Maritime Spatial Planning Data Framework (MSPdF)

How to structure input data for MSP process, monitoring & evaluation

Abramic, A., Norton, D., Sarretta, A., Menegon, S., Katsika, M., Gekas, V., Rybka, K., Fernández-Palacios, Y.

Produced by Technical Expert Group (TEG) on Data for MSP.

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1. INTRODUCTION - MSP DATA FRAMEWORK DEMAND

The process of Maritime Spatial Planning (MSP) requires the collection of spatial data and information related to a great variety of issues and processes. When facing the data collection task, it is necessary to answer questions such as: how can we define the marine environment or marine biodiversity? What type of data should be collected and included in the analysis for suitability zoning of economic activities, cumulative impact assessment or land-sea interactions? What are the relevant maritime and coastal uses? What type of information needs to be collected within the socio economic and governance topics?

These questions have been analysed, discussed and documented by the Technical Expert Group on MSP data (TEG)[1], established in April 2020 by the Directorate-General for Maritime Affairs and Fisheries (DG MARE) and the European Climate, Infrastructure and Environment Executive Agency (CINEA, ex-EASME). The TEG was established to deal with the current state of play of MSP data management, resolve ongoing issues (such as harmonisation of MSP "output" data) and exchange knowledge and experience between practitioners and experts on MSP.

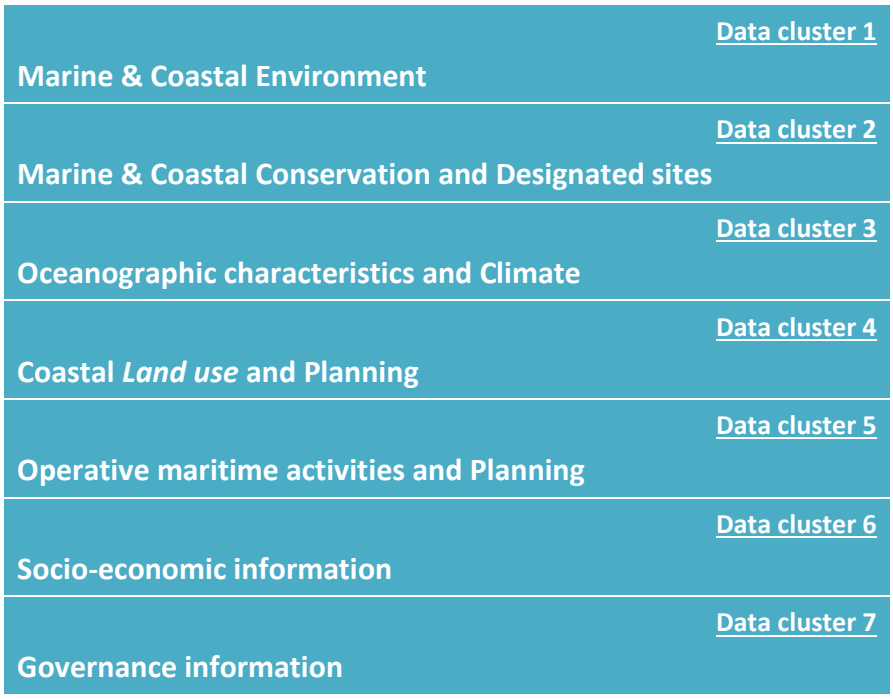


Figure 1. Seven clusters of the MSP data framework.

This document presents the conceptual framework proposed to be applied to identify and structure the data necessary for the development of maritime spatial plans. The **MSP data framework** provides the structure to organise input spatial information and data that needs to be considered within the full MSP process.

The required input data has been organised in seven thematic clusters covering from the marine environment through to governance themes, according to the experience of previous initiatives (Figure 1).
Each cluster is provided with a description, including its relevance to the different stages of the planning process, structure mainly based on already established frameworks, digital resources for data management and harmonisation, and possible data sources.

It is expected that this document will serve to facilitate the MSP data collection process and management. Further, the very same framework can be used to establish the monitoring and evaluation of the operational plans. It includes checklists for the seven MSP relevant clusters, proposing and listing the information that should be considered, in case it has not yet been included in the decision-making process. The various interests and benefits of the application of the MSPdF are summarized in Figure 2.

[1] Technical Expert Group (TEG) on Data for MSP | The European Maritime Spatial Planning Platform (europa.eu)

Interest and benefits of application of the MSPdF:

The use of the selected data clusters and checklists in the MSP process provides the following interests and benefits:

- **Guides data collection**
- **Structures Input data**
- **Facilitates identification of data gaps**
- **Identifies relevant information not previously included in MSP process**
- **First milestone for MSP input data harmonisation - improves interoperability (structure and proposed harmonisation data models and semantic code lists)**
- **Improves comparability of applied data collections**
- **Improves the analyses potential and results comparability**
- **Supports design for monitoring and evaluation**

Figure 2. Interests and benefits of application of the MSPdF.

2. MSP DATA FRAMEWORK DEVELOPMENT

The data collection process needs to be well structured. This has several benefits, ensuring efficient data gathering, avoiding duplication, unnecessary or useless data collection, and making spatial information manageable.

Within the PLASMAR project (INTERREG Macaronesia 2017-2020, MAC/1.1a/030)[2], during the data collection process, target data was thematically classified into five clusters: 1. Data on the marine environment; 2. Spatial data and information on marine protected areas; 3. Physical oceanography; 4. Coastal Land use; and 5. Current Maritime Activities (Abramic et al. 2020).

This framework was called the PLASMAR MSP Data Framework (Figure 3), which facilitated the cross-border data collection process between the three archipelagos participating in the project: Madeira and Azores (belonging to Portugal) and the Canary Islands (Spain).

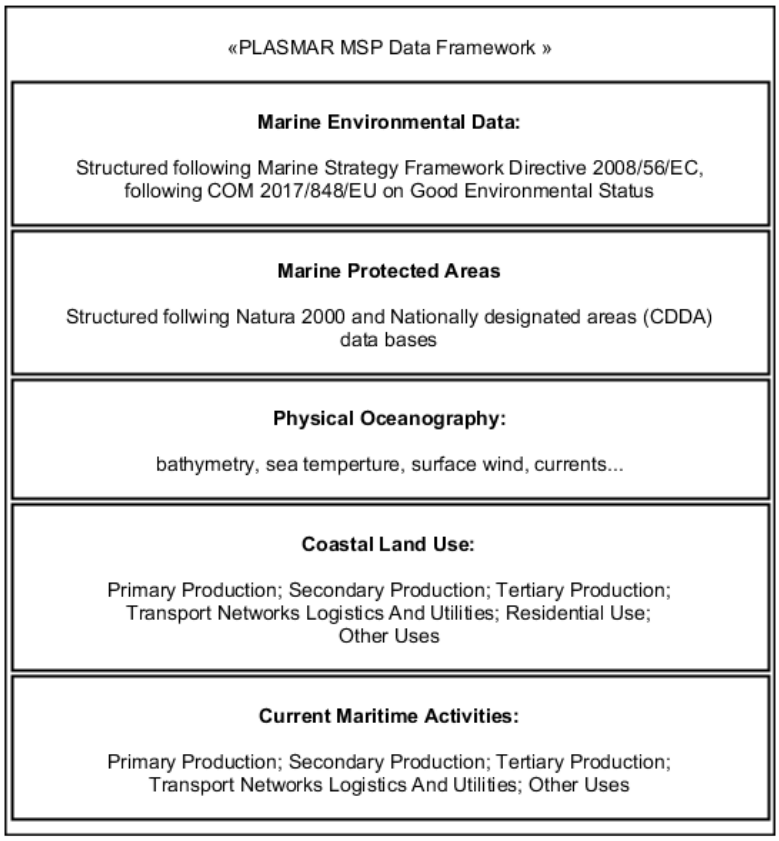


Figure 3. PLASMAR MSP data framework.

The PLASMAR data framework was successfully tested and applied for the data collection in the project. Even more, it was found to be appropriate and useful within the method developed under the PLASMAR project for the identification of suitable areas for the establishment of specific maritime economic activities. This suitability zoning method, which was applied using the INDIMAR decision-support system, was effectively tested for offshore wind energy, aquaculture and mineral extraction (Abramic et al. 2021).

The PLASMAR framework served as the baseline for the further development of the MSP data framework within the TEG in order to ensure its application at a wider geographical level and provide useful checklists, not only for the data collection at different scales, but also for the assessment of operational maritime spatial plans.

The TEG established a working sub-group for the iterative testing, improvement and finalisation of the MSP Data framework (MSPdF). Development and iteration of the MSPdF was done based on and

[2] www.plasmar2017.eu

within the participating experts' ongoing experiences and projects, and covered different stages of the MSP process, including data collection, national planning and/or MSP project development.

The development of the MSPdF under the TEG was initiated with the addition of two clusters: *6. Socio-economic information*, and *7. Governance information* (both included in MSPglobal Policy Brief: Identifying Existing and Future Conditions in Marine Spatial Planning, UNESCO/IOC 2021).

The current version of the MSPdF presented in this document incorporates the improvements agreed after various iterations and analyses of data collection elements (type of data and related categories) that were applied within the following:

1. National MSP processes including Poland, Greece, Cyprus, Italy, Sweden and France.
2. Cross-border EU MSP projects, namely PLASMAR, THAL-CHOR 2, MSPMED, SIMCelt, SIMNORAT, SIMWESTMED, SEAnse, SIMAtlantic, MED OSMoSIS, MSP-OR, eMSP NBSR and PLASMAR+.

The information on the type of data and spatial information categories to be considered and included was collected using a specific survey (Figure 4) that was designed and shared within the TEG (see Annex 1).

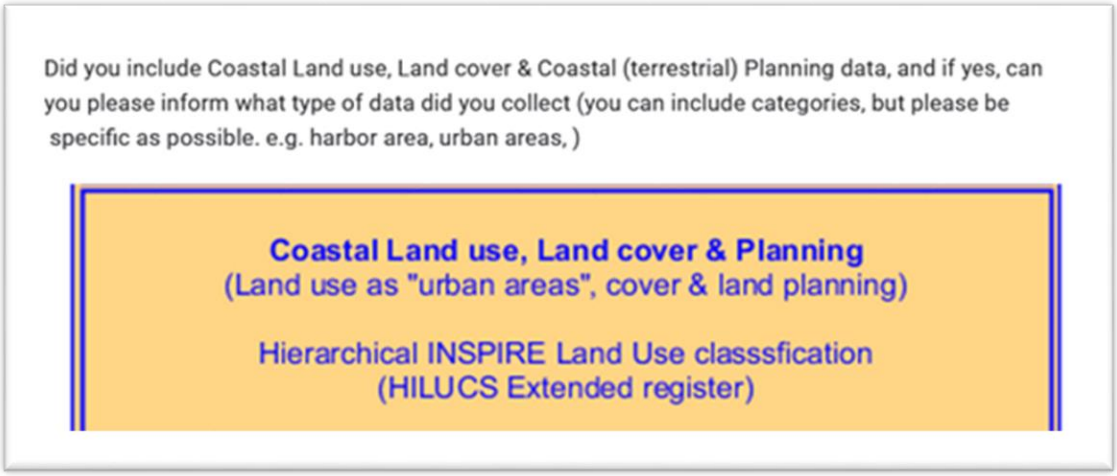


Figure 4. Survey question on Coastal Land use, Land cover & Planning.

After several rounds of iterative testing within the TEG working sub-group, it was agreed to apply the structure presented in the next section, for the definition, development and implementation of the seven data clusters that are part of the MSP data framework.

3. STRUCTURE AND DEFINITION OF THE CLUSTERS

To fully describe and facilitate the understanding of each of the seven data clusters, it was agreed to incorporate the main information within four main sections:

1. **Cluster description**. Includes an explanation of what spatial information should be incorporated and why it is relevant for the MSP process. It also details why such spatial information should be included in MSP input data collection, but also why it is relevant for the monitoring and evaluation of operative plans.
2. **Structure of the cluster and checklist.** It includes details on how the parameters contained within the cluster could be listed and structured and organised in a checklist. It proposes options following already established frameworks (e.g., Good Environmental Status of the Marine Strategy Framework Directive 2008/56/EC, or the Essential Ocean Variables established by The Global Ocean Observing System).
3. **Digital resources** for data management and harmonisation, which are readily available as potential data models (e.g., INSPIRE, Open Geospatial Consortium, International Hydrographic standards), including registers (e.g., SeaDataNet,), related code lists and classifications (e.g., Hierarchical INSPIRE Land Use Classification System).
4. Possible **data sources** such as from EMODnet, Copernicus etc., which provide harmonised regional or even European products;

3.1. Marine & Coastal Environment

Data cluster 1
Marine & Coastal Environment
MSFD Good Environmental Status
WFD Good Ecological Status

3.1.1. Cluster description

Information on the marine environment is considered essential within the MSP methodology, as part of the necessary assessment of environmental sustainability of the maritime activities considered under the MSP process. Impacts related to pressures of the maritime sectors on the environment and the potential for the mitigation and sensitivity of ecosystems need to be evaluated. This complex assessment requires the management of complex information on the state of the environment, ecosystems' carrying capacity, and pressures of the maritime activities governed by the MSP plans.

3.1.2. Cluster structure & checklist

The MSP data cluster related to the Marine & Coastal Environment is structured following the Marine Strategy Framework Directive (MSFD) and the Water Framework Directive (WFD) for the marine and coastal spaces, respectively, as presented in the following paragraphs.

Data on the marine environment could be described as some of the most complex spatial information to be defined, identified and collected. To properly list parameters required to assess environmental sustainability, it is proposed to follow the Good Environmental Status (GES) structure included in the Marine Strategy Framework Directive 2008/56/EC (MSFD) for building a part of the checklist for the Marine environment. The GES is described in the COM 2017/848/EU, listed with 11 Quality descriptors and 39 related criteria elements, divided into essential features and characteristics of marine waters & predominant pressures and impacts.

The GES description includes biological pressures, physical pressures and substances, litter and energy. Essential features and characteristics are described as relevant ecosystem elements: species groups of seabirds, marine mammals, marine reptiles, fish and cephalopods, pelagic habitats, benthic habitats and ecosystems, including food webs.

The GES Quality descriptor 1 usefully defines marine biodiversity, a term difficult for non-biologists to understand, relating it to the following three main themes: species groups (seabirds, marine mammals, marine reptiles, non-commercial fish, cephalopods), benthic habitats, and pelagic habitats. For each of these biodiversity themes, criteria related to the distribution, abundance, demographic characteristics, etc., are included and provide a detailed description of healthy marine biodiversity.

The GES Quality descriptors presented in Figure 5 and their related criteria provide a structured checklist for the data collection on the marine environment that is necessary to be considered and (if possible) applied in the MSP process for developing sustainable maritime sectors.

Data cluster 1 **Marine Strategy Framework Directive 2008/56/EC, Good Environmental Status COM 2017/848/EU**
Descriptor 1: Biodiversity
– Species groups of seabirds, marine mammals, marine – –
Descriptor 2: Non-indigenous species
Descriptor 3: Commercial species
Descriptor 4: Marine food webs
Descriptor 5: Human-induced eutrophication
Descriptor 6: Sea floor integrity
Descriptor 7: Hydrographical conditions
Descriptor 8: Contaminants
Descriptor 9: Contamination of fish and seafoods
Descriptor 10: Marine litter
Descriptor 11: Energy and noise

Figure 5. Structure & checklist of the marine data following GES of the MSFD, applicable to the Marine Environment Data.

Anthropogenic pressure that is coming from the land is highly relevant for the marine environment and should be considered within the MSP process. Similarly, to how the MSFD is managing marine waters, the Water Framework Directive 2000/60/EC (WFD) is managing, protecting and improving the coastal, transitional and inland waters, administrating it in connection with the related river basins.

Thus, the WFD defines Good Ecological Status (GEcS), described by **biological quality elements** (including phytoplankton, phytobenthos, benthic invertebrates, macrophytes -aquatic flora- and fish) and supporting physico-chemical **quality elements** (nutrients, organic pollutants, acidification, and specific pollutants) and **hydromorphology quality elements**, as detailed in Figure 4. This structure is also contributing to building the checklist for the Marine & Coastal Environment Data Cluster.

Data cluster 1 **WFD Good Ecological Status**
Biological Quality Elements:
– Phytoplankton – Phytobentos – **Benthic Invertebrates** – **Fish** – **Macrophytes**
Physico-chemical elements:
– Nutrients – Organic pollutions – **Acidification** – **Specific pollution**
Hydromorphology elements:
– Hydrology – Morphology

Figure 6. Coastal, transitional and inland waters environmental data structure and checklist following the GecS of WFD.

Following GES of MSFD and GecS of WFD, the first level of the checklist for the Marine & Coastal Environment cluster was established. The use of the check list for the marine environment related to the GES quality descriptors that are relevant for the specific MSP process (Figure 6) can go into more details, considering the GES criteria elements. GES criteria elements are available in the document Commission Decision (EU) 2017/848 available on https://eur-lex.europa.eu/eli/dec/2017/848

Regarding the relevant quality elements related to the WFD GEnS (Figure 4), more details can be found within the Water Framework Directive 2000/60/EC, where the specific features describing the environment of the coastal, transitional, rivers and artificial and heavily modified surface water bodies (as ports and harbours) are incorporated: https://eur-lex.europa.eu/eli/dir/2000/60

3.1.3. Digital Resources

All marine areas under the MSFD are covered by national monitoring programmes and assessments related to the GES. Most of the **national MSFD monitoring programmes** include time series delivered by marine environment surveys. Time series can define trends and potential changes of marine environmental conditions, however aggregated data as GES assessments (Figure 7) are easier to manage and integrate within the MSP processes.

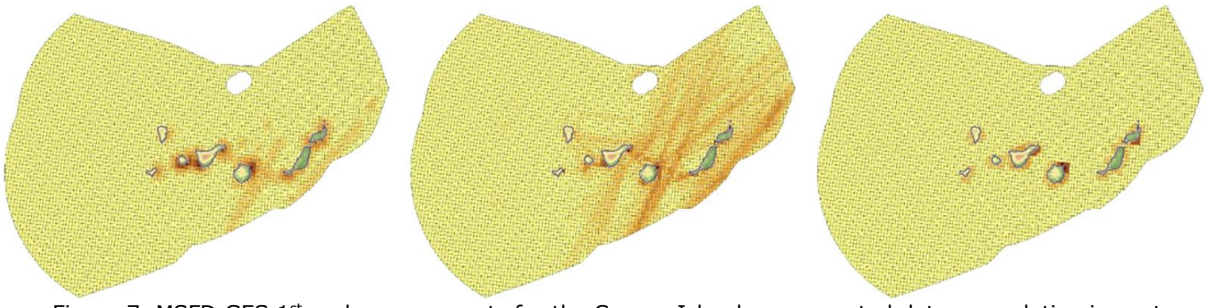


Figure 7. MSFD GES 1st cycle assessments for the Canary Islands- aggregated data: cumulative impact assessment on marine environmental noise; on marine debris- maritime pressures; on marine debris - terrestrial pressures. These assessments are publicly available through the spatial data infrastructure of the Spanish Ministry of Environment[3].

[3] Metadata catalogue available: https://www.mapama.gob.es/ide/metadatos/srv/spa/catalog.search#/home

INSPIRE (Directive 2007/2/EC) provides several **data models** (Marine regions, Habitat and biotopes, Species distribution, etc.) that can be used for the assessment and monitoring (Oceanographic geographical features) of the marine environment following the GES. This is described in detail in the paper "INSPIRE: Support for and requirement of the Marine Strategy Framework Directive"[4].

3.1.4. Possible data sources

One of the reasons to structure marine environment data based on **GES** is the MSFD Article 19 on "Public consultation and information", which requires **monitoring data and assessments to be shared following INSPIRE Directive** 2007/2/EC. This requirement facilitates data collection and reprocessing in the MSP, as data sets and assessments should be searchable through operational national and European metadata catalogues.

The assessments provided within the reporting processes related to the MSFD and to the WFD are also available on the **Water Information System for Europe** (WISE)[5] and **WISE Marine**[6] developed and managed by the European Environmental Agency.

[4] https://doi.org/10.1016/j.marpol.2018.02.020
[5] https://water.europa.eu/
[6] https://water.europa.eu/marine

3.2. Marine & Coastal Conservation and Designated sites

Data cluster 2
Marine & Coastal Conservation and Designated sites
Management, Restriction and Regulation

3.2.1. Cluster description

Conservation data is required to be considered and analysed within the MSP process. It is necessary to assess the potential (in)compatibilities of specific uses and activities with marine and coastal protected areas, with any other type of conservation figures, or even with designation with maritime sectors that are managed by MSP. To consider (in)compatibilities with current and future maritime uses and activities, it is necessary to understand the conservation objectives related to each designated area. Within this cluster, it is necessary to have spatial information on the area where marine conservation/designation is applied; further, we need to understand what type of management is applied and, if possible, what types of maritime activities are incompatible.

3.2.2. Cluster structure & checklist

This type of data includes all the different classifications of coastal and marine protected sites, but also any other kind of designation related to non-standard conservation (as *Other effective area-based conservation measures*), safety, security, or risk control from natural and man-made hazards (e.g., volcanic risk area, collision risk area, flooding risk area).

Data cluster 2	
Marine & Coastal Conservation and Designated sites	
Marine Protected Areas	– Extension – Management – Regulation – Restriction
Coastal Protected Areas	
Designated sites (conservation, security, safety, risk control)	

Figure 8. "Marine/coastal conservation and designated sites" cluster structure and checklist.

The cluster checklist (Figure 8) includes the need to review whether the marine and/or coastal areas under some degree of protection or designation have already been considered and identified as relevant for the MSP plan under development or analysis. If relevant, the details related to the area/site extension, management and regulation, and the main restrictions related to the coastal and maritime uses and activities should be considered.

3.2.3. Digital Resources

For the classification of the detailed information and data related to the abovementioned conservation and other designated areas, it is proposed to use already established classes, such as:

- Categories System defined by the International Union for Conservation of Nature (IUCN), divided into seven categories, according to management and protection objectives (Day et al. 2012);

- INSPIRE Protection Classification Value: aimed at classifying the purpose of protection (nature conservation, archaeological, ecological, geological, environmental…)[7];
- Natura 2000 designation;
- *Other effective area-based conservation measures* classes[8] or any other type of classes that can facilitate encoding the designation and related objectives of the site.

The **INSPIRE models repository** includes two relevant models: ***Protected site simple*** and ***Specialised data model*** for the **Natura 2000 data set**. Models include the INSPIRE Register **code list for designated sites**. The scheme, UML, code lists and data specifications that are available and can be reused for this cluster are available on the official INSPIRE web site[9]. Figure 9 shows the UML INSPIRE scheme of Protected site simple with designation code lists (IUCN, UNESCO's codes, Natura 2000, etc.).

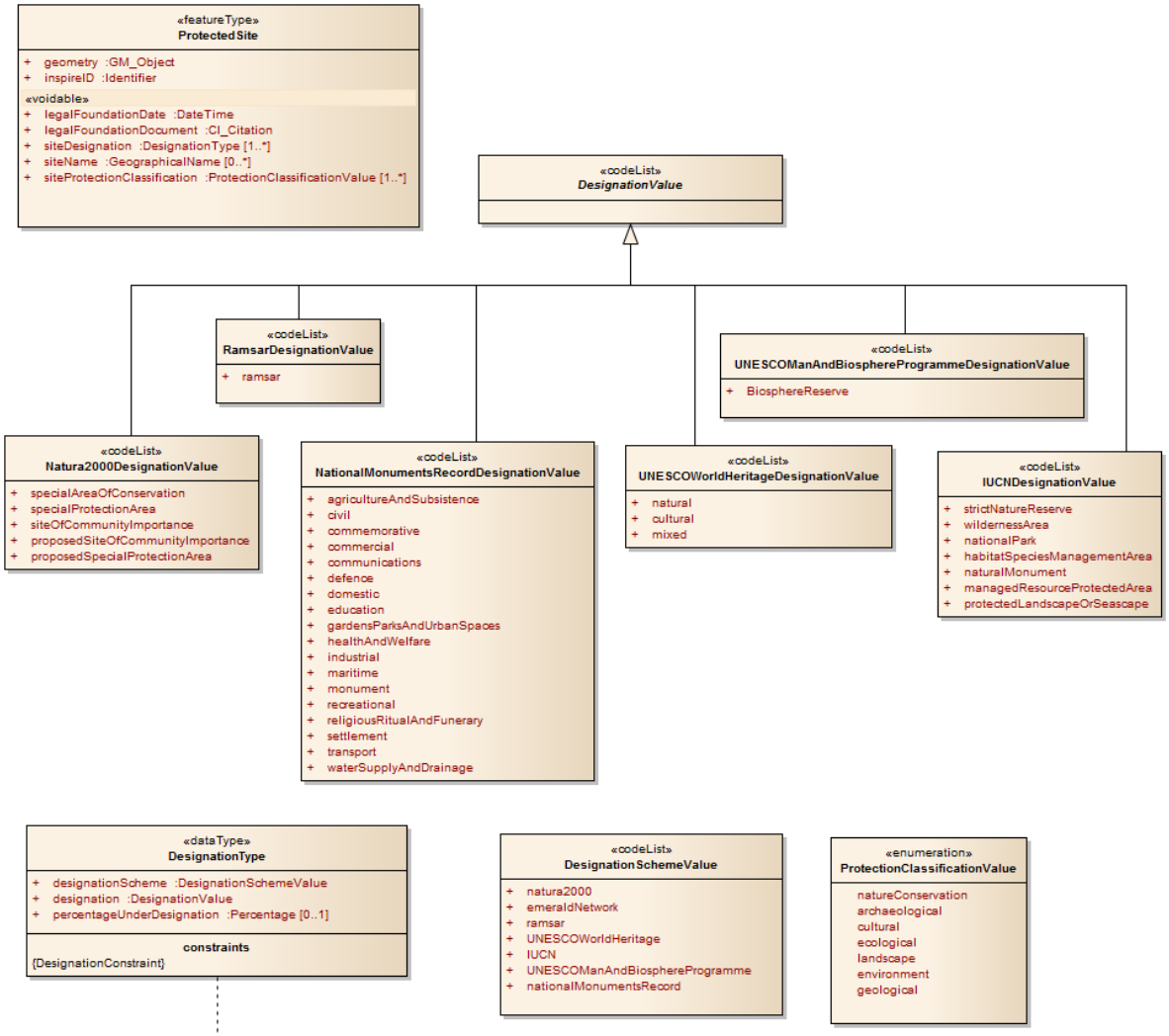


Figure 9. UML INSPIRE schema of Protected Site simple with designation code lists (IUCN, UNESCO's codes, Natura 2000…).

3.2.4. Possible data sources

To collect conservation data and spatial information it is possible to use two accessible/open data bases, both provided by the **European Environment Agency**: first, the **Nationally Designated**

[7] https://inspire.ec.europa.eu/enumeration/ProtectionClassificationValue

[8] https://biodiversity.europa.eu/protected-areas/other-effective-area-based-conservation-measures

[9] https://inspire.ec.europa.eu

Protected Areas Inventory (formally named **Common Database on Designated Areas**, CDDA) and the second one is on the **Natura 2000 Network**.

Both databases are harmonised products that cover the whole European Union, from which we can extract information on coastal and marine conservation. These products provide information on protected areas' spatial extent, but also conservation targets, which is the information required for the analysis on (in)compatibilities of uses with specific maritime and/or coastal sectors (e.g., offshore wind energy with MPA, depending on the specific conservation targets).

Nationally Designated Protected Areas Inventory (CDDA): applies the IUCN Protected Area Categories System that encodes the conservation objectives within seven categories, starting with the most restricted class *Strict Nature Reserve (Ia)* until the least restricted *Protected Area with sustainable use of natural resources (VI)*. The seven categories are defined in the IUCN publication Guidelines for Applying Protected Area Management Categories (Dudley *et al.* 2012). The European data set which includes terrestrial and marine designated areas for the entire EU, is updated annually and publicly available within the European Environmental Agency data infrastructure[10].

Natura 2000 Network: compiles the protected areas designated under the Birds Directive 79/409/EEC and the Habitats Directive 92/43/EEC, covering conservation of marine species (including birds, mammals, turtles…) and benthic habitats. The Natura 2000 database is more complex and includes a higher level of detail than the CDDA. It contains structured information on conservation, site identification, location, ecological information (applying EUNIS codes), description, protection status, management, and map. As CDDA, Natura 2000 European database is publicly available within the European Environmental Agency data infrastructure[11] and can be explored through Natura 2000 network Viewer[12].

3.3. Oceanographic characteristics and Climate

3.3.1. Cluster description

Within the process of MSP, it is essential to consider and collect data on the oceanographic and climatic conditions. A variety of different parameters are considered under this data cluster, incorporating issues related to physical aspects (e.g., sea temperature and salinity, atmospheric pressure, bathymetry, winds, currents, waves, etc.), and chemical aspects (oxygen, nutrients, dissolved organic carbon, etc.), among others.

Thus, these oceanographic and climatic characteristics can relate to maritime uses and activities in different ways. Oceanographic conditions can define natural potential or even constraints for a number of maritime uses and activities. The oceanographic natural potential is highly relevant to the maritime renewable energy sector, including wind, wave and current conditions. Further, oceanographic conditions can also present limiting factors for different maritime activities and sectors. E.g., sea depth can restrict offshore wind farm distribution, as the bathymetry threshold is defined by technology and economic sustainability. Regarding aquaculture, sea water temperature is a limiting factor for the selection of the species to be cultured. Rough oceanographic conditions can make it difficult, expensive, and increase the risk of accidents within the maintenance of facilities at sea (aquaculture, offshore wind, wave energy, etc.) during the operation phase.

By monitoring the oceanographic conditions, the local climate can be understood, and parameter variations and current trends identified. Oceanographic conditions are relevant for understanding how current climate change is affecting the MSP, including modification of the natural potential or even limiting factors.

[10] https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-17
[11] https://www.eea.europa.eu/data-and-maps/data/natura-13
[12] https://natura2000.eea.europa.eu/

3.3.2. Cluster structure & checklist

Several frameworks have been identified as useful to structure the oceanographic conditions and climatic data cluster:

- Essential Ocean Variables
- EMODnet Physics parameters
- Copernicus Ocean Monitoring Indicators

These frameworks can be used as a checklist for the identification and incorporation of the Oceanographic characteristics and Climate Data Framework that needs to be considered within the MSP data collection, assessment and evaluation. Within the analysis any of three proposed frameworks could be used:

3.3.2.1. Essential Ocean Variables

This framework is designed by the Global Ocean Observing System (GOOS) to approach ocean observations with a focus on Essential Ocean Variables (EOV), ensuring assessments that cut across platforms and recommend the best, most cost-effective plan to provide an optimal global view for each EOV. EOVs are identified by the GOOS Expert Panels, based on the criteria shown in Figure 10.

Essential Ocean Variables by GOOS	Data cluster 3
Physics:	
– Sea state, – Ocean surface stress – **Sea surface height** – **Temperature** – **Currents** – **Salinity**	
Biochemistry*:	
– Oxygen – Nutrients – **Inorganic carbon** – **Transient tracers** – **Particulate matter** – **Nitrus oxide** – **Stable carbon isotopes** – **Dissolved organic carbon**	
Biology and Ecosystems*:	
– Phytoplankton biomass and diversity – Zooplankton biomass and diversity – **Fish abundance and distribution** – **Marine turtles, birds, mammal abundance and distribution** – **Hard coral cover and composition** – **Seagrass cover and composition** – **Macroalgal canopy cover and composition** – **Mangrove cover and composition** – **Microbe biomass and diversity (*emerging)** – **Invertebrate abundance and distribution (*emerging)**	

Cross-disciplinary (including human impact)*:
– Ocean colour – Marine debris – **Ocean sound**
* Occurs overlapping with marine and coastal environment cluster.

Figure 10. Essential Ocean Variables by GOOS, one of the possible checklists for the Oceanographic characteristics and Climate cluster. ECV are overlapping with checklist for the marine and coastal environment.

The EOV framework has significant overlaps with the Marine environment data cluster (Biology and Ecosystems, Cross-disciplinary parameters). The frameworks provided by EMODnet Physics portal and Copernicus are also suitable for listing the oceanographic and climatic parameters that should be incorporated into the data collection or assessments for the MSP process.

3.3.2.2. EMODnet Physics parameters

The available parameters cover temperature, salinity and currents profiles, sea level trends, wave height and period, wind speed and direction, water turbidity (light attenuation), underwater noise, river flow, and sea-ice coverage (see Figure 11). Products and data are available on EMODnet central portal[13].

Data cluster 3 EMODnet Physics parameters
Physics:
– Waves – Water Temperature – Water Salinity – **Currents** – **Optical Properties** – **Sea Level** – **Atmospheric Pressure** – **Winds** – **Water conductivity / BioGeoChemical**
Bathymetry

Figure 11. EMODnet Physics parameters, possible checklist for oceanographic parameters and analysing climate change in the scope of the MSP.

3.3.2.3. Copernicus Ocean Monitoring Indicators

Copernicus Marine Service structures Ocean Monitoring Indicators[14] into four main classes: Ocean circulation, Ocean Climate, Ocean Variability and Extremes, and Ocean Health. Each of the classes includes defined key variables (parameters) that can be used to track the vital health signs of the ocean and changes in line with climate change (Figure 12).

[13] https://emodnet.ec.europa.eu

[14] https://marine.copernicus.eu/access-data/ocean-monitoring-indicators

Data cluster 3 **Copernicus Ocean Monitoring Indicators**
Ocean Circulation:
– Ocean Heat Transport – Ocean volume transport – **Boundary currents** – **Wind driven circulation** – **Ocean gyres & Upwelling** – **Meridional Overturning Circulation**
Ocean Climate:
– Sea Water Temperature – Ocean carbon uptake – **Ocean freshwater** – **Ocean heat uptake** – **Sea ice change** – **Sea level rise**
Ocean Variability & Extremes:
– Climate Variability – Cold spells – **Extreme Sea level** – **Marine Heat Waves** – **Storm & Cyclone potential** – **Sea State**
Ocean Health:
– Chlorophyll & primary production – Ocean acidification – **Ocean deoxygenation** – **Eutrophication & bloom** – **Oligotrophication** – **Coral health**

Figure 12. Copernicus Ocean Monitoring Indicators, possible checklist for oceanographic parameters and analysing ocean climate variability and health in the scope of the MSP.

3.3.3. Digital Resources

The **Data Specification on Oceanographic Geographical Features**[15] **provided by INSPIRE** is a complex data model, based on the **Observation and Measurements framework**[16]. It covers physical and chemical characteristics of the sea, i.e., properties such as sea surface temperature or salinity. This type of information is typically presented as a set of point data, e.g., temperature observations from a fixed monitoring station, or as gridded data, e.g., wave height observations from a satellite. This data model is applicable for point and gridded data, and other more complex observations that are common in oceanography, such as vertical profiles through the ocean depths or trajectories along the ocean surface.

[15] https://inspire.ec.europa.eu/Themes/143/2892

[16] ISO 19156 Observations and Measurements standard for consistent encoding of observation-related metadata.

The second data model that should be considered is the **INSPIRE data model on Sea Regions**, that is simpler in structure and less complex to apply. This data model is appropriate for aggregated data and more suitable for the MSP process. It provides a generic framework for describing subdivisions and aggregation of seas according to physical or chemical properties. For example, areas of sea according to their mean temperature, or areas with similar hydrodynamic characteristics. The Sea Regions theme also provides mechanisms to describe areas of seabed or sea surface e.g., oil spills, or sea ice.

One of the most important umbrella catalogues for ocean and marine data management, including resources, is the **Sea Data Net** pan-European data infrastructure. This data initiative includes and facilitates easy to look up vocabularies, based on the British Observation Data Centre web services, incorporating oceanographic parameter terms for improving ocean observation semantics.

3.3.4. Possible data sources

European Exclusive Economic Zones (EEZs) are very well covered by the harmonised **Copernicus Marine Environment Monitoring Service (CMEMS)**, including available products on ocean variables. The CMEMS provides time series raster products in Network Common Data Form (NetCDF). Raster time series are data sets that can define trends and possible changes of oceanographic conditions and climate change (see Figures 13 and 14). Still, if we want to analyse natural potential or limiting factors within the area of planning, it can be difficult to manage a 20-year raster time series. For an easier analysis and assessment of the oceanographic conditions, it is recommended to develop raster data with basic statistics such as arithmetical mean, maximum, minimum, and percentiles (10 to 90) values. In this way, the information contained in large time series is statistically summarised into one single or a manageable number of raster files. The spatial information in this way is more manageable and easier to apply within the assessments of the current plans.

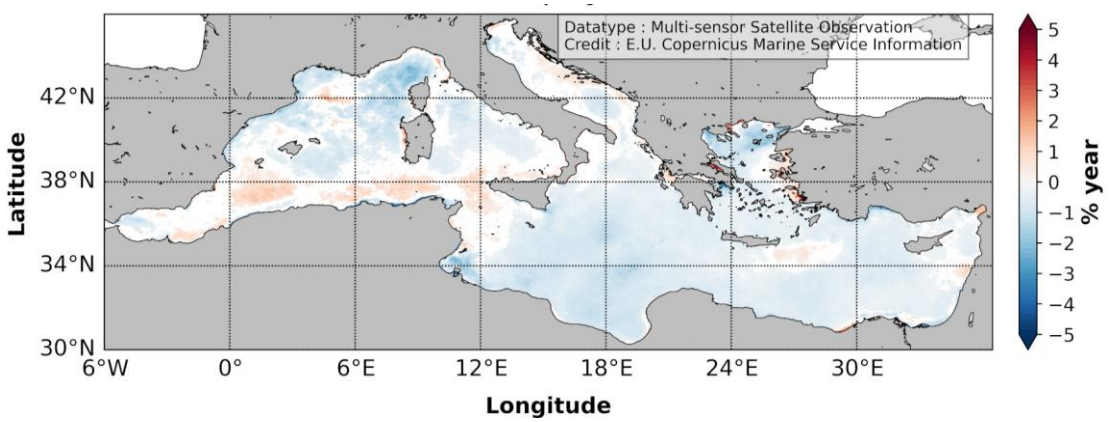


Figure 13. Chlorophyll *a* trend, product delivered by Copernicus Marine Service

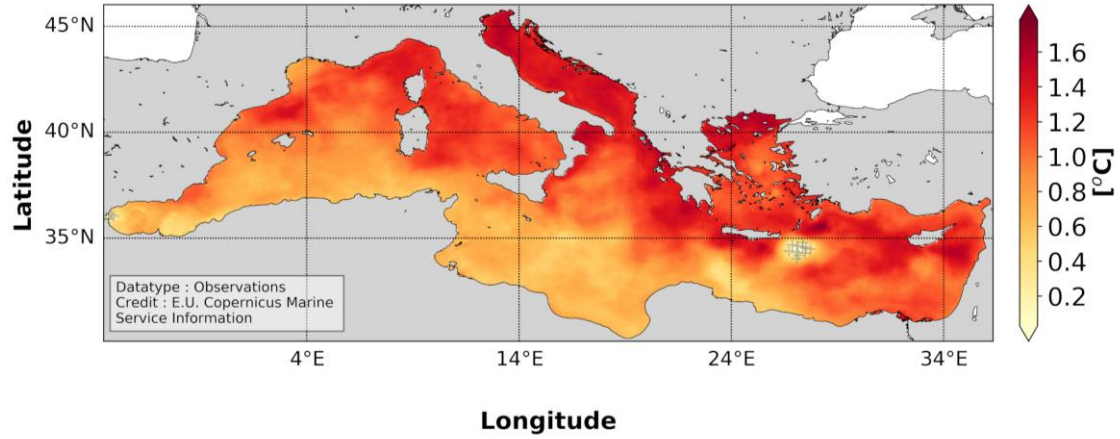


Figure 14. Sea Surface Temperature cumulative trend, product delivered by Copernicus Marine Service.

EMODnet Physics is one of the seven domain-specific projects of the **European Marine Observation and Data Network (EMODnet)** program. In situ data recorded by fixed platforms (moorings, tide gauges, HF radars, etc.), moving platforms (ARGO, Lagrangian buoys, ferryboxes, etc.) and repeated observations (CTDs, etc.) are available. An example is shown in Figure 15. The available data products are data collections, reanalysis and trends of parameters, space and time aggregated *in situ* data and model outputs.

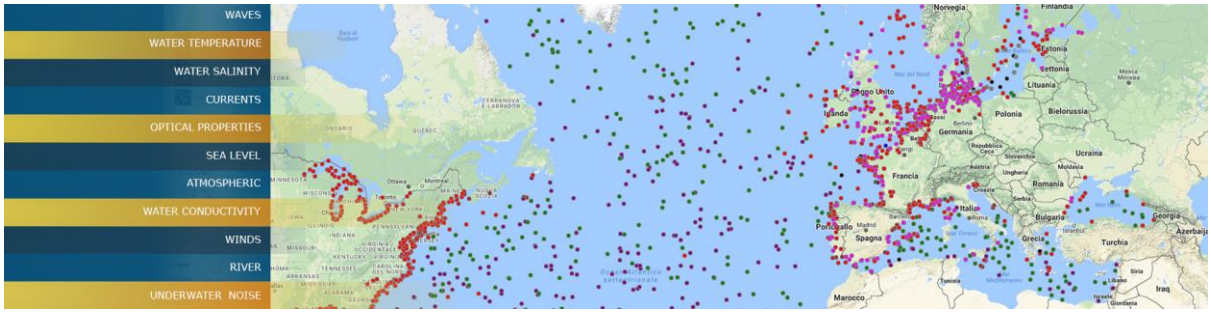
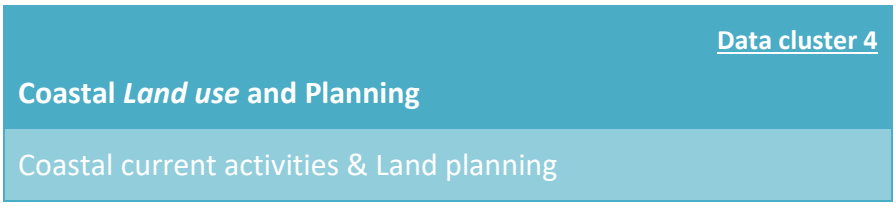


Figure 15. EMODnet Physics, in situ data from operational platforms and research projects. EMODnet Physics collection of in situ data (time-series, profiles and datasets) as recorded by platforms (tide gauge, operational oceanographic buoys, CTDs, etc.). It integrates data from major marine and oceanographic initiatives and data repositories as EuroGOOS ROOS, SeaDataNet NODCs, ICES, PANAGAEA, etc.

3.4. Coastal *Land use* and Planning



3.4.1. Cluster description

Within the process of MSP, it is key to deliver land-sea interaction analysis, a review of potential conflicts, and synergies between maritime sectors and coastal human activities. This type of study requires data collection of coastal land use (anthropogenic activities within the coastal belt). Thus, it is necessary to understand and consider the distribution of the current operative activities, but also the planned activities in the coastal areas, as these can have significant links and effects on maritime sector distribution. Coastal land use and planning (e.g., coastal zone management plans) need to be considered and integrated within the MSP process.

For *Land use* data, classification systems for describing human activities and uses, applying categories and levels in a nested hierarchy, are commonly used and already standardised. The most general or aggregated classification includes broad land-use categories (such as 'agriculture' or 'urban and built-up') and when increasing the level, it is provided higher level of land-use classification (e.g., 'agriculture/crops/rice' or 'urban and built-up/urbanised area/residential use').

A good example is the **Hierarchical INSPIRE Classification Land Use System (HILUCS)**. It applies nested hierarchies, providing a broad to specific classification. It is managed with the INSPIRE registry[17] and given as a closed (non-extendable) code list of human activities.

3.4.2. Cluster structure & checklist

The data cluster on Coastal Land use and planning is structured following the **Hierarchical INSPIRE Classification Land Use System (HILUCS)** and divides Land use and planning into the six main classes: **Primary production** - Areas where the manufacturing industries process the primary products; **Secondary production** - Industrial and manufacturing activities which take the output of the primary sector; **Tertiary production** - Services that are products for other businesses and consumers both private and public services; **Transport network logistics and utilities -** Basic infrastructure and networks of the society; **Residential use** - Areas used predominantly for housing of people; **Other uses** - areas not included in the previous five categories. The HILUCS register provides a comprehensive checklist of the potential coastal sectors and uses that should be considered in the MSP process. Additionally, for operative coastal sectors, it is necessary to consider plans within the coastal areas, Integrated Coastal Zone Management initiatives to incorporate currently non-operative but planned land use.

[17] https://inspire.ec.europa.eu/codelist/HILUCSValue

Data cluster 4
Coastal Land use & Planning
Coastal current and planned Land use following **Hierarchical INSPIRE Land Use Classification System*:**
– **Primary production** – **Secondary production** – **Tertiary production** – **Transport networks logistics and utilities** – **Residential use** – **Other uses**
* **https://inspire.ec.europa.eu/codelist/HILUCSValue**

Figure 16. Coastal Land use & Planning cluster structure and checklist, following the HILUCS.

3.4.3. Digital Resources

Land use is a territory classified according to its current and future planned functional dimension or socio-economic purpose. Land use INSPIRE theme is split into two different types: existing Land use and planned Land use. For mapping existing activities, INSPIRE includes ***Land Use*** **data model** (see class diagram in Figure 17), and for spatial plans ***Planned Land use*** **data model** (see class diagram in Figure 18), available within the data specification, and all related resources on INSPIRE geoportal: https://inspire.ec.europa.eu/Themes/129/2892

Both data models use the HILUCS code list, land use classifications system. The use of the HILUCS is regulated with INSPIRE Directive 2007/2/EC and related regulations on interoperability of the spatial data sets. HILUCS is highly recommended for the codification of the coastal uses as it is interoperable with the classification system applied in the recommended models for MSP[18]: MSP INSPIRE data model and EMODnet MSP model.

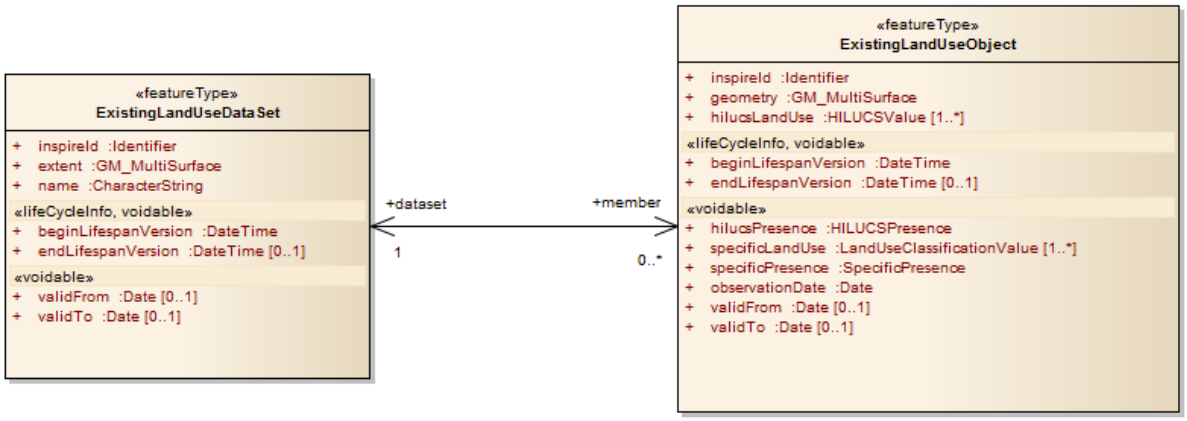


Figure 17. INSPIRE Existing Land Use: Class diagram https://inspire.ec.europa.eu

[18] https://maritime-spatial-planning.ec.europa.eu/sites/default/files/hz0121216enn.en .pdf

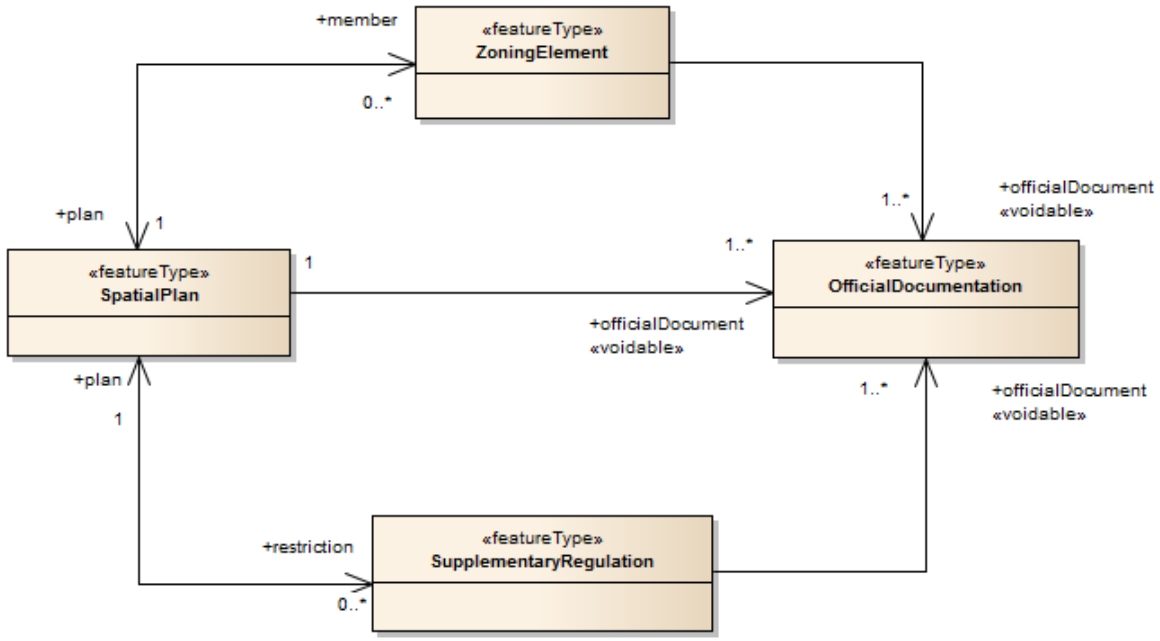


Figure 18. INSPIRE Planned Land Use Overview: Feature class diagram, https://inspire.ec.europa.eu

3.4.4. Possible data sources

For the purpose of collecting information on coastal activities, the **European Land Cover CORINE data set**, based on photo interpretation, is suitable and can be used as a Land use proxy. The importance is that CORINE products cover the whole of Europe and provide harmonised data sets for related coastal areas. CORINE products' time series are available at Copernicus Land Monitoring Service from 1990, with the last updated version in 2018. An example is shown in Figure 19. When higher precision on the coastal activities is necessary, it is possible to combine CORINE data sets with local and regional Land use products.

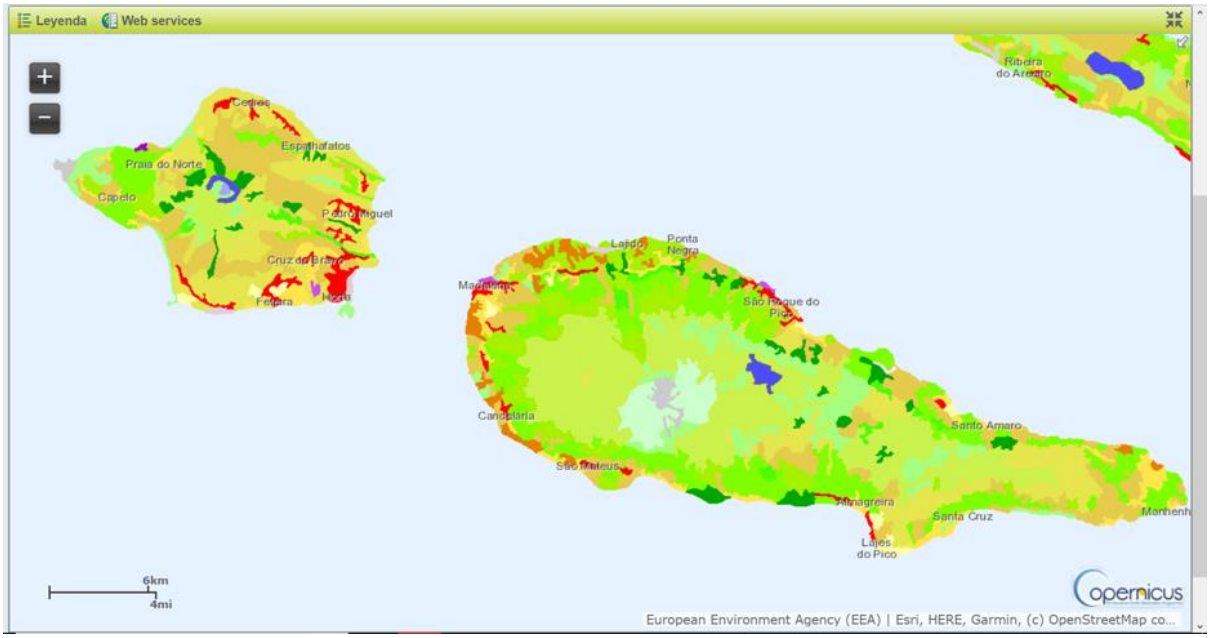


Figure 19. Harmonised data set on EU Land cover CORINE, including the Azores islands Faial and Pico.

3.5. Operative maritime activities and Maritime Spatial Planning

Data cluster 5
Operative maritime activities and Planning
Maritime current uses and maritime Spatial Planning

3.5.1. Cluster description

To understand the current distribution of the maritime sectors it is necessary to **collect spatial data on human activities within the marine areas that are included in the planning area**. Data on the distribution of the fisheries, maritime transport, nautical activities, aquaculture, renewable energy, mineral extraction, maritime tourism, etc., are necessary to assess potential spatial conflicts, but also synergies between maritime and coastal sectors. Data on the distribution of maritime activities and uses are a base point to understand the need for spatial planning, managing conflicts and applying possible multi-use and co-use solutions.

Beyond data on operative maritime activities, within this cluster, we need to consider the spatial data on maritime planning, zoning of marine areas and other possible designated types of maritime sector distribution.

3.5.2. Cluster structure & checklist

The land use INSPIRE code list - HILUCS has been extended to cover MSP specific features such as for example, submarine outfalls, underwater cultural heritage, designated areas for specific types of nautical sports, or designated areas for a specific type of offshore energy. The required developments for the extension of the HILUCS codelist have been undertaken as part of MarSP project within the development of the MSP INSPIRE data model.

As a result, the Extended HILUCS code list for maritime uses and activities[19] is an open code list (available for further extension) developed for detailed mapping of maritime uses and activities. It is publicly available on the registry, hosted and managed by ECOAQUA University Institute at the ULPGC. This register is based on the INSPIRE HILUCS code list, with extension of specific classes required for the maritime uses.

Like the Cluster on Coastal Land use, the Operative maritime activities cluster is structured following the HILUCS and divides marine uses into five main (excluding Residential use) classes: **Primary production**, **Secondary production**, **Tertiary production**, **Transport networks logistics and utilities,** and **Other uses** (see Figure 20).

[19] Extended HILUCS code list for maritime activities
http://www.geoportal.ulpgc.es/registro/plannedLandUse/HilucsExt/index.html

Data cluster 5
Operative maritime activities and Planning
Maritime current & planned uses following **Extended Hierarchical INSPIRE Land Use Classification System** **for maritime activities & MSP*:**
– **Primary production** – **Secondary production** – **Tertiary production** – **Transport networks logistics and utilities** – **Other uses**
* http://www.geoportal.ulpgc.es/registro/plannedLandUse/HilucsExt

Figure 20. Operative maritime activities & Planning cluster structure and checklist, following the extended HILUCS for maritime activities & MSP.

3.5.3. Digital Resources

INSPIRE provides two data models applicable within the marine use and planning, *Land use* and *Planned Land use*[20]. Both models were extended for describing current maritime activities and planning applied with ***Basemaps***[21]***, MSP INSPIRE data model***[22]*, and* ***EMODnet MSP model*** (hybrid model). Use of any of these three technical solutions is recommended by the TEG[23], to **facilitate the development of the EU harmonised MSP Data layer**, hosted by the EMODNet Human Activities.

Previously mentioned as a checklist, the Extended HILUCS code list is a digital resource that provides the possibility to map maritime activities with necessary levels of detail.

3.5.4. Possible data sources

Spatial data on operative maritime uses and activities should be collected from the **local, and regional data providers**, as they usually include the most updated and precise information. Still, within the data collection should be considered **EMODnet Human Activities products**[24], as they provide harmonized distribution of maritime sectors within the EU seas.

[20] INSPIRE Land use https://inspire.ec.europa.eu/Themes/129/2892
[21] Guidelines on transboundary MSP output data structure in the Baltic Sea
[22] MSP INSPIRE model data specification V2.0
[23] Proposal for making harmonized MSP plan data available across Europe
[24] https://emodnet.ec.europa.eu/en/human-activities

3.6. Socio-economic information

Data cluster 6
Socio-economic information
Socio-demographic and Economic data

3.6.1. Cluster description

The application of an ecosystem-based approach within the MSP process contributes to finding the balance between the conservation of the marine environment and the use of the marine and coastal resources, while promoting the sustainable development and growth of the marine and coastal economies, as presented within the Integrated Maritime Policy for the European Union and in the Directive 2014/89/EU establishing a framework for maritime spatial planning. It is necessary to understand the needs for development of the maritime sectors and identify how to incorporate the environmental trade-offs in the MSP equation.

Information on the coastal population, unemployment, number of jobs and income of current and planned coastal and maritime sectors, is necessary and needs to be understood prior to the planning process. Further, the same type of information should be monitored once the plans are operational, serving the identification of trends in employment, maritime/coastal sectors development and related income.

3.6.2. Cluster structure & checklist

To clarify what is meant by **socio-economic information for MSP**, Figure 21 shows a framework that breaks down the categories and interactions between different types of socio-economic data. Socio-economic data can be divided into two main categories, **socio-demographic data** and **economic data**. Economic data is then further divided between **coastal economic data** and **ocean economic data**. Within this framework, coastal economic data includes data on all economic activity within the coastal zone, whereas ocean economic data includes data on economic activity that uses the ocean as input or output, either directly or indirectly[25]. Businesses can either operate only in the coastal economy or in the ocean economy, or both. In terms of overlap between both ocean and coastal economic data and socio-demographic data, employment is the main data sub-category that cross cuts all types of socio-economic data.

The main economic data that is required for the measurement of the ocean and coastal economies were identified by Colgan (2013) as the number of businesses/establishments; employment; wages/income; and contribution to Gross Domestic Product (GDP).

[25] A more formal definition by Norton et al. 2022 defines the differences between the ocean economy and coastal economy as follows “The ocean economy is defined as any economic activity that directly or indirectly uses the sea as an input or produces an output for use in a sea-specific activity. The coastal economy, on the other hand, represents all economic activity that takes place in the coastal region, which is not necessarily part of the ocean economy.” http://hdl.handle.net/10793/1807

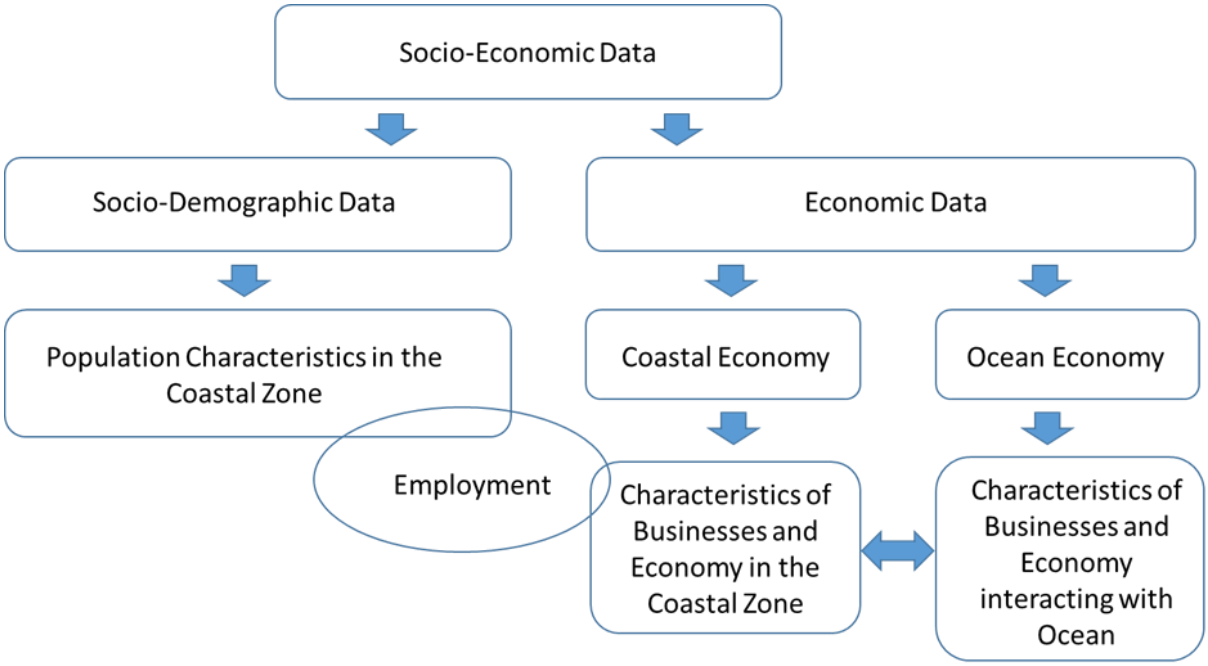


Figure 21. Framework for Marine Spatial Planning Socio-Economic Data.

The checklist for the socio-economic information cluster is simplified, and includes two basic classes of information: socio-demographic, where we need to check for the relevant population characteristics (starting with human population, the most basic category), and economic information that is divided in coastal and ocean economy, referring to the information on jobs and income, related to each sector (see Figure 22).

Data on economic activity in the EU is categorised using a hierarchical classification system known as NACE (Nomenclature of Economic Activities). It classifies economic activities and products to a 4-digit code that allows economics to be aggregated and subdivided into a hierarchical structure with four levels.

While this system is useful, due to confidentiality purposes and when combined with smaller spatial scales, this data may not be available to the class level below national spatial scale. Additionally, some classes may not be wholly marine, and some further work may be required to ascertain the marine proportion of the class. Notwithstanding these issues, the EC in 2022[26] identified a list of NACE codes with wholly or significant marine proportions that it uses in measuring the ocean economies of EU member states.

Data cluster 6 **Socio-economic information**
Socio-demographic:
– Population characteristics
Economic information:
– Coastal & Ocean economy – Coastal & Maritime sectors **jobs & income**

Figure 22. Socio-economic cluster structure, and checklist.

[26] https://data.europa.eu/doi/10.2771/793264

3.6.3. Digital Resources

The application of socio-economic data to the MSP process requires the availability of such data in a spatial format. The best comparable and coherent classification for the incorporation of socio-economic spatial data is through use of the EU NUTS classification (Nomenclature of territorial units for statistics), which divides the administrative and economic territory of the EU (EU, 2022[27]).

This multi-level hierarchical classification allows for the breakdown of EU member states into spatial units for the production of regional statistics, including socio-economic data. As the nested spatial units get smaller, they are associated with lesser amounts of data. NUTS 0 is member state level and is associated with the most data and information while NUTS 3 level is associated with limited data. There are also smaller spatial units below NUTS3 called Local Administrative Units (LAUs) with very limited socio-demographic information and practically no economic data.

Data on economic activity in the EU is categorised using a hierarchical classification system, similar to the HIUCS, known as NACE (Nomenclature of Economic Activities) code. It classifies economic activities and products to a 4-digit code that allows economics to be aggregated and subdivided into a hierarchical structure with four levels.

3.6.4. Possible data sources

Once the coastal regions have been identified there is a requirement to source coherent datasets for socio-demographic and economic data across EU regions. There is a trade off in this type of data between scale and detail, with more detail available particularly for economic data at larger NUTS scale (NUTS2 and NUTS3) as compared to LAU level. There is also a trade off with the amount of data available at different level NACE codes with less data available at class level compared to section or division level.

Within the **ocean economy data**, for many sectors it may be difficult to source data below national level, depending on the size of sectors and the spatial area required. For example, tourism sectors (e.g. food and accommodation) are large enough to have data at sub national level and will be provided by **Eurostat** through Structural Business Statistics data by NUTS 2 regions and NACE code. At the national scale the EU Blue Economy Reporting provides more detailed data on marine related economic sectors based on aggregation and attribution of NACE code activities for turnover, GVA and employment.

The lack of suitable ocean economic data or more detailed socio-economic data at local scale for marine spatial planning is a major challenge and highlights the need for any socio-economic data, especially economic data, to be considered in conjunction with the other data types when making decisions related to marine spatial planning at local scale.

For the **coastal economy**, it may be easier to access data within a coastal NUTS region. For example, GDP estimates are available through Eurostat at NUTS 3 level and this is also the case for employment data. Details on wages/income and the total number of businesses with some breakdown by NACE code are available at NUTS 2 level through Eurostat.

Eurostat also provides socio-demographic data as noted above at NUTS 3 scale with data at LAU scale available for a limited number of variables available through CensusHub2.

[27] DOI: 10.2785/321792

3.7. Governance information

Data cluster 7
Governance information
Competence & Legislation

3.7.1. Cluster description, related structure & checklist

The incorporation of the Governance information cluster is key as it includes the information and data of two key elements.

The first component is related to the need to understand and consider within the MSP process the **competences distribution of the different levels of the public administration within the area of planning**. This component of the cluster provides understanding of which administration has the competence for the different areas on the sea, including the coastal zone. EEZ and Continental shelf usually have a national competence (e.g., Ministry of Maritime Affairs), but Territorial waters or/and Internal waters can be administered by departments of the local or regional governments. In particular, within the planning, monitoring and evaluation process, it is relevant to have information on the competences distribution of the various maritime sectors and uses including fisheries, energy, maritime transport, but also connected coastal sectors and uses, primarily ports and terrestrial transport, but also other including recreational use.

The second component of the Governance cluster refers to **the varied regulation that applies to the area of planning, including the marine, but also coastal areas**. We should consider the incorporation of the current regional, national and international regulation that applies to the marine and coastal areas. Regulation that applies to the planning area needs to be considered, as it can support but also constrain the planning process and implementation. It should also be taken into account if two or more policies that apply in the same area can have synergies or incompatibilities, e.g., in the assessment process. The implementation of the environmental laws and the EU directives such as the MSFD can support the ecosystem approach with the MSP process. However, the environmental policies, such as those related to the conservation of marine birds or habitats, need to be taken into account as they can incorporate limits to the development of the maritime sectors in certain areas. It is necessary to consider this aspect and identify the potential compatibilities can support the planning process.

Data cluster 7
Governance information
Administrative competence:
– Area of planning – Maritime activities – **Coastal Activities**
(Inter)national regulations:
– Conventions – Legislation – **Policies**

Figure 23. Governance cluster structure and checklist.

The checklist for the Governance information cluster (shown in Figure 23) needs to consider which administrations have the competences for the area of planning - including internal waters, territorial sea, contiguous zone, EEZ and continental shelf. Further it is necessary to consider the

administrative competence of the maritime and coastal sectors, previously identified as relevant sectors for MSP within the clusters four (Coastal Land use and Planning) and five (Operative maritime activities and Maritime Spatial Planning).

The second component of the cluster recommends considering within the MSP process the international conventions such as the United Nations Convention on the Law of the Sea (UNCLOS), or the International Convention on Maritime Search and Rescue (SAR Convention) that apply to the planned area. Further, it is necessary to check and consider national and international legislation that applies to the sea and coastal areas, starting with environmental directives introduced in the national laws. Furthermore, it is necessary to consider any national and international policy that applies to the planning areas that could support (or complicate) the planning process.

3.7.2. Digital Resources

INSPIRE includes two data models that can be considered for storing the governance information. The first one is included in the ***Administration Units*** **theme**, which includes the specified ***Maritime Units*** **data model**.

Still, the ***Area Management Restriction and Regulation Zones*** **data model** (Figure 24) includes ready to use attributes to describe the type of legislation that applies, the competent authority and related area extensions.

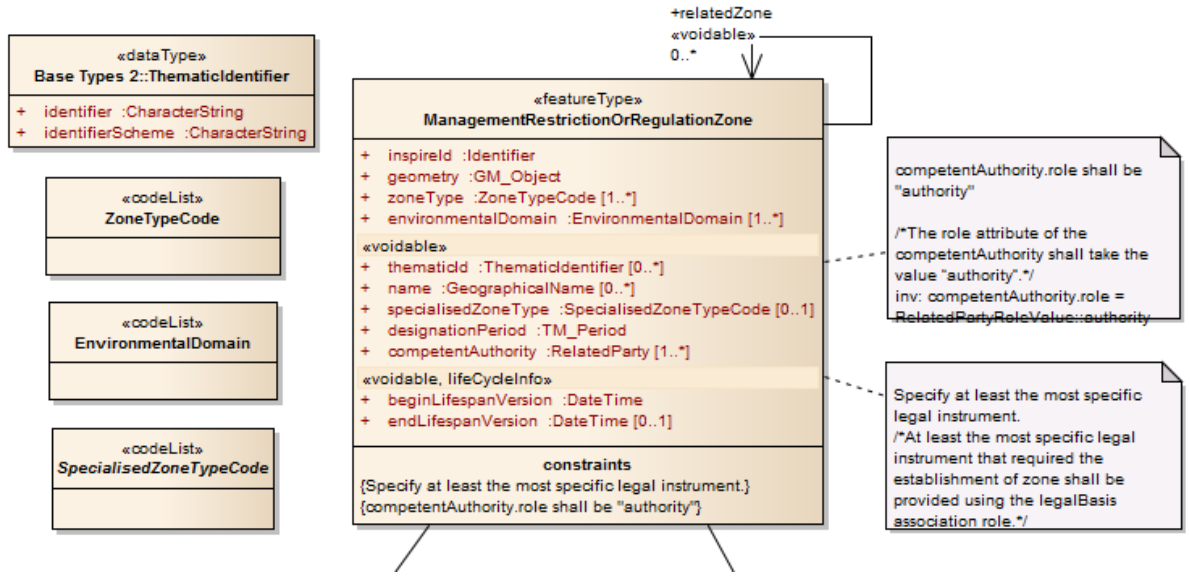


Figure 24. INSPIRE Area Management Restriction and Regulation Zones data model.

3.7.3. Possible data sources

For now, there are no digital portals that dedicate specific effort to the incorporation of spatial data related to the national or international legislation and competences distribution. Nevertheless, a number of maritime/marine geo-portals include information on the areas that are under the UNCLOS (United Nations Convention on the Law of the Sea) or specific EU environmental directives.

4. CONCLUSIONS

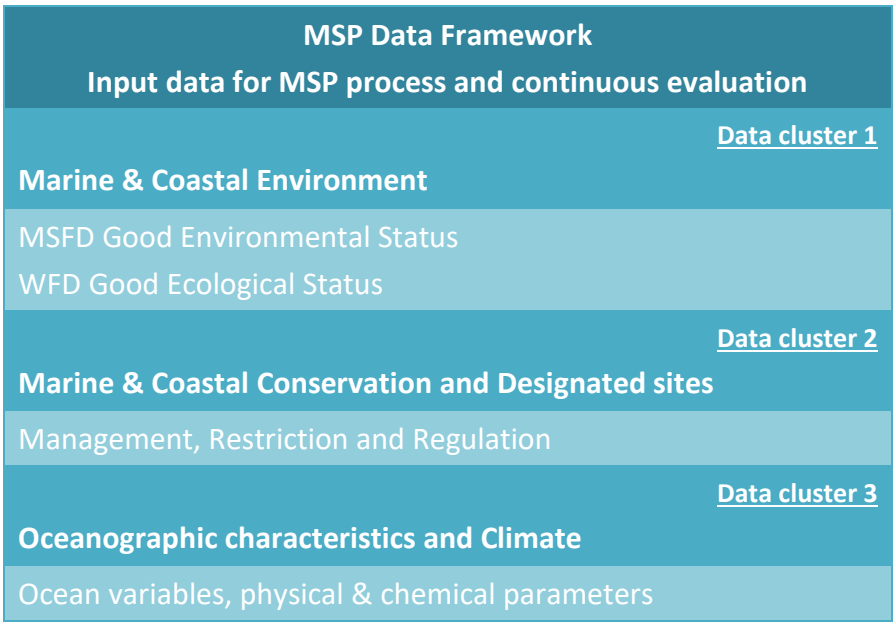
The MSPdF development was initiated in 2017, mainly to facilitate and structure data collection with the cross-border MSP project in EU Macaronesia (PLASMAR 2017-2020). As data was required for the three different archipelagos (Azores, Madeira and Canary Islands), collected by three different partners and regions in two Member States, as a parallel process and in a harmonised way, it was decided to develop a structured framework. The common structure made it possible to understand what type of required data is available and what is missing for each region and area. Thus, it was possible to compare data collections within three archipelagos and assess MSP "input" data availability. Added to this, it was possible to assess the zoning exercise results, delivered for the three archipelagos with the same tools, applying the same methodology, but with different data availability.

The MSPdF became a TEG topic of interest at the end of 2021. A specific sub-group was established for the analysis of the national and MSP project data collections. An iterative process was developed for the improvement of the framework, as the means for integrating any relevant parameters for the MSP process.

An initial version of the MSPdF, as described in this report, had five clusters that included the topics of marine environment, conservation, oceanography, coastal and maritime uses, to which two *new* clusters were added, socioeconomic and governance topics. Structuring the *new* clusters was an innovative work which was not straightforward, as the MSP community (both, data experts and planners) do not have broad experience with these topics. The socioeconomic and governance clusters were structured and modelled with a focus on basic issues such as income, jobs, competence and legislation. Further development of these two clusters is expected within the next phase of the EU MSP process, providing a more detailed structure and the inclusion of additional issues in order to better describe and incorporate these topics.

Further, an additional coastal (land) component was included within the framework, incorporating the status of the coastal environment and the location of the coastal protected areas. Climate change is addressed within the oceanography cluster, since it is possible to analyse and assess it with oceanographic time series information.

In the present version of the MSPdF (shown in Figure 25), each data cluster includes a list of parameters, or even topics, in the form of a checklist, which should be considered (but are not necessarily relevant) for each MSP process. Within the MSPdF, an innovative checklist is developed that users can follow to identify the spatial information that should be considered and, next, assess the relevance for each specific MSP use-case.



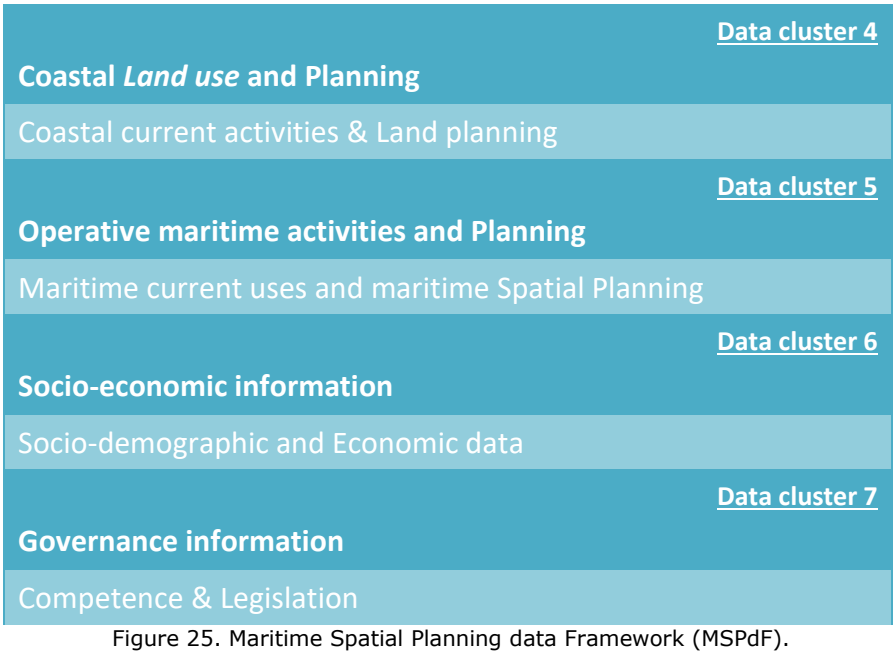


Figure 25. Maritime Spatial Planning data Framework (MSPdF).

MSPdF is not only valuable for structuring data collection processes, but also for the following MSP evaluation and monitoring process. The framework facilitates users to go through each cluster and identify the type of information relevant for a specific planning process, assessing the data collection of the plan. In this way, it is possible to identify spatial information relevant and available, even though it might not have been used within the planning or zoning exercise. This provides the opportunity to include available information, not considered in the planning, but applied in the following steps of monitoring and evaluation (e.g., unconsidered temperature trends due the climate change, available by Copernicus program).

The framework is indexing potentially relevant parameters for decision making and planning. Thus, it is possible to compare and assess data collections related to different plans.

Further, by following the checklists (structure of each cluster) it is possible to identify relevant data gaps, as well as spatial information not included in the planning process. These can provide valuable results, as they serve for the identification of the type of surveys required for the following phase of the MSP process.

Finally, the development of the MSPdF is the first step in the harmonisation of the MSP input data, identifying and structuring relevant spatial information required for the planning process.

5. RECOMMENDATIONS

The development and resulting MSPdF has been presented within this document. The recommended use is explained in the following sections.

5.1.1. MSP data collection process

The MSPdF includes a proposal of the checklists to be followed during the MSP data collection process. The framework lists the potential data required to describe initial conditions of the planning area, spatial information to deliver analyses, and facts required for the knowledge-based decision-making during the MSP process. This framework could be used when the data collection process is initiated or can also be applied in a later phase of development. In this way, it can be a means to consider all parameters included in the seven cluster checklists, if they are relevant for the MSP process, and the need to include them in the data collection for required analyses and decision making.

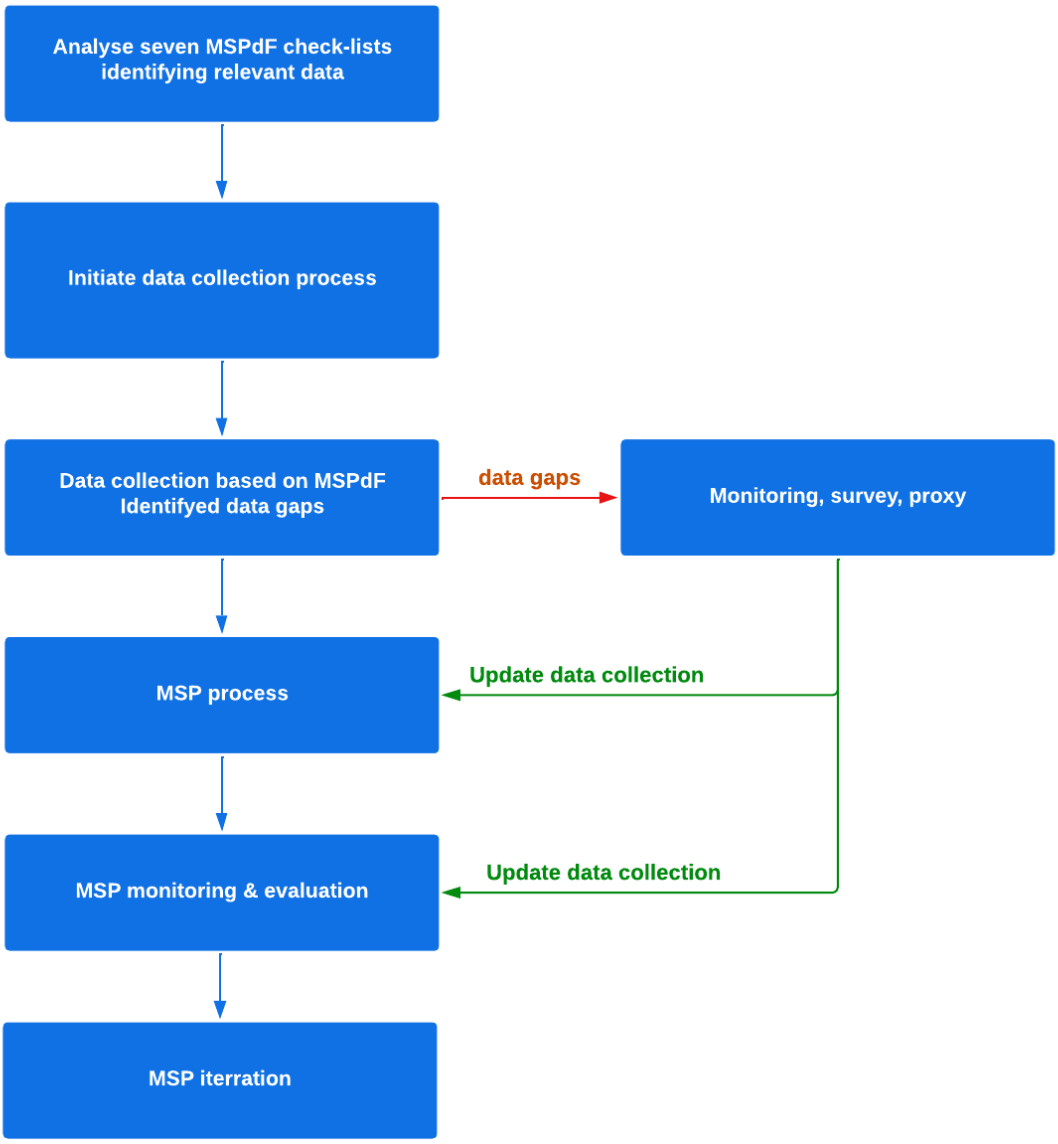


Figure 26. Flow diagram to be applied for the application of the MSPdF to the MSP data collection process.

Following the data framework makes the identification of data gaps possible. This missing information can then be programmed for future monitoring, survey or proxy identification. In this

way, data collection can be updated for the monitoring and evaluation phase, or even during the development of the MSP.

5.1.2. MSP monitoring & evaluation process

The MSP data framework checklists can be followed during the monitoring and evaluation process of the already operative MSP process, as shown in Figure 27. The framework lists potential data and spatial information which, if relevant, should be collected and analysed during the monitoring process, to evaluate the operational MSP plan.

By going through the seven check lists, it is possible to identify data that is relevant for the development of the MSP process but was not considered in the development process. In this way, identified data sets could be included in the monitoring and evaluation process, and following iteration of the MSP plan.

Identified data gaps should be programmed for monitoring, survey or proxy identification, so that they can be used within the evaluation of the operative MSP and included in the updated MSP.

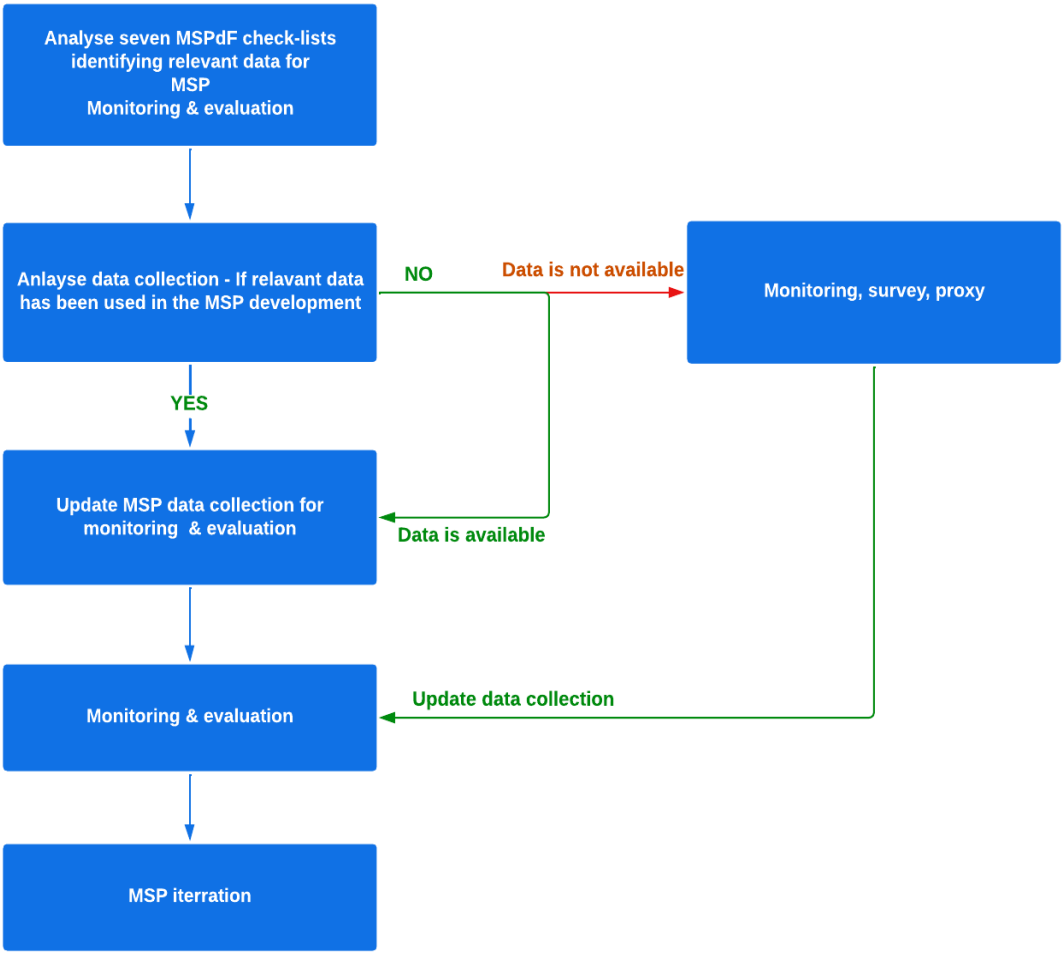


Figure 27. Flow diagram to be applied for the application of the MSPdF to the MSP monitoring and evaluation process.

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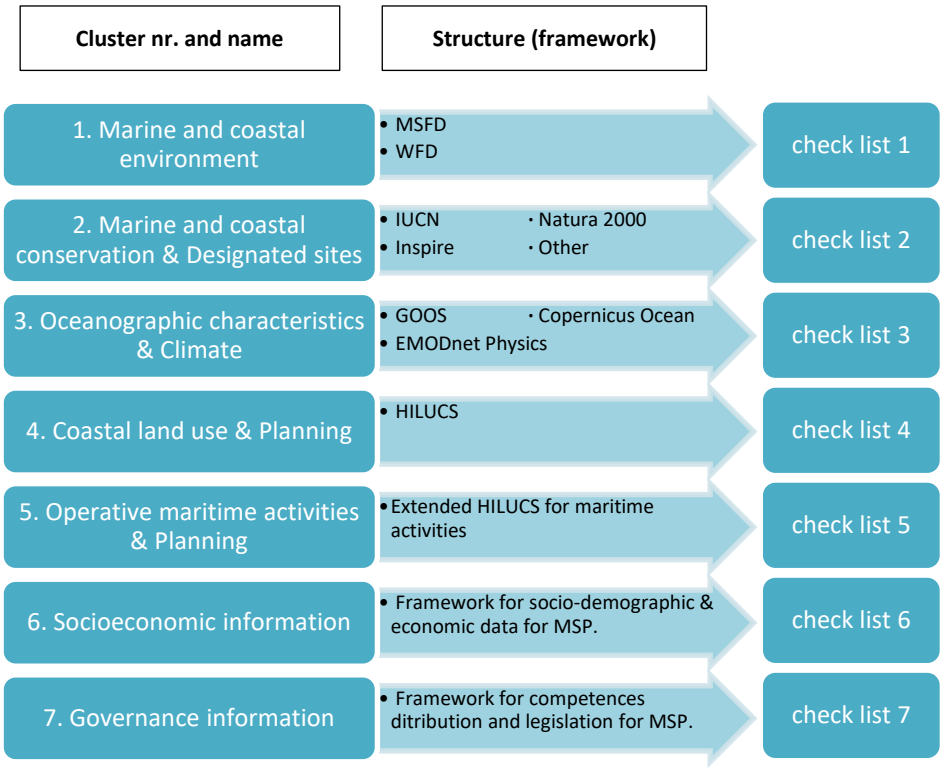
Survey Link for Annex
https://drive.google.com/file/d/1hm7u-gZJOCUiWmcBijzSbFduWy3xhjbV/view?usp=sharing

7. ANNEX 1.



The MSP data framework is based on seven selected thematic data clusters which serve to structure data and incorporate the main issues relevant to each of these clusters, as summarised in Table 1. Specific checklists for each data cluster have been created after sorting and arranging those main issues.

Table 2 presents a summary of the main available digital resources (such as data models) and data sources at the European scale, for each of the seven data clusters. More detailed information and data sources available at the national, regional and local scales in the case of each MSP planning area are to be identified in order to incorporate them into the MSP process.

Table 1. Summary of the seven thematic clusters that are part of the MSPdF, and detail of the frameworks and issues incorporated in each of them.

CLUSTER NR. AND NAME	Structure (selected frameworks)	Potential topics / parameters incorporated
1. Marine and coastal environment	- MSFD - WFD	- GES quality descriptors: 1. Biological Diversity, 2. Non-indigenous Species, 3. Commercial species, 4. Marine Food Webs, 5. Eutrophication, 6. Sea Floor Integrity, 7. Alteration of Hydrographical Conditions, 8. Contaminants, 9. Contaminants in Fish and Seafood, 10. Marine Litter, 11. Energy and Noise.

		- WFD Good Ecological Status: Biological quality elements, Physico-chemical elements, Hydromorphological elements.
2. Marine and coastal conservation & Designated sites	- Extension - Management - Restriction - Regulation.	- IUCN Protected Areas Categories System (7). - INSPIRE Protection Classification Value: purpose of protection (nature conservation, archaeological, ecological, geological, environmental…). - Natura 2000 sites: SAC, SCIs and SPAs. - other effective area-based conservation measure OECM - other types of areas designated with related objectives: safety, security, or risk control from natural and man-made hazards (e.g., volcanic risk area, collision risk area, flooding risk area).
3. Oceanographic characteristics & Climate	- GOOS - EMODnet Physics parameters - Copernicus Ocean Monitoring Indicators	- Essential Ocean Variables: Physics, Biochemistry, Biology and ecosystems, cross-disciplinary (incl. human impact). - Physics and bathymetry parameters: temperature, salinity and currents profiles, sea level trends, wave height and period, wind speed and direction, water turbidity (light attenuation), underwater noise, river flow, and sea-ice coverage. - Ocean Health, Temp. and salinity, Currents, Water mass and heat exchange, climate variability, sea ice, sea level, ocean heat content, sea state (waves, wind).
4. Coastal land use & Planning	- Hierarchical INSPIRE Classification Land Use System (HILUCS).	- Managed with the INSPIRE registry and given as a closed (non-extendable) code list of human activities. Structured in **six main classes**: Primary production, Secondary production, Tertiary production, Transport networks logistics and utilities, Residential use, and Other uses.

		https://inspire.ec.europa.eu/codelist/HILUCSValue
5. Operative maritime activities & planning	- Extended HILUCS code list for maritime activities.	- Structured in **five main classes**: Primary production, Secondary production, Tertiary production, Transport networks logistics and utilities, and Other uses. http://www.geoportal.ulpgc.es/registro/plannedLandUse/HilucsExt/index.html
6. Socioeconomic information	- socio demographic information of coastal areas - data on coastal and ocean economy	Structured in: · socio-demographic data: population characteristics in the coastal zone; · economic data (coastal and ocean economy): nr. businesses, nr. jobs, wages/income, and contribution to GDP, after Colgan (2013).
7. Governance information	-Competences distribution -(inter)national legislation	(different levels of administration) within the area of planning. International conventions and legislation that applies on marine and coastal area that are considered with planning

Table 2.

CLUSTER NR. AND NAME	Digital resources (readily available)	Possible data sources
1. Marine and coastal environment	- National MSFD monitoring programmes - INSPIRE data models can be used for assessments and monitoring (Oceanographic Geographical Features, Sea Regions, Habitat and Biotopes, Species Distribution)	- GES monitoring data and assessments shared following INSPIRE Directive: facilitates data collection and reprocessing. - Water Information System for Europe (WISE), developed and managed by the European Environmental Agency.

2. Marine and coastal conservation & Designated sites	- INSPIRE models repository (Natura 2000 data set): *Protected site simple* and *Specialised data.* - INSPIRE Register code list for designated sites (IUCN, UNESCO's codes, Natura 2000…)	- Common Database on Designated Areas, CDDA (EEA). Applies the IUCN Protected Area Categories System. - Natura 2000 Network (EEA): structured information on conservation, site identification, location, ecological information (EUNIS codes), description, protection status, management and map. Both are harmonised products covering the whole EU and provide spatial extension, conservation targets.
3. Oceanographic characteristics & Climate	- INSPIRE Data Specification on Oceanographic Geographical Features: complex data model based on the Observation and Measurements framework. - INSPIRE Sea Regions data model. - Sea Data Net pan-European data infrastructure: catalogue for ocean and marine data management.	- Copernicus Marine Environment Monitoring Service (CMEMS): series raster products in Network Common Data Form (NetCDF). - EMODNet Physics under the European Marine Observation and Data Network (EMODnet) program.
4. Coastal land use & Planning	- INSPIRE *Land Use* data model and *Planned Land use* data model. Both use HILUCS code list and are available on INSPIRE geoportal.	- European Land Cover CORINE provides harmonized data sets for whole Europe (1990-2018). - Possible combination with regional or local products when higher precision is required.
5. Operative maritime activities & Planning	- Three technical solutions are recommended by TEG to facilitate the development of the EU harmonised MSP Data layer, hosted by the EMODNet Human Activities portal: *Basemaps, MSP INSPIRE data model, EMODnet MSP model*.	- Local and regional data providers. - EMODnet Human Activities Portal products.

6. Socioeconomic information	- Sociodemographic data: · Eurostat for NUTS3; · CensusHub2 for LAU scale.	- Ocean economy: · Eurostat, even at sub national scale for large sectors (by NUTS2 and NACE codes). · EU Blue Economy Reporting, for national scale and NACE codes. - *Coastal economy:* Eurostat: NUTS3 level, GDP or employment. data; NUTS2 level, employment, wages/income, nr. businesses data.
7. Governance information	- INSPIRE data models: Administration Units theme, which includes the *Maritime Units* data model. And the *Area Management Restriction and regulation Zones* data model (info on applied legislation, competent authorities and area).	- Specific geoportals provide details on the areas of application of the UNCLOS or specific EU Environmental Directives.

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