DOI has been assigned
F2.	Yes	All available metadata like e.g.Platform name, platform type, Provider, Country, date-time, parameters, latitude, longitude, quality control flags,calibration, projectID, scientist and technician ID, Sample-history,... are assigned to each measurement.
F3.	Yes	Platform Id and code are mentioned within dataset
F4.	Yes	Data products are indexed and accessible at the institutional level ERDDAP system and also SeaDataCloud
A1.	Yes	Can be assessed via: 1.FTP Folder/Google Drive (raw - restricted access) 2.Database PostgresSQL (normalized DB - restricted access) 3.ERDDAP webservice (https://nodc.ogs.it/erddap/index.html - FAIR)
A1.1.	Yes	FTP and SQL used at institutional level (free and open-source data download) and also available at European level
A1.2.	Yes	For institutional level access, FTP and SQL access can be facilitated via username/password
A2.	Yes	Data is kept available

Table 3. Findability and Accessibility evaluation for CNR fixed platforms.
https://b2share.eudat.eu/records/62a4a29cac7b4291b28b85cce9dec3a9

Northern Adriatic IRS - Fixed platform CNR (AA Aqua Alta Ptf, S1-GB, PALOMA)		
	F and A Self-assessment	**Comment**
F1.	AA: yes S1-GB : no PALOMA: partial	AA: a DOI has been assigned within EUDAT PALOMA: PID assigned by ICOS for a subset of measured parameters
F2.	AA: yes S1-GB : no PALOMA: partial	AA: described in DEIMS PALOMA: yes for the parameters available in the ICOS portal
F3.	AA: no S1-GB : no PALOMA: partial	AA yes for the parameters available in with EUDAT in e-LTER portal PALOMA: yes for the parameters available in the ICOS portal
F4.	AA: yes S1-GB : no PALOMA: partial	AA: yes for the parameters available in with EUDAT in e-LTER portal PALOMA: yes for the parameters available in the ICOS portal
A1.	AA: yes S1-GB : unknown PALOMA: partial	AA: yes for the parameters available in with EUDAT in e-LTER portal PALOMA: yes for the parameters available in the ICOS portal

Northern Adriatic IRS - Fixed platform CNR (AA Aqua Alta Ptf, S1-GB, PALOMA)		
A1.1.	AA: yes S1-GB : no PALOMA: partial	yes for the parameters available in with EUDAT in e-LTER portal PALOMA: yes for the parameters available in the ICOS portal
A1.2.	AA: no S1-GB : partial PALOMA: partial	PALOMA: yes for the parameters available in the ICOS portal
A2.	AA: yes S1-GB : no PALOMA: no	yes for the parameters available in with EUDAT in e-LTER portal

Table 4. Findability and Accessibility evaluation for IRB Fixed platform.

Northern Adriatic IRS - Fixed platform of IRB (CIM ODAS I and CIM ODAS II)		
	F and A Self-assessment	**Comment**
F1.	Yes	National and institutional ID assigned
F2.	Yes	All available metadata like e.g.Platform name, platform type, Provider, Country, date-time, parameters, latitude, longitude,quality control flags,calibration, projectID, scientist and technician ID, Sample-history,... are assigned to each measurement
F3.	yes	Metadata and measurement data are directly linked within the database
F4.	Yes	Not yet publicly accessible, interface close to publishable
A1.	Yes	Coastal observations platform webpage allows the visualisation of metadata and data in real time
A1.1.	Yes	HTTPS
A1.2.	Yes	For institutional and individual access, FTP and SQL access are established
A2.	Yes	Data is kept available

Table 5. Findability and Accessibility evaluation for OGS manual/vessel-based sampling.

Northern Adriatic IRS - Manual/vessel-based sampling (Northeastern Adriatic sampling grid)		
	F and A Self-assessment	**Comment**
F1.	Yes	National and institutional ID assigned
F2.	Yes	All available metadata like e.g.Platform name, platform type, Provider, Country, date-time, parameters, latitude, longitude,quality control flags,calibration, projectID, scientist and technician ID, Sample-history,... are assigned to each measurement
F3.	Yes	Metadata and measurement data are directly linked within the database
F4.	Yes	Not yet publicly accessible, interface close to publishable,
A1.	Yes	Coastal observations platform webpage allows the visualisation of metadata and data.
A1.1.	Yes	HTTPS
A1.2.	Yes	For institutional and individual access, FTP and SQL access are established
A2.	Yes	Data is kept available

3.1.3. Overview of data handling and outlook at the regional level

The Interreg Italy-Croatia project Adriaclim has developed an ERDDAP based provider network for the Adriatic Sea, where climate-change relevant data is fed into an ERDDAP network and integrated datasets can be searched and retrieved. Oceanographic real-time, delayed-mode and model data are available. Data providers (partial datasets) are currently: CMCC, IOF, RBI, ARPA, CNR.

For the further development of systematic data handling bi- and trinational data-integration services around the NA-IRS are envisaged to be further established. Searchable and curated data products with interdisciplinary datasets, tailored to user needs are currently available only for commercialised products, where source data is not available, but data products like wave, current and wind models are commercially available. A decision on common data aggregators as well as on cost and benefit sharing need to be developed. Currently separated ERDDAP networks will have to be either unified or connected. Alternative data handling through EU/global data aggregators need to be explored and evaluated for practicability.

3.2. Iberian Atlantic Margin IRS

Partners: Instituto Hidrográfico (IH), Portugal; Puertos del Estado (PdE), Spain; The Oceanic Platform of the Canary Islands (PLOCAN), Spain

3.2.1. Data availability/accessibility

The JERICO-RI component of the IAM IRS consists of several platform types that are listed in D3.1 Table 3. Data availability at the European, regional, national, and institutional level divided into platform type and partner that operates the platform is shown in Table 6.

Table 6. Data availability/accessibility in the IAM-IRS by platform type/partner.

Platform type	Partner	European	Regional	National	Institutional
Multiparametric and wave buoys	IH	Partially	Yes*	No	Yes
Multiparametric and wave buoys	PdE	Yes	Yes*	No	Yes
Tide gauges	PdE	Partially	Partially*	No	Yes
Tide gauges	IH	Partially	Partially*	No	Yes
HF Radars	IH	Yes	Yes*	No	Yes
HF Radars	PdE	Yes	Yes*	No	Yes
HF Radars	PLOCAN	Yes	Yes*	Yes	Yes
Fixed platforms	PLOCAN	No	No	No	No

*See comments below

- IH Multiparametric & Wave buoys - Real-time multiparametric buoys are being sent to European aggregators and to IBIROOS; wave buoy data are not yet being sent to the European aggregators or IBIROOS (presently ongoing the discussion towards the inclusion of this data in the sets sent to European Aggregators/IBIROOS)
- IH Tide Gauges – Only some selected tide gauges (about 50% of the total number) are being sent to European aggregators and IBIROOS (presently ongoing discussion for the inclusion of the totality of the stations is the data sets sent to European Aggregators/IBIROOS).

- IH Data Availability at National Level – An Oceanographic National Data Center through which these data sets are made available does not presently exist. A cooperation between Instituto Hidrografico (IH) and Instituto Portugues do Mar e da Atmosfera (IPMA) started recently aiming to build up a national level ocean data aggregator based on federated model connecting national ocean data producers, see: https://nodc-portugal.pt/index.html.
- IH Data availability at national level – real-time data for different platforms that integrated the MONIZEE infrastructure are provided through the Hidrografico+ portal which is also IH contribution to JERICO-S3 Virtual Access
- PdE Tide Gauges – All tide gauges in PdE REDMAR network transmit sea level data in real-time and delayed mode to European data aggregators (Copernicus Marine Service and EMODnet Physics). Other parameters such as wind waves ("agitation"), atmospheric pressure and wind are not transmitted to European aggregators and are available only at institutional level. There is not a centralised national data centre in place at this moment. However, we share our data with other institutions in Spain: e.g.: real-time data sea level data are sent to the National Tsunami Warning System (National Geographic Institute), and delayed mode data are used by the Hydrographic Institute for chart datum and tidal constants computation.
- PdE multiparametric and wave buoys: data from these buoys are being sent to European aggregators through the IBI In Situ TAC. There is no National Data Center in Spain, but data is shared with other institutions like the Spanish Met Office (AEMET), which sends the data to the Global Telecommunication System (GTS).
- Availability at Regional Level (IH, PdE, PLOCAN): The IRS partners are sending their data to the IBIROOS Focal Pont (PdE) for aggregation which then sends the gata to feed the CMEMS In Situ TAC. In the In Situ TAC the data aggregation is organised expressly by EuroGOOS regions (ROOSes), and the main aggregators like PdE for IBI, are attending the ROOSes meetings as representatives from In Situ TAC. Although no IBIROOS portal exists, in the In Situ TAC Dashboard (http://www.marineinsitu.eu/dashboard/) one of the filters is the Region, so the data can be selected only for the IBIROOS stations.

3.2.2. Findability and Accessibility evaluation of specific platforms

Findability and Accessibility attributes of FAIR were evaluated for the Nazare Coastal multiparametric buoy and Leixoes Tide gauge are provided for (Tables 7 and 8). Comments related to the self-assessment are provided for each table.

Table 7. Findability and Accessibility evaluation for Nazare Coastal multiparametric buoy.

Iberian Atlantic Margin IRS - Coastal multiparametric buoy (Nazare, IH)		
	F and A Self-assessment	**Comment**
F1.	Yes	Broad community ID/WMO identifier assigned and persistent; institutional ID assigned
F2.	Yes	Platform name, platform type, Provider, Country, Last data time stamp, parameters, latitude, longitude, edmo code, quality control flags
F3.	Yes	Platform Id and code are mentioned within dataset
F4.	Yes	Map viewer provides filters such as platform type which makes the data easy to find

A1.	Yes	Platform webpage allows for downloading the data by clicking on a link in multiple formats
A1.1.	Yes	Free and open-source data download
A1.2.	Yes	No login required
A2.	Not Applicable	Not relevant as data is still available

Table 8. Findability and Accessibility evaluation for Leixoes Tide gauge.

Iberian Atlantic Margin IRS - Tide gauge (Leixoes, IH)		
	F and A Self-assessment (Y, N, partially, unknown)	**Comment**
F1.	Yes	Broad community ID/WMO identifier assigned and persistent; institutional ID assigned
F2.	Yes	Platform name, platform type, Provider, Country, Last data time stamp, parameters, latitude, longitude, edmo code, quality control flags
F3.	Yes	Platform Id and code are mentioned within dataset
F4.	Yes	Map viewer provides filters such as platform type which makes the data easy to find
A1.	Yes	Platform webpage allows for downloading the data by clicking on a link in multiple formats
A1.1.	Yes	Free and open-source data download
A1.2.	Yes	No login required
A2.	Not Applicable	Not relevant as data is still available

3.2.3. Overview of data handling and outlook at the regional level

At the IAM IRS level, we can identify three levels of harmonisation/aggregation of the observations collected by the different platforms operated by the partners:

- A first level corresponds to the integration of data in IBIROOS, which implies that for example IH (Portugal) data is automatically sent to PdE (Spain), the IBIROOS FocalPoint, from where it feeds several European aggregators (CMEMS).
- A second level derives from the fact that several of the existing capacities were installed as part of regional projects (funded by regional mechanisms such as INTERREG programs) and implied some degree of articulation and aggregation of the data. As an example, HF radar stations in the SW and NW of Iberian Peninsula were installed in the framework of projects TRADE/TRADE II and RadaronRaia, which involved IH (responsible for the installation and operation of the HF stations along the south and north coasts of Portugal) and PdE (responsible for installation and operation of HF stations in the SW and NW coasts of Spain), data being shared by both institutions. Multiparametric buoys were installed in those areas as part of projects RAIA/RAIAco and data is being shared in the web portals of regional observatories implemented by these projects.
- A third and recent level of harmonisation/aggregations in this IRS is being developed as part of the IAM Pilot Study that brings together data collected by the different observing systems operated by IH, PdE and PLOCAN, for selected periods, to build demonstrators of the add-value of integration in the improvement of knowledge about Transboundary Processes and Connectivity or Extreme Events.

PdE participates in several on-going international initiatives and working groups to improve metadata availability and access: e.g.: MIC working group (Copernicus Marine Service and EMODnet), EuroGOOS Tide Gauge Task Team tide gauge metadata inventory (http://eutgn.marine.ie/geonetwork/srv/spa/catalog.search#/map), EuroGOOS DataMEQ (Data Management, Exchange and Quality) Working Group, or other GOOS programs (OceanOPS, GLOSS, etc).

At present, the data included in the JERICO-RI component of the IAM IRS mainly comprises physical data (currents, sea surface height, temperature, salinity). In the process of developing this regional component of the infrastructure, one of the challenges will be the integration of biological, chemical and geological (e.g., suspended sediments) measurements that will progressively become more available. Some of this data will be potentially provided by new partners, which at national level can become associated to JERICO-RI. However, non-JERICO operators will certainly provide part of this data. This raises the need to define how these observations will be integrated with the JERICO-RI data. A particular important area in this regard is the future integration of citizen-science measurements.

3.3. Bay of Biscay IRS

Partners: AZTI Marine Research, Spain; Centre national de la recherche scientifique (CNRS), France; French Research Institute for Exploitation of the Sea (IFREMER), France

3.3.1. Data availability/accessibility

JERICO-RI observation platforms from Bay of Biscay IRS (hereinafter BoB-IRS) listed in D3.1 Table 4 have been grouped by platform type and partner. A self-assessment has been made regarding the availability of data at different geographic levels (Table 9). In the case of AZTI (Spanish partner), both data availability and levels of aggregation of the data are very heterogeneous, depending on the type of platforms. For some platforms, like fixed platforms and HF radar, sending operational physical data, the data flow up to the European aggregations and regional databases is well established, whereas for others it is only partially completed (for most of the manual sampling) or in progress (like for the gliders, which is a new technology at the institution).

Manual sampling includes different activities achieved in response to regional (Basque Country) drivers. One example is the Marine Ecological Quality Monitoring network, which has been performing, since 1995, monthly measurements of the ecological status of transitional and coastal waters[1] of the Basque Country based on the sampling of 51 stations (32 in estuaries). The main objective is to assess the state of the transitional and coastal water masses of the Basque Country to comply with the provisions of the Water Framework Directive and to contribute to improving the state of such water masses, and provide the information to the Basque Water Agency (URA) , which is in charge of distributing the information through its webpage: (https://www.uragentzia.euskadi.eus/informacion/biblioteca-de-ura/u81-000374/es/). No data flow is defined towards regional or pan-European aggregators. Another component of the manual

[1] Variables measured are Organic matter, Hydrocarbons, Heavy metals, Grain Size, Pesticides and biocides, Polychlorinated biphenyls, Benthos composition, pH, Oxygen, Subsurface Temperature, Sea surface Salinity, Dissolved oxygen (concentration), PAR (Photosynthetically Active Radiation), Transparency (Secchi disc), Chlorophyll, Turbidity, Nutrients, Particulate matter.

sampling in AZTI are the ecosystem multidisciplinary surveys which are conducted every year for estimating the Total Admissible Catches of anchovy (TAC) for the coming season. These campaigns extended since 2016 the list of sampled variables and provide in addition other data on the oceanographic environment, Plankton communities, Pelagic fishes and other species, Pelagic predators, Environmental DNA and Marine litter. While data on fish stock assessment are channelled towards regional/International databases (ICES), for the rest of the variables no channels for the data flow at this level are yet established.

In Table 7, we have also added the case of the extended network of coastal videometry systems, based on the Kostasystem technology (developed by AZTI), operating along the Basque coast. The first installation took place in 2007 and since then more than 20 stations have been operating. Videometry technology consists of collecting imagery of the coasts, estuaries, or riverine environments from a fixed platform, providing an abundant source of high spatial and temporal resolution hydrodynamic and morphological data together with other relevant information for coastal management issues. Different types of averaged and accumulated images are produced, based on a defined time interval and acquisition frequency. The images are corrected, georeferenced and then processed using image analysis algorithms to extract sound information. Data are available through the network web https://www.kostasystem.com/en/ and are provided to identified end users (in the fields of R&D, coastal risks and management). However, and in spite of their potential for coastal research issues, they are not currently channelled towards regional or European databases or aggregators.

In general, for the manual sampling and coastal videometry systems, there is still work needed to define clear data policy and strategic elements, and in general to pave the way towards FAIR datasets. It is also worth highlighting that other institutions contribute to the Regional observational efforts like the IEO (Spanish Institute of Oceanography) and Puertos del Estado (partner of Atlantic Margin IRS, and whose status is described in section 3.2).

In the case of CNRS and Ifremer (French partners), most observations and resulting data flows are organised through the ILICO national Research Infrastructure (https://www.ir-ilico.fr/?PagePrincipale&lang=en), which is composed of several national observing services deployed along the three French marine coasts including the Bay of Biscay. Data flows are designed for each national observing network (named SOMLIT, DYNALIT, SONEL, COAST-HF, PHYTOBS, BENTHOBS). Concerning the manual sampling, the SOMLIT observing network, based on 21 stations and 45 sampled parameters, aims, since 1997, to characterise the multi-decadal evolution of coastal ecosystems and to identify anthropogenic and climatic forcings. Data flow is defined towards national data centre and European aggregators (e.g., SeaDataNet, EMODnet biology). Data are distributed through national databases and data flows to pan-European aggregators are under development. BENTHOBS (20 stations since 1974), the network dedicated to the observation of the benthic macrofauna is also aggregating data on national databases. The distribution in European data aggregators is under deployment, with few stations already available on EMODnet Biology.

The DYNALIT observing network is also considered here as a manual sampling-based network. Dedicated to the observation of the nearshore morpho-dynamics, the 32 sampled stations are

collecting parameters to characterise each region (e.g., turbidity, numerical terrain model, altimetry and topo-bathymetry). Data are aggregated on local or national databases.

SONEL (89 stations to observe sea level changes from tide gauges) and COAST-HF (14 stations for long-term high-frequency *in situ* measurements of physical and biogeochemical parameters from moored buoys) are observing networks based on fixed platforms. For those two networks, data are aggregated on national data centres (Coriolis for COAST-HF and Coriolis + Shom data center for SONEL). At European level, collected observations are deployed on EMODnet and Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Center (CMEMS-INSTAC).

All datasets from the national research infrastructure ILICO are organised to follow FAIR principles. To ensure the implementation and all the interoperability between the 7 national data centres dedicated to in situ observation, the national research infrastructure DATA TERRA (https://www.data-terra.org/en/) with a dedicated branch to ocean data named ODATIS drives necessary developments to improve data accessibility and propose services to access data from all national networks from centralised tools.

As in Spain, specific observations based on manual sampling are achieved within the monitoring programs of the Water Framework and Marine Strategy Framework Directives. Other recurrent observations are acquired for monitoring the impact of major industrial equipment (e.g., the Blayais nuclear power plant in the Gironde Estuary). In both cases and for their biological components, data are acquired in tight interaction with PHYTOBS and BENTHOBS (see above) and stored in the national data base QUADRIGE, which is run by IFREMER and interfaced with international initiatives such as OSPAR and EMODNET.

Table 9. Data availability/accessibility in the BoB-IRS by platform type/partner.

Platform type	Partner	European	Regional	National	Institutional
Manual sampling	Ifremer CRNS	Partially	Yes	Yes	Yes
Manual sampling	AZTI	Partially	No	Yes	Yes
Fixed platform	Ifremer CRNS	yes	Yes	Yes	Yes
Fixed platform	AZTI	Yes	Yes	Yes	Yes
HF Radar	AZTI	Yes	Yes	Yes	Yes
Glider	AZTI	In progress	In progress	In progress	Yes
Coastal Videometry	AZTI	No	No	Yes	Yes

3.3.2. Findability and Accessibility evaluation of specific platforms

A first example concerns the HF radar system, operated by AZTI and EUSKALMET (Basque Meteorological Service) since 2009 (Table 10). The F and A status of this system has benefited from the activities developed in JERICO-RI (JERICO-NEXT and JERICO-S3) and also on the existing EU coordination in the management and accessibility to HFR data driven by the European HFR Node, which was established in 2018 under the coordination of the EuroGOOS HFR Task Team. JERICO-NEXT contributed to the homogenization of data and metadata formats and Quality

Assessment/Quality Control[2]. Several tasks related to the use and dissemination of HFR technology and data are ongoing in JERICO-S3. HFRs are an important component of several regions working in strategy building and demonstration of innovative coastal observation approaches. In addition, HFR-related tools (standardisation, QC) and direct access to HFR data are offered through the Virtual Access to JERICO-RI resources. In parallel, the EU HFR Node is fully operational since December 2018 in distributing tools and support for standardisation to HFR providers as well as standardised near real time HFR total current data to the Copernicus Marine Environment Monitoring Service *in situ* Thematic Assembly Center (CMEMS-INSTAC) and EMODnet Physics.

The HF radar example is representative of the F and A status of data from fixed platforms, which are also distributed to the Copernicus Marine Environment Monitoring Service *in situ* Thematic Assembly Center, but less representative of other data sets from the platforms provided in the previous sections. In Spain (from the example provided by AZTI) there is thus a high heterogeneity in the degree of accomplishment of F and A criteria, which is highly platform dependent.

In 2022, AZTI started the project **ebegi** (https://www.azti.es/en/proyectos/ebegi/) with the aim to capitalise these efforts by ensuring better communication and coordination among the different components of the ocean observation in the area, for the development of a common scientific and technological strategy towards the constitution of an optimised observatory. One of **ebegi**'s main expected outcomes is to enhance the provision of Marine Ecosystem Data (both historical and real-time) that respond to the needs associated with ecosystem-based management and other demands in the fields of conservation and recovery of Biodiversity and Habitats, the challenges of Climate and Global Changes and the implementation of Policies and Directives on the management of the marine environment. Its development is organised in five work packages, covering different aspects, from strategy to experimentation, in a 7-year work plan initially conceived for the period 2022-2029 and includes an specific task for "Publication of FAIR data", which has started with development of a database which integrates all the metadata of the existing measurement systems, measured datasets and activities in the area and the establishment of a plan towards F and A criteria (DOIs for systems and data, and the development of Data Management Plans (DMPs) for a selected set of datasets).

The second example concerns a fixed platform network from the COAST-HF French observing network (14 coastal buoys) dedicated to observing physical and biogeochemical parameters with automated continuous sensors since 2000 (Table 11). MOLIT is one of the platforms of the network located in the northern part of the Bay of Biscay. The F and A status of this particular system has benefited from the national research infrastructure ILICO for deploying the FAIR approach for this system. Data and metadata formats and quality control procedures benefit from best practices developed in previous H2020 JERICO-NEXT project for fixed platforms. Furthermore, data are integrated and distributed by the national Coriolis data centre (the infrastructure used for the Argo Global Data Assembly Center) sustaining the application of FAIRness criteria.
COAST-HF network is distributing data to the Copernicus Marine Environment Monitoring Service *in situ* Thematic Assembly Center (CMEMS-INSTAC) and EMODnet Physics.

[2] Mantovani C., Corgnati L., Horstmann J., Rubio A., Reyes E., Quentin C., Cosoli S., Asensio J.-L., Mader J., Griffa A. (2020). Best Practices on High Frequency Radar Deployment and Operation for Ocean Current Measurement. Front. Mar. Sci. 7: 210. doi: 10.3389/fmars.2020.00210.

The MOLIT station example is also representative of the F and A status of data from fixed platforms (buoys), which are also distributed to the Copernicus Marine Environment Monitoring Service *in situ* Thematic Assembly Center. In France, the Data Management Plan from ILICO Research Infrastructure fosters the consideration of F and A criteria.

Table 10. Findability and Accessibility evaluation for Higer HF Radar station.

Bay of Biscay IRS - HF Radar (Higer, AZTI)		
	F and A Self-assessment	**Comment**
F1.	Yes	DOI for surface current data products from Copernicus; European HF Radar community will follow this standard, and soon add DOI to HF Radar systems/networks
F2.	Yes	Platform name, platform type, Provider, Country, Last data time stamp, parameters, latitude, longitude, edmo code, quality control flags
F3.	Yes	Metadata and data are integrated into the same netcdf files- The European common data and metadata model for real-time surface current HFR data was defined and implemented (Corgnati et al., 2018), compliant with Climate and Forecast Metadata Convention version 1.6 (CF-1.6), OceanSITES convention, CMEMS-In Situ TAC requirements and INSPIRE directive.
F4.	Yes	Data products are indexed and accessible at the institutional level ERDDAP system and also SeaDataCloud
A1.	Yes	Can be accessed via ERDDAP and HTTP
A1.1.	Yes	Free and open-source data download
A1.2.	Yes	For Copernicus data download need authentication, for others it's open access
A2.	Partially	Part of the metadata is persistent, but not all since metadata is in the same file as data

Table 11. Findability and Accessibility evaluation for COAST-HF station.

Bay of Biscay IRS - network of fixed platforms/buoys (COAST-HF)		
	F and A Self-assessment	**Comment**
F1.	Yes	Broad community WMO identifier (6200021) assigned and persistent; DOI for time series (10.17882/46529)
F2.	Yes	Platform name, platform type, Provider, Country, Last data time stamp, parameters, latitude, longitude, edmo code, quality control flags
F3.	Yes	Metadata are available on website and in files (netCDF format) with data.
F4.	Yes	Map viewer provides filters such as platform type which makes the data easy to find. Data products are also available from catalogs and European portals.
A1.	Yes	Platform webpage allows for downloading the data by clicking on a link in multiple formats (csv, netCDF)
A1.1.	Yes	Free and open-source data download
A1.2.	Yes	For Copernicus yes, for others it's open access
A2.	Yes	Metadata is persistent on website and on catalogs

3.3.3. Overview of data handling and outlook at the regional level

Regional initiatives such as IBI-ROOS (Iberia-Biscay-Ireland Operational Oceanographic System) strongly contribute to the harmonisation and aggregation of data at the IRS-level. For example, in the framework of IBI-ROOS, the Interreg project MyCOAST contributed to the harmonisation of coastal observing systems and data flows along Interreg Atlantic area for applications (e.g., Search and Rescue, Flooding warning systems). Other initiatives were driven to improve data accessibility of observation needed for coastal and regional operational oceanography as river runoffs.
However, such initiatives are more focused on physical parameters and there are still real needs for developing harmonised data flows for other disciplines (e.g., biology, biogeochemistry, sediment transport).

The Basque Operational Oceanography System, named EuskOOS, is a multiplatform system composed by ocean buoys, coastal stations, coastal videometry systems, HF Radars and waves and ocean models. The data from EuskOOS are already included in **ebegi** project but EuskOOS has also recently revamped its data system and portal to: (1) reach higher impact in the Basque society and (2) contribute to the European Ocean Observing System Portals with interoperable datasets. This revamping has been carried out by developing two main elements of the data centre (backend and frontend) upgrading to an interoperable open data management ERDDAP server (backend), followed by the generation of a user-friendly portal (frontend) for, data visibility and accessibility[3].

During the development of the new EuskOOS data storage, accessibility and visibility, the need of DMP for each of the specific datasets was identified. Beyond the general need of those DMP, they should be friendly, useful and machine accessible so more users could access, correctly understand each step of the data cycle and ultimately reuse those datasets. In this sense, and under the umbrella of the **ebegi** project, AZTI has organised internal courses during 2023 to build a culture among DMP that will be implemented in the future years, not only to all new datasets retrieved/generated in AZTI but also to the existing ones.

Presently, there are clear differences between Spain and France in the strategy adopted to manage data flows within the FAIR landscape. As for Spain these strategies strongly differ depending on the nature of the observations and on projects. In France, such a heterogeneity is reduced due to the existence of unique pathways both with the national RI ILICO and to a lesser extent the structuration of data flows associated with the implementation of EU directives. We would like to emphasise that these two approaches could coexist within a future Bay of Biscay Integrated Regional System: the French approach being probably more efficient for channelling data flows generated by JERICO RI per se, whereas the more flexible Spanish approach being probably more relevant for processing the data flow generated by external JERICO partners.

3.4. Kattegat-Skagerrak-Eastern North Sea IRS

Partners: Swedish Meteorological and Hydrological Institute (SMHI), Sweden; Institute of Marine Research (IMR), Norway; Norwegian Institute for Water Research (NIVA), Norway; Danish Meteorological Institute (DMI), Denmark; Helmholtz- Zentrum Geesthacht (HZG, now Hereon),

[3] L. Solabarrieta et al., "Revamping data system and portal in the Basque Operational Oceanography," 2022 IEEE International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea), Milazzo, Italy, 2022, pp. 193-197, doi: 10.1109/MetroSea55331.2022.9950947.

Germany; Helmholtz Centre for Polar and Marine Research, the Alfred Wegener Institute (AWI), Germany

3.4.1. Data availability/accessibility

The KASKEN partners carry out sampling in the Kattegat-Skagerrak-Eastern North Sea region using multiple methods and platforms. These include sampling from research vessels and the use of satellite remote sensing. In D3.3 the main focus is on platforms with automated sensors such as FerryBox systems and buoys for observing physical, chemical, bio-optical and biological parameters. Assessments of fish stocks are not included in the description made here. Investigations of benthic habitats are also made, but these are outside the scope of this deliverable. The exception is the underwater observatory operated by AWI/Hereon at Helgoland. Further, within the KASKEN partners there is ongoing monitoring of freshwater discharge and transports and modelling efforts for ocean physics and biogeochemistry, however these are not further described in this deliverable.

The data from sampling on research vessels include underway systems (FerryBox and Moving Vessel Profiler), CTD-casts and water chemistry and phytoplankton sampling. In addition, zooplankton samples are collected using nets. The resulting data are stored at the National Oceanographic Data Centre at SMHI in Sweden, at NIVA and IMR (NMDC - Norwegian Marine Data Centre (www.nmdc.no/nmdc/) and the Norwegian Environment Agency (Miljødirektoratet, Vannmiljø, www.vannmiljo.miljodirektoratet.no/) in Norway. Danish marine monitoring is governed by the Danish Environmental Protection Agency (Miljøstyrelsen). In Germany the monitoring is in general made at the state level, not at the national level. All the countries in KASKEN submit data to ICES (www.ices.dk). In addition, data are submitted to European data aggregators: EMODnet biology, EMODnet chemistry, EMODnet physics and to EEA (European Environmental Agency). It should be noted that data is also made available and used at the global level through the United Nations - UNESCO-IOC, the Intergovernmental Oceanographic Commission. Examples include the International Oceanographic Data and Information Exchange" (IODE; www.iode.org), the Harmful Algae Event Database (HAEDAT; http://haedat.iode.org) and the Integrated Ocean Carbon Coordination Project (http://www.ioccp.org).

The JERICO KASKEN partners operate FerryBox systems, instrumented oceanographic buoys and other fixed platforms. The platforms were described in Table 6 in D3.1. An updated table with information on data availability is provided in Table 12. There is new information compared to what was available when D3.1 was produced. IMR is setting up a new observing system on the island Torungen in the Skagerrak and NIVA are setting up new FerryBox systems.

The Global Ocean Observing System (GOOS) has defined the Essential Ocean Variables (EOV). GOOS has a European part named EuroGOOS. In the KASKEN area two regional observing systems partly overlap: the Baltic Sea Oceanographic System (BOOS; http://www.boos.org) and the North West European Shelf Operational Oceanographic System (NOOS; https://noos.eurogoos.eu). At present mainly physical oceanographic parameters, oxygen and to some degree bio-optical measurements are made available through BOOS and NOOS. Tide gauges measuring sea level are the most common observing systems (Figures 1 and 2).

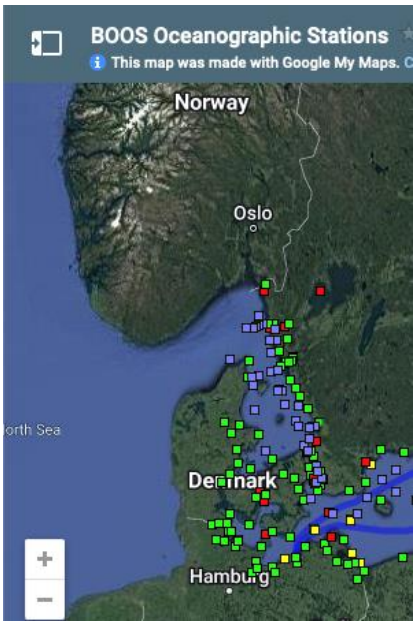

Fig. 1. Countries in the KASKEN area contribute data to the Baltic Sea Oceanographic System (BOOS). Data on sea levels from tide gauges is the most common parameter. Screenshot from http://www.boos.org/boos-stations.

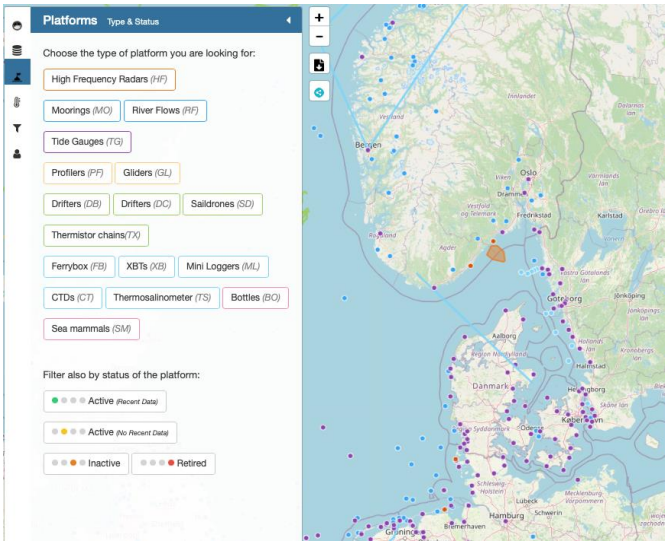

Fig. 2. Countries in the KASKEN area contribute data to the North West Shelf Ocean Observing System NOOS. Data on sea levels from tide gauges is the most common parameter. Screenshot from https://nwsportal.bsh.de.

Table 12. Overview of data availability of platforms for automated observations in the Kattegat-Skagerrak-Eastern North Sea. BOOS = Baltic Sea Operational Oceanographic System, NOOS, tbd = to be decided. Data from plankton imaging systems are not part of the table but described separately.

Platform type	Name of platform	Partner	Geographic information	European	Regional	National	Institutional
FerryBox	Color Fantasy, Connector, Color Hybrid (not yet operational)	NIVA	Skagerrak, Kattegat, Belt Sea (Oslo-Kiel), North Sea, Skagerrak	tbd	tbd	Yes, NorSOOP and soon NMDC	Yes
FerryBox	R/V Svea, Tavastland	SMHI	North Sea, Skagerrak, Kattegat, Baltic Sea	Yes, CMEMS	No	Swedish ODC and SMHI Open Data portal	Yes
FerryBox	C/V Magnolia Seaways	Hereon	North Sea	Yes, CMEMS	Yes, NOOS, ferrydata data portal, SOCAT	Yes, COSYNA (Hereon)	Yes
Stationary FerryBox/Underwater observatory	Helgoland	AWI/Hereon	North Sea - Wadden sea	No	No	Yes	Yes
Stationary Ferrybox/observing system on island	Torungen (not yet operational)	IMR	Skagerrak, Norwegian coast	tbd	tbd	tbd	tbd
Instrumented oceanographic buoy	Koster buoy, Väderö buoy	SMHI	Skagerrak, Koster Sea National Park, Sweden	Yes, CMEMS	No	Swedish ODC	Yes

Ocean acidification and the carbonate systems

At present pCO_2 and pH are observed using FerryBox systems on M/S Color Fantasy, C/V Magnolia Seaways and on R/V Svea. On R/V Svea also depth profiles are made at stations. Observations are part of ICOS - Integrated Carbon Observation System https://www.icos-cp.eu. Data is also made available through the Surface Ocean CO_2 Atlas (SOCAT; https://www.socat.info).

Automated plankton observations

Automated imaging in flow systems is used for automated observations of plankton in the KASKEN area. SMHI operate the Imaging FlowCytobot (IFCB) as part of the Ferrybox on R/V Svea and NIVA operate an IFCB as part of the Ferrybox on Color Fantasy. IMR plans to operate an IFCB as part of the observing system on island Torungen. KASKEN partners and some other JERICO partners have a collaboration on developing data products from the automated plankton observations. The automated sampling results in hundreds of thousands of images of plankton and supervised machine learning (AI) is used for automated analysis of the images (Fig. 3 and Karlson et al., 2022[4])

[4] Karlson, B., Berdalet, E., Kudela, R.M., 2022. The GlobalHAB mini-symposium on automated plankton observations. Harmful Algae News 71, 1-4.

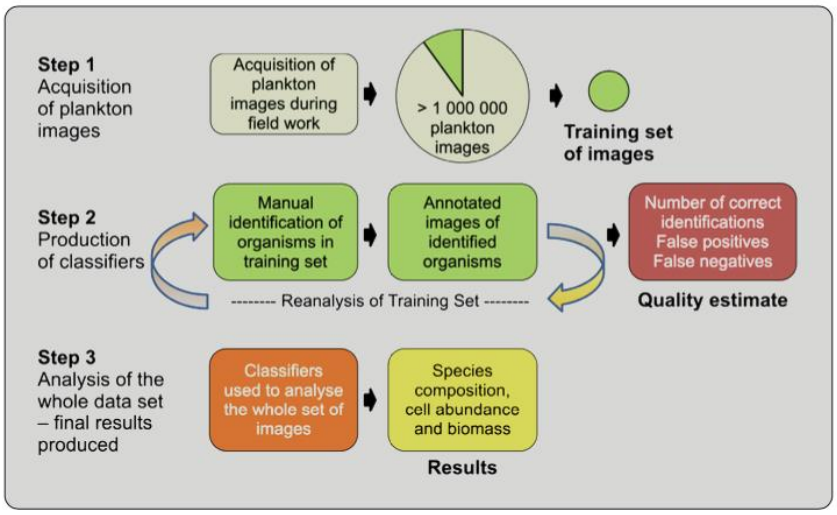

Fig. 3. A description of the steps needed to produce quantitative data on phytoplankton diversity, biomass and cell abundance from automated imaging in flow systems, e.g., the Imaging Flow Cytobot. From Karlson et al. (2022)[4].

Systems for storing and sharing data from the IFCB are not yet in place in Europe. However, there is a great deal of activity on this topic in the European IFCB Network (Karlson et al. 2021). It is likely that EMODnet biology will host the final results from automated plankton observations. This means that also the Ocean Biodiversity Information System OBIS (https://obis.org) and EurOBIS will receive results and that they will be made available globally. A JERICO-KASKEN system for sharing and visualising plankton data from the IFCB is in development at SMHI. JERICO partners and national data centres will store the original data.

3.4.2. Findability and Accessibility evaluation of specific platforms

Two examples are provided from the KASKEN-IRS in terms of Findability and Accessibility attributes: the Color Fantasy FerryBox operated by NIVA (Table 13) and R/V Svea FerryBox operated by SMHI (Table 14).

Table 13. Findability and Accessibility evaluation for Color Fantasy Oslo-Kiel FerryBox.

KASKEN IRS - FerryBox (Color Fantasy Oslo-Kiel, NIVA)		
	F and A Self-assessment	**Comment**
F1.	Partially	Unique ID used internally for data, but not sure about metadata
F2.	Yes	Platform name, platform type, Provider, Country, time stamp, parameters, latitude, longitude, quality control flags
F3.	Unknown	Not sure if metadata identifier is linked to dataset
F4.	No	At present, data are not registered in a searchable/indexable resource. Historical data has been previously provided to EMODnet physics.

A1.	Partially	At present, data and metadata are retrievable internally via a python script and not by data aggregators. API access can be granted to individual users. An externally available solution is being developed, and will soon be made available through NMDC.
A1.1.	Partially	Free and open-source data download internally, but not yet fully developed for external access.
A1.2.	Partially	Authentication/authorisation procedure can be arranged for API access.
A2.	Unknown	Unsure what the metadata preservation policy is being used at present.

Additional info regarding Table 13: NIVA is working on improving system for links to EMODnet and CMEMS that will improve F and A attributes in the near future.

Table 14. Findability and Accessibility evaluation for R/V Svea Baltic/North Sea.

KASKEN IRS - FerryBox (R/V Svea Baltic/North Sea, SMHI)		
	F and A Self-assessment	**Comment**
F1.	Yes	The ICES system for describing data based on country, ship, year, station, date, time and depth is used for "bottle data". A Unique ID is created, e.g. "SHARK-HYD+2023+77SE+0033+0+0" FerryBox data is described using CMEMS standards
F2.	Yes	Platform name, platform type, Provider, Country, time stamp, parameters, latitude, longitude, quality control flags; in some cases reference to SOP's or articles are used
F3.	Yes	Metadata is part of dataset
F4.	Yes	Data is available through the Swedish Oceanographic Data Centre at SMHI. There are several ways to access the data: Manual user interface at https://sharkweb.smhi.se and machine to machine through https://sharkdata.smhi.se/ Another possibility is SMHI Open Data at https://www.smhi.se/en/services/open-data/search-smhi-s-open-data-1.81004 Data is also available through CMEMS and EMODnet. pCO_2 and pH are made available through SOCAT
A1.	Yes	
A1.1.	Yes-partially	Data is available through CMEMS and SOCAT. A system for sharing plankton data from imaging systems is in development.
A1.2.	No	Not relevant because access is fully open.
A2.	Yes	Not relevant, all metadata are stored together with data.

Additional info regarding Table 14: SMHI is a data centre for CMEMS that includes other data from the Baltic Sea area; SMHI is building a system for collecting and visualising plankton data from imaging in flow systems. The system has potential to become a data node for near real time plankton data.

3.4.3. Overview of data handling and outlook at the regional level

Data harmonisation and aggregation in KASKEN area

At present ICES, IOC, EMODnet and CMEMS are the main international data centres for aggregating data from the KASKEN area. NOOS is used for visualising a few parameters, e.g. sea level. Harmonisation is mainly carried out through work in JERICO and in ICES and IOC working groups and through OSPAR. There is also a Nordic collaboration through activities initiated by the Nordic Council of Ministers. Examples of harmonisation activities are intercalibrations and workshops. There are yearly meetings in ICES working groups that partly deal with harmonisation of methods and data. In 2022 there were activities on harmonising observations of ocean acidification, on molecular methods (metabarcoding) for investigating phytoplankton diversity and an international workshop on automated plankton observations using imaging methods.

A future vision of regional data handling/access

There is a need for building a system for sharing and visualising observations and model results in the KASKEN area in near real time. Open access to data would be fundamental to this. The current systems either share data long after observations were made (ICES, IOC-HAEDAT, EMODnet) or include very few parameters (NOOS, BOOS and CMEMS). KASKEN could set up a regional centre (with a web site) for sharing and visualising data from different platforms and instruments. Sharing of data can be done at the European level but visualisation should be done at the regional level. The needs

from society, e.g. aquaculture, fisheries, tourism and coastal management, would guide the activities. A conclusion from work on data harmonisation and aggregation is that the quality control of data is best made by the institutes producing the data. ERDDAP and Darwin core seem to be standards to follow when sharing data.

About data availability/accessibility in the KASKEN region

-Data sharing has been good and practical for some parameters. For other parameters further work is needed.

Examples on novel data handling

- Joint work on automated plankton observations using imaging in flow systems (e.g. IFCB) and observations of harmful algae
- Joint work on carbonate system (pCO_2, pH)
- Sea truth data on chlorophyll for improving algorithms for estimating chlorophyll from satellite remote sensing of ocean colour. The overall aim is to assess phytoplankton biomass.

Gaps and future vision

- Need regional data sharing especially for harmful algae; data can be aggregated at European level, but need to include KASKEN visualisation system/warnings; use data for modelling and HABs forecast
- How to include/integrate non-JERICO-RI observations
- multi-platform approaches in the region, but not yet achieved
- Possibly combine North Sea + Kattegat + Skagerrak for visualisation system/warnings
- Need way to share data that is being collected on marine litter

3.5. Norwegian Sea IRS

Partners: Institute of Marine Research (IMR), Norway; Norwegian Institute for Water Research (NIVA), Norway; NORCE Norwegian Research Centre (NORCE), Norway; Faroe Marine Research Institute (FAMRI), Faroe Islands

3.5.1. Data availability/accessibility

The Norwegian Sea IRS partners are conducting sampling and observations in the Norwegian Sea area. Hereby a suite of methodologies is used, including observations/sampling from research vessels, FerryBoxes, fixed stations and satellite remote sensing. Main focal point of the IRS in in JERICO is on automated platforms, with the fishery related observations and ecosystem cruises as background information.

The data from the Norwegian Sea IRS is stored within the National Oceanographic Data Centre, i.e., the Norwegian Marine Datacentre (NMD) hosted by IMR. In addition to being the National Oceanographic Data Centre, NMD operates the NMDC an infrastructure programme storing data from the main Norwegian institutions observing the Norwegian Sea area. This ensures that the observational efforts from the JERICO partners are severely connected to the other providers existing. IMR with NMD is as well hosting the Copernicus Marine Service InSitu Assembly centre for the Arctic region enabling a seamless provision of data flow towards the European landscape. Furthermore, the discrete Norwegian Sea IRS data is delivered to ICES, and complementing to the CMEMS service to the ICOS activities (SOCAT).

The activity in JERICO-S3 is as well connected with the Global Ocean Observing System (GOOS)/EuroGOOS activities hosting the Arctic ROOS data as well as being central in the EuroGOOS activities with Henning Wehde acting as the Chair of the EuroGOOS AISBL Board of Directors. The close collaboration in ongoing activities such as forming the European Ocean Observing system (EOOS) is therefore ensured.

Table 15. Data availability/accessibility in the NS-IRS by platform type/partner.

Platform type	Partner	European	Regional	National	Institutional
Manual sampling	IMR	Yes	Yes	Yes	Yes
Manual sampling	FAMRI	Yes	No	Yes	Yes
Manual sampling	NORCE	Yes	Yes	Yes	Yes
Manual sampling	NIVA	Yes, ICES	No	Yes	Yes
FerryBox	NIVA/FAMRI	Yes*	Yes*	Yes*	Yes
Underwater observatory	AWI	Yes	No	Yes	Yes
Fixed platform	NORCE	Yes	YES	Yes	Yes

*Data are available, but not for all time periods

3.5.2. Findability and Accessibility evaluation of specific platforms

Two examples are provided from the Norwegian Sea-IRS in terms of Findability and Accessibility attributes: the Hurtigruten Coastal Steamer FerryBox operated by NIVA and the fixed station Eggum, exemplary for the 8 fixed stations established in the 1930s along the Norwegian Coast (IMR). Those stations are probed by fisherman doing CTD Casts and manual sampling of additional parameters.

Table 16. Findability and Accessibility evaluation for Trollfjord Bergen-Kirkenes FerryBox.

Norwegian Sea IRS - FerryBox (Trollfjord Bergen-Kirkenes, NIVA)		
	F and A Self-assessment	**Comment**
F1.	Partially	Unique ID used internally for data, but not sure about metadata
F2.	Yes	Platform name, platform type, Provider, Country, time stamp, parameters, latitude, longitude, quality control flags
F3.	Unknown	Not sure how metadata identifier is linked to dataset
F4.	No	At present, data are not registered in a searchable/indexable resource. Historical data has been previously provided to EMODnet physics.
A1.	Partially	At present, data and metadata are retrievable internally via a python script and not by data aggregators. API access can be granted to individual users. An externally available solution is being developed,and will soon be made available through NMDC.
A1.1.	Partially	Free and open-source data download internally, but not yet fully developed for external access.
A1.2.	Partially	Authentication/authorisation procedure can be arranged for API access.

A2.	Unknown	Unsure what the metadata preservation policy is being used at present.

Additional info regarding Table 16: NIVA is working on improving system for links to EMODnet and CMEMS that will improve F and A attributes in the near future.

Table 17. Findability and Accessibility evaluation for eight coastal stations manual sampling.

Norwegian IRS – Fixed station manual sampling (Eggum, IMR)		
	F and A Self-assessment	**Comment**
F1.	Yes	Unique ID used internally for data, and metadata stored in NMD
F2.	Yes	Platform name, platform type, Provider, Country, Last data time stamp, parameters, latitude, longitude, edmo code, quality control flags
F3.	Yes	Platform Id and code are mentioned within dataset
F4.	No	The IMR website is under reestablishment, therefor at present data is not registered in a searchable/indexable resource
A1.	Partially	NMDC webpage allows for downloading the basic data by clicking on a link in netcdf format. Additionally available data from manually conducted sampling is available by request
A1.1.	Partially	Free and open-source data download for basic parameters. Additionally available data from manually conducted sampling is available by request
A1.2.	Partially	No login required for basic parameters
A2.	Not relevant	Not relevant as data is still available

3.5.3. Overview of data handling and outlook at the regional level

At present, data handling in the NS-IRS is handled by individual institutes, collated at the national level within the national data centre NMDC, and routed to ROOSs which eventually sends data to pan-European data aggregators. Virtually no intercomparison or synthesis is being done at a national level. This is due to the lack of a national coastal observing infrastructures.

In terms of new activities within the NS-IRS, a new FerryBox installation has been made by NIVA in cooperation with FAMRI on M/S Norønna between Denmark, Faroe Islands and Iceland. The data handling from this new installation will follow the same developments as the other NIVA FerryBoxes described above, and data will be made available to NMDC and European data aggregators. Furthermore, NS-IRS is planning to co-host a workshop in 2023 on data harmonisation of pCO_2, cDOM, chlorophyll, and imaging instruments.

A future outlook for consolidated data handling and data synthesis for projects will involve the development of a coastal service plan via JERICO-S3 WP9. Further catalyst and funding commitments are required to progress. A possible future coastal observing system for NS-IRS could involve multiple national coastal observing infrastructures (e.g., COASTWATCH for Norway) that would improve cooperative coastal observing and value-added actions, as well as merging non-JERICO-RI observations that are presently being made by other research programs and national monitoring.

3.6. Recommendations based on regional data handling and accessibility

This deliverable provides inputs from IRSs regarding data handling and accessibility that could contribute to a gap analysis of the dataflows compared to the JERICO-S3 data management plan (DMP), which is useful information for later stages in JERICO where dataflows can be improved. This is relevant for both work towards ESFRI and future JERICO-RI efforts, or others (EMODnet, work in ROOSes etc).

The next step would be to analyse how complete the metadata actually is (which was not covered in this deliverable), and how interoperable it is (D6.7 approach). The D6.7 approach only assessed selected coastal observing platforms from a few PSS and IRS. The data aggregators, to a large extent, determine how interoperable and reusable the data is, by their recommended metadata and data model/format. In practice, a detailed analysis of metadata revealed that metadata are not complete - more work here is needed.

Another recommendation through this deliverable is that some degree of uniformity should be recommended with regards to data handling and accessibility at all levels, but especially at the regional level where there are some special requirements and needs, but no general guidelines as to how to proceed. A coordinated effort via JERICO-S3 would be highly beneficial. Some examples of how this could be achieved were provided in the main report – HF radar data handling and accessibility, for example, is very well coordinated at the European level which the has trickled down to the regional and national levels. Other platforms, for example FerryBoxes, could benefit from a similar common approach that could be adopted by regions. This high degree of platform dependence in terms of FAIR criteria for data handling and accessibility, also complicates multi-platform integration, which is one of the main aims of the JERICO-RI.

Another aspect of the varying degree of uniformity across regions and platforms, is also to what level JERICO-RI data is accessible for current and future users, stakeholders, and policy makers (vis a vis WP9)? Most descriptions of accessibility and availability in the main report are related to scientific availability of data – that is, primarily researchers or organizations that synthesise data for use by researchers. A major shortcoming could be a lack of data products that can be used and understood by users such as policy makers or industry stakeholders (e.g., aquaculture, fisheries, maritime operations). To what extent can or should JERICO-RI provide data products at the regional or pan-European level for user "consumption" – and how?

All IRS report a clear vision to further data FAIR-ness and integration at regional and trans-regional level. All institutions gather datasets from multiple platforms and combine them into multiplatform, multiparameter datasets that ensure interoperability and multiparametric analyses at regional extent. This aspect of multiplatform data integration is a value that is worthwhile to be considered and preserved in all further FAIR-ness and data integration efforts at regional, trans-regional, and pan-European level.

Finally, a common recommendation based on inputs from all IRSs is what should regions aim for in terms of regional data accessibility? Is it sufficient for national nodes to be linked together on a common regional data catalogue? Or is the presence of all data at European aggregators with a tag

that links the data to JERICO-RI and respective region be sufficient? Or is there a need for a JERICO-RI data catalogue from which all JERICO-related data can be accessed and viewed? As mentioned above, each IRS has some degree of specificity in their future visions, that are in many ways connected to KSCs and national/regional needs. However, a common set of recommendations would play an important role in shaping regional data accessibility and availability.

4.CONCLUSIONS

All data collected within the JERICO-RI network of coastal observations is curated. Data is preserved, integrated (at various levels) and respective metadata is stored and connected with the data.

Use of the following data aggregators is reported:

- Institutional databases
- National databases
- National reporting in the frame of MSFD/WFD
- Regional ERDDAP networks
- SEA Data Net
- Copernicus Marine Service
- EMODnet
- GTS (Global telecommunication system)
- CMEMS
- ROOS/EuroGOOS/GOOS
- NCBI
- GBIF
- Genebank
- European Nucleotide Archive

Data and respective metadata are findable at various levels: within an institution, within a network of organisations at national and international level. Access to metadata and data is mainly following individual regulations on data ownership, cost and benefit sharing.