GROWTH AND INNOVATION IN OCEAN ECONOMY – GAPS AND PRIORITIES IN SEA BASIN OBSERVATION AND DATA

Literature Survey
EMODNET MedSea Checkpoint

Total number of pages: 87

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Growth and innovation in ocean economy
Gaps and priorities in sea basin observation and data

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Glossary

ACCOBAMS: Agreement on the Conservation of Cetaceans in the Black Sea Mediterranean Sea and Contigous Atlantic Area

AEMET: State Meteorological Agency (ES)

AIS: Automatic Identification System

API: American Petroleum Institute

ARGO: system for observing temperature, salinity, and currents in the Earth's oceans

ARPEGE: Research Project on Small and Large Scales

AVISO: Archiving, Validation and Interpretation of Satellite Oceanographic Data

BirdLife: Global Species Programme collates and analyses information on all the world's birds

BODC: British Oceanographic Data Centre

BOUSSOLE: Buoy for the acquisition of long-term optical time series

Cal/Val: Calibration/Validation

CAMP: Coastal Area Management Programme

CARBONOCEAN: Marine carbon sources and sinks assessment

CetaceanAlliance: Preserving Whales and Dolphin of the Mediterranean Sea

CFP: Common Fisheries Policy

CH4: Methane

Chl: Chlorophyll

CISL: Computational and Information Systems Laboratory

CLIM012: Global and European sea level rise

CLIM013: Sea surface Temperature

CLIM9434: Ocean heat content

CLS: Collecte Localisation Satellites (FR)

CLU: CLU s.r.l. (IT)

CMCC: Euro-Mediterranean Centre for Climate Change (IT)

CNR: National Research Council (IT)

CO2: Carbon Dioxide

COCONet: Continuously Operating Caribbean GPS Observational Network

CODAS: Consolidated Operations and Delay Analysis System

Copernicus: European Programme for the establishment of a European capacity for Earth Observation

COST: Cooperation in Science and Technology

CPR: Continuous Plankton Recorder

Cs-137: Caesium-137

CSDMS: Community Surface Dynamics Modeling System

CYCOFOS: Cyprus Coastal Ocean Forecasting and Observing System

DAC: Data Assembly Center

DCR: Data Collection Regulation

DCF: Data Collection Framework

DDT: Dichloro-Diphenyl-Trichloroethane

DG-MARE: Directorate-General for Maritime Affairs and Fisheries

DIC: Dissolved Inorganic Carbon

DIN: Dissolved Inorganic Nitrogen

DIP: Dissolved Inorganic Phosphorous

DIRM: Inter-Regional direction of Mediterranean Sea

DON: Dissolved Organic Nitrogen

DOP: Dissolved Organic Phosphorus

DTM: Digital Terrain Model

E-AIMS: Euro-Argo Improvements for the GMES Marine Service

EC: European Commission

ECMWF: European Centre for Medium-Range Weather Forecasts

ECV: Essential Climate Variables

EDF-EN: EDF Energies Nouvelles (FR)

EDMED: European Directory of Marine Environmental Data

EEA: European Environmental Agency

EEC: European Economic Community

EEZs: Exclusive Economic Zones

EGO: European Glider Observatory

E-HYPE: Pan-European hydrological model

EIONet: European Environment Information and Observation Network

EMODnet: European Marine Observation and Data Network

EMSA: European Maritime Safety Agency

EMSO: European Multidisciplinary Seafloor and Water Column Observatory

ERIC: European Research Infrastructure Consortium

ESFRI: European Strategy Forum on Research Infrastructures

ESA: European Space Agency

ESI: Environmental Sensitivity Index

ESONET: European Seas Observatory NETwork

E-SURFMAR: Surface Marine Operational Service

EU: European Union

EUMETNET: European National Meteorological Services

EUNIS: European Nature Information System

Euro-Argo: European contribution to ARGO program

EUROGOOS: European Global Ocean Observing System

EUROSION: European initiative for sustainable coastal erosion management

EuroSITES: European Open Ocean Observatory Network

EUROWATERNET: European Environment Agency's Monitoring and Information Network for Inland Water Resources

EUSeaMap: Mapping European seabed habitats

EWGs: Expert Working Groups

FAO: Food and Agriculture Organization

FEM: Association de Préfiguration de l'IEED France Energies Marines (FR)

FishStat: Universal software for fishery statistical time series

FixO3: Fixed point Open Ocean Observatory network

FP7: Seventh Framework Programme

GDAC: Global Data Assembly Center

GEBCO: General Bathimetric Chart of the Oceans

GES: Good Environmental Status

GEO: Group on Earth Observation

Geoportal: type of web portal used to find and access geographic information
GEOSS: Global Earth Observation System of Systems
GFCM: General Fisheries Commission for the Mediterranean
GIS: Geographic information system
GISC: GMES in-situ coordination
GLA: Green Line Association
GMES: Global Monitoring for Environment and Security
GNOO: National Group for Operational Oceanography
GOOS: Global Ocean Observing System
GPS: Global Positioning System
GRDC: Global Runoff Data Center
GSA: Geographical Sub-Areas
H2S: Sulfuric Acid
HAB: Harmful Algal Bloom
HadISST: Hadley Centre Sea Ice and Sea Surface Temperature data set
HCMR: Hellenic Centre for Marine Research (GR)
HF: High Frequency
HO: Hydrostatic Office
HyMeX: Hydrological cycle in the Mediterranean Experiment
ICES: International Council for the Exploration of the Sea
ICCAT: International Commission for the Conservation of Atlantic Tunas
ICZM: Integrated Coastal Zone Management
IEO: Instituto Español de Oceanografía
IFREMER: Institut Français de Recherche pour l'Exploitation de la Mer (FR)
IH-Cantabria: Fundación Instituto de Hidráulica Ambiental de Cantabria (ES)
IHO: International Hydrographic Organization
IMEDEA: Mediterranean Advanced Studies Institute
IMO: International Maritime Organization
IMP: Integrated Maritime Policy
INGV: National Institute of Geophysics and Volcanology (IT)
INSPIRE: Infrastructure for Spatial Information in the European Community
IOC: Intergovernmental Oceanographic Commission
IPCC: Intergovernmental Panel on Climate Change
IRIS-SES: Integrated Regional monitoring Implementation Strategy in the South European Seas
ISAC: Institute of Atmospheric Sciences and Climate
ISCOMAR: Isleña Marítima de Contenedores
ISO: International Organization for Standardization
ISPRA: Italian National Protection Agency
IUCN: International Union for Conservation of Nature
IUU: Illegal, Unreported and Unregulated
JCOMM: Joint WMO-IOC Commission on Marine Meteorology
JERICO: Towards a joint European research infrastructure network for coastal observatories
JRC: Joint Research Centre
LAT: Lowest Astronomical Tide
LIFE: EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU

LBS: Land Base Sources
MAP: Mediterranean Action Plan.
MAPMED: Management of port areas in the Mediterranean Sea Basin
MARBEF: Marine Biodiversity and Ecosystem Functioning
MARBOUND: VLIZ Maritime Boundaries Geodatabase
MEDAR/MEDATLAS: Mediterranean Data Archaeology and Rescue
MEDESS4MS: Mediterranean Decision Support System for Marine Safety
Med-Hycos: Mediterranean Hydrological Cycle Observing System
MEDISEH: Mediterranean Sensitive Habitats
MEDPAN: MEDiterranean Protected Areas Network
MEDPOL: Programme for the Assessment and Control of Marine Pollution in the Mediterranean
MEDSLIK: Mediterranean oil spill model
MyO: MyOcean, Ocean Monitoring and Forecasting
MNHN: Inventaire National du Patrimoine Naturel
MONGOOS: Mediterranean Operational Network for the Global Ocean Observing System
MOOSE: Mediterranean Ocean Observing System on Environment
MPA: Marine Protected Area
MRI: Marine Research Infrastructure
MRE: Marine Renewable Energy
MS: Member States
MSFD: Marine Strategy Framework Directive
MSP: Maritime Spatial Planning
MSSD: Mediterranean Strategy for Sustainable Development
NATURA 2000: centrepiece of EU nature & biodiversity policy
NAUSICAA: National Sea Centre
NOAA: National Oceanic and Atmospheric Administration
NRT: Near Real Time
NKUA: National and Kapodistrian University of Athens
NUTS: Nomenclature of territorial units for statistics
OCEANS-CAT: OCEANS Catalonia International SL (ES)
OCHA: Office for the Coordination of Humanitarian Affairs
OGC: Open Geospatial Consortium
OSSE: Observing System Simulation Experiments
OSE: Observing System Experiment
OSOCC: Oil Spill Operations and Co-ordination Centre
OWF: Offshore Wind Farms
P01: BODC Parameter Usage Vocabulary
P02: SeaDataNet Parameter Discovery Vocabulary
P03: SeaDataNet Agreed Parameter Groups
PAL: Passive Acoustic Listener
PANGAEA: Data Publisher for Earth & Environmental Science
PCB: polychlorinated biphenyls
pCO2: partial pressure of carbon dioxide
PERSEUS: Policy-oriented marine Environmental Research in the Southern European Seas
pH: Acidity
PLOCAN: Oceanic Platform of the Canary Islands

PODAC: Product-Oriented Design And Construction Cost Model
POSEIDON: Applications of Seismic Oceanography: Seismic data inversion and processing and spectral analysis strategies
PROTECTEDPLANET: The latest initiative harnessing the World Database on Protected Areas
PSMSL: Permanent Service for Mean Sea Level
Pu-239: Plutonium-239
RAC-SPA: Regional Activity Centre for Specially Protected Areas
RAMSAR: Convention on Wetlands of International Importance
REMPEC: Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
REMSS: Remote Sensing Systems
RESPONSES: project investigating EU policy action on climate change
RI: Research Infrastructure
RITMARE: Italian Marine Research Program
RivDIS: Global River Discharge
RMS: Root Mean Square Error
ROOS: Regional Operational Oceanographic Systems
RORO: Roll-on/roll-off
SACOSTA: Environmental Sensitivity of the Coastline
SAR: Search and Rescue
S-AWS: Shipborne Automated Weather Stations
SeaBASS: SeaWiFS Bio-optical Archive & Storage System
SCREAM: Spatially Continuous Resource Economic Analysis Model
SDN: SeaDataNet, pan-european infrastructure for ocean & marine data management
SEDNET: European Sediment Network
SESAME: Synchrotron-light for Experimental Science and Applications in the Middle East
SHOM: Service hydrographique et océanographique de la marine
SIH: French Fisheries Information System
SKIRON: The regional weather forecasting system
SOCIB: Balearic Islands Coastal Observing and Forecasting System (ES)
SONEL: Système d'Observation du Niveau des Eaux Littorales
SOOP: Ship Of Opportunity Programme
SPA: Special Protection Area
SPAMI: Specially Protected Areas of Mediterranean Importance
SPLASHCOS: Submerged Prehistoric Archaeology and Landscapes of the Continental Shelf
SST: Sea Surface Temperature
STAG: Scientific and Technical Advisory Group
STECF: Scientific, Technical and Economic Committee for Fisheries
TAC: Total Allowable Catch
TBT: Tributyltin
TMOOS: Marine Technologies, Operational Oceanography and Sustainability Department
TN = Tot_N: Total Nitrogen
TOC: Total Inorganic Carbon
TOSCA: Tracking Oil Spills & Coastal Awareness network
TP= Tot_P: Total Phosphorus
TPT: triphenyltin
UCY: University of Cyprus (CY)

UHSLC: University of Hawaii Sea Level Center
UN: United Nations
UNCLOS: United Nations Convention on the Law of the Sea
UNEP: United Nations Environment Programme
UNESDO: United Nations Educational, Scientific and Cultural Organization
VLIZ: Flanders Marine Institute
VMS: Vessel Monitoring System
VOS: Voluntary Observing Ship
WASP: Wind Atlas Analysis and Application Program
WDPA: World Database on Protected Areas
WISE: Water Information System for Europe
WFD: Water Framework Directive
WMO: World Meteorological Organisation
WMOP: SOCIB Western Mediterranean Sea Operational forecasting system
WRF: Weather Research and Forecasting
WSAG: Water System Analysis Group
WWF: World Wildlife Fund

Executive Summary

The EMODnet Mediterranean Sea (MedSea) Checkpoint Literature Survey was carried out from January to September 2014 in order to answer the following questions: is there an overview of data appropriateness and availability? Can any statement of fitness for purpose be made?

This Literature Survey summarizes the first substantial attempt to classify the input data sets existing at the Mediterranean Sea level and it explains a methodological framework for the nomenclature, metadata collection and the result statistical analysis. This work allowed for the first time to have an overview of the type and number of data sets required by Challenges (Windfarm siting, Marine Protected Areas, Oil platform leak, Climate and coastal protection, Fisheries management, Marine Environment and River inputs).

Furthermore, a set of assessment criteria were defined, focused on "what" is available for the Challenges and "how", producing a definition of two assessment criteria, called "appropriateness" and "availability". The former includes the spatial extent and resolution, time extent and resolution, purpose, lineage, usage, completeness, consistency, accuracy while the latter the visibility, accessibility and performance.   Fitness for purpose is to be understood as the totality of the appropriateness and availability criteria that can satisfy stated and implied needs.

The data needed by the Challenges were then classified in terms of '*characteristics*' (nomenclature consistent with the Marine Strategy Framework Directive) belonging to five, traditional environmental monitoring matrices: Air, Fresh and Marine waters, Biology/Biota, Seabed and Human Activities. The SeaDataNet common vocabulary list was used to classify the *characteristics*, associate them to the Challenges and to the environmental matrices.

It was found that Challenges require 73 different *characteristic* categories and in particular: four in the Air matrix, 16 in the Biology/Biota matrix, 7 in the Fresh water and 22 in the Marine water matrix, 8 in the Seabed matrix and 16 in the Human Activities matrix. *Characteristic* categories recurrently needed by the Challenges are: 1) for Seabed matrix: bathymetry, lithology,coastal geomorphology; 2) for Marine/Fresh water matrix: temperature, salinity, sea level and currents; 3) for Biology/Biota matrix: Fish abundance; 4) for Human Activities Matrix: man-made structures, adminisrative units, transport activities, trawling activities and impact.

For the 73 *characteristics* required by the Challenges more than 500 upstream data sources were inserted in the Literature Survey database (Annex 3). The number of data providers is about 112, i.e. about 10 data providers on average for each Challenge.

In order to progress toward an assessment of the 'fitness for purpose' and without having yet Challenge products to work with, we selected 18 Use Cases that utilize the major *characteristics* of the Challenges and we have extracted an initial evaluation of the fitness for purpose of the implied data sets. Not surprisingly data sets belonging to the Air, Biology/Biota and Seabed matrices could be seen to have medium to low 'fitness for purpose' due to lack of sufficient spatial and temporal resolution, low visibility and accessibility.

In conclusion this Literature survey showed that in the Mediterranean Sea it is possible to have an overview of the type of data and data sources required for the Challenges and that appropriate fitness for purpose criteria can be defined. For some of the *characteristic* required by the Challenges fitness for purpose has been initially evaluated and this experience will be transferred to the Data Adequacy Reporting.

1   Introduction

The concept of Sea-Basin checkpoints was introduced within the Marine Knowledge 2020. In spite of EU initiatives such as EMODnet, Copernicus and Data Collection Framework (DCF) for Fisheries to deliver seamless layers of marine data across national boundaries, there are still shortcomings with the availability and accessibility of EU marine data. Data collection have been largely put in place for specific and/or national purposes. There is still an approximate overview on a sea-basin scale of gaps and duplications and there is no overall view of what the priorities are for further data collection or assembly.

The EMODnet-MedSea project aims to quality assess, extract the synergies between and identify the gaps of, the present monitoring data sets for the entire Mediterranean Sea in view of seven applications or 'challenges':

CH1- Windfarm Siting, CH2- Marine Protected Areas, CH3- Oil Platform Leak, CH4- Climate and Coastal Protection, CH5- Fisheries Management, CH6- Marine Environment, CH7- River Inputs.

This is an innovative approach which assesses monitoring on the basis of 'use' by the society at large, thus reinforcing the sustainability of the marine observing system at European scale.

The EMODnet assessment effort in view of societal challenges and applications shall be coupled with Research Infrastructure initiatives that will use a purely science-based approach to upgrade and scientifically assess the value of different measurements. The task is outstanding but necessary if an earth observing system for disaster risk reduction, resource exploitation and climate monitoring for the marine environment has to succeed.

The high level scheme for the EMODnet Checkpoint is given in Fig. 1: Sea-Basin checkpoints are at the end of a long value-addying chain and they feed back to the European data collection frameworks by assessing the quality of the monitoring systems.
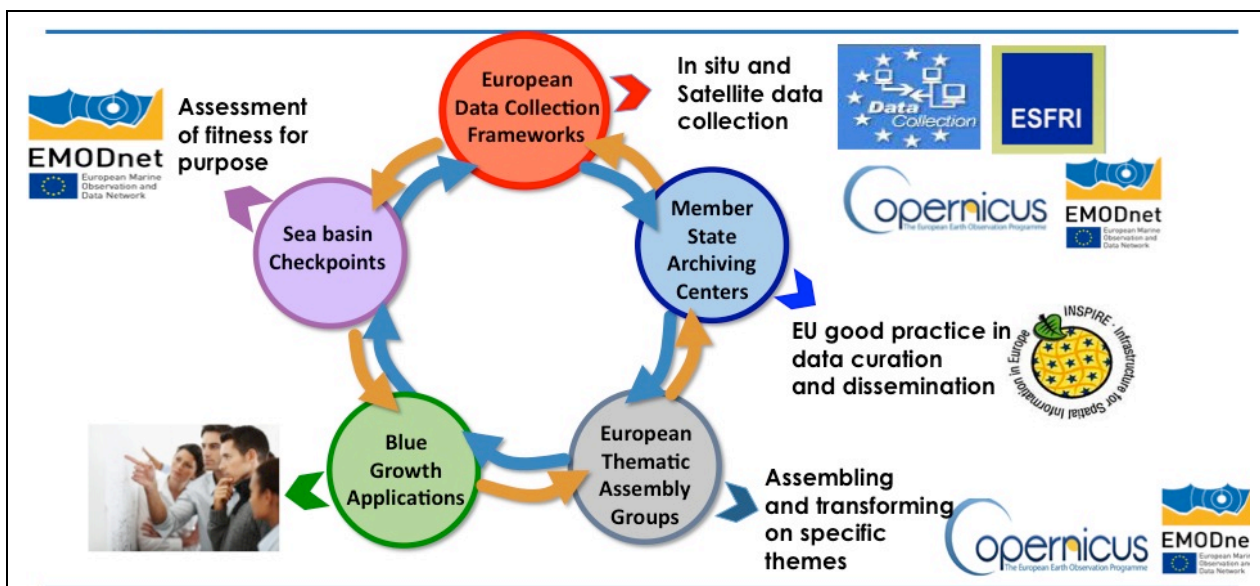

Fig. 1 Localization of EMODNET Sea basin Checkpoints in the EU data sharing and production framework

The objective of this literature survey is to summarise previous studies on the "data adequacy" in the Mediterranean Sea or elsewhere if not available in the Mediterranean. This generally means to answer the following questions:
- Is there an overview of data availability ?
- If we have an overview, how complete are the data? Is incompleteness due to reluctance of data-owners to release data or because of a lack of measurements ?
- Are there any statements made as to fitness for purpose ?

1.1   The science-based evaluation of monitoring systems at basin scale

The evaluation of monitoring data allows for detection of gaps and redundancies in monitoring programmes. The intensity of monitoring needed to detect trends over space and time is determined by the natural spatial and temporal variation of the measured characteristics, measurement and model error, and the acceptable error rate. A characteristic with high natural variability requires more intensive sampling to achieve the same statistical significance.

Periodic evaluation of monitoring programs is important because the monitoring objectives may change, the available technology improves, and the amount of data accumulates over time. The Marine Strategy Framework Directive, having a cycle of six-years, needs to consider, inter alia, adjustments and upgrades of monitoring programmes, changes in the knowledge requirements for better policy and management, and cost reductions. Knowledge on quality of data is another element of an evaluation of the monitoring system. In turn, the quality of data and products is assured by the knowledge of the instrument and sensors and their accuracy and by the application of appropriate sampling strategies, and protocols that assure the quality of field work, data and use of data.

Traditionally the scientific evaluation of monitoring systems or observing programs has been carried out with Observing System Simulation Experiments (OSSE) and Observing System Experiment (OSE). These techniques have been used first in meteorology (Arnold and Hey, 1986) and then in oceanography (Berry and Marshall, 1989, McPhaden et al., 1998) to find out about optimal sampling schemes for satellite and in situ sensors.

These methods are particularly useful to test the redundancy/complementarity of the observing network in order to estimate the past state of the oceans and the forecast initial conditions. Recently the Jerico Project (see section 4) has develop OSSE and OSE for coastal observations, from gliders to fixed stations (Jerico, http://www.jerico-fp7.eu/deliverables/d92-wp9-ose-first-report and http://www.jerico-fp7.eu/deliverables/d93-osse-first-report). Furthermore, the FixO3 project (see section 5) is also carrying out studies for an optimum observational network of FixO3 platforms, integrated and complemented by other platforms (http://www.fixo3.eu/wp11/). The E-AIMS project (http://www.euro-argo.eu/EU-Projects-Contribution/E-AIMS) is developing OSE and OSSE for ARGO profiling floats in the Mediterranean and other European Seas, assessing the ARGO float drifting depths and temporal cycles.

In the Mediterranean Sea, OSE and OSSE were carried out for several components of the large scale observing system: the satellite altimetry monitoring (Pujol et al.,2010), the Ship Of Opportunity Programme (SOOP, http://www.jcommops.org/soopip/soopip_overview.html, Raicich and Rampazzo, 2003, Raicich, 2006), ARGO profiling floats (Taillandier et al., 2006) and biochemical measurements at large scales (Crispi et al., 2006). Results of such studies helped to build the present large scale observing system in support of the Copernicus Marine Environment Service.

OSE and OSSE focus on measurements and networks that are required to reach goals of scientific reliability, accuracy, etc. in the marine sciences and engineering: the priority for the development of one measurement with respect to the other is decided on the basis of a scientific goal. This might not translate in a 'monitoring measurement' or 'monitoring network' and thus will not be directly of

interest to EMODnet Checkpoint activities. However, OSE and OSSE are fundamental methodological ways to assess the quality of a multi-platform, multi-disciplinary observing network in order to get high quality ocean state reconstructions, analyses and forecasts.

1.2 The EMODNET-Checkpoint assessment methodology and the Challenges

The seven challenges for the EMODNET MedSea Checkpoint require the assembling of data sets from monitoring programs that did not have the Challenges themselves as primary reason for their collection. Even if a science-based monitoring assessment would be beneficial, the purely science-driven approach of the kind described above cannot properly assess the availability of different data sets (visibility, accessibility, performance of the services, etc) and thus does not allow to estimate their fitness for purpose.

During the EMODnet MedSea Checkpoint project we will assess multi-disciplinary, multi-platform and multi-use data sets that are necessary for the construction of the seven Challenge outputs, listed in Table 1.

Windfarm siting	Determine the suitability of wind farm development in the Northwestern Mediterranean
Marine Protected Areas	Analyze the existing Mediterranean network of marine protected areas (national and international sites)
Oil Platform leak	Issue a Bulletin within 24 hours to determine the fate and transport of oil from a platform
Climate and coastal protection	Document in several ways sea level changes, water column annual mean temperature changes, sediment mass changes.
Fishery management	Collect mass and number of fish landings, discards and bycatch (of fish, mammals, reptiles, seabirds) by species and year
Marine Environment	Seasonal averages and changes of eutrophication in the basin for the past ten years
River Inputs	Time series of all river water discharges, sediment loading, total nitrogen and phosphates, eels abundance

Table 1: The 7 EMODnet MedSea Checkpoint Challenges and the products required to assess the 'fitness for purpose' of the input monitoring data

The assessment methodology will consists of the following steps:

1) establish a framework for information collection related to input data required by each Challenge;

2) access, catalog and elaborate the input data sets in order to produce the outputs needed by each Challenge (Table 1);

3) document the availability and appropriateness of the input data sets during the production of the Challenge outputs;

4) analyse the fitness for purpose of the input data.

In this literature survey we will overview the input data sets discovered during the first nine months of the project where we established the framework for information collection. We will then document how many data sets are required by the Challenges and we will analyse their

importance and synergies. We will also map the input data sources without however being able to assess the availability and the appropriateness since we have not produced Challenge outputs yet.

Thus it is difficult to assess the fitness for purpose in this Literature survey. Effectively we will substitute the outputs of the Challenges with literature 'Use Cases' where several important Challenge input data sets are considered. The Use Cases will show the conceptual paradigms by which 'fitness for purpose' can be assessed to guide our future analysis.

As an example of this methodology, an EC Report[1] containing a technical assessment of the information available in EU Member Countries for the Marine Strategy was published recently. The assessment was carried out in four steps, namely checking completeness, adequacy, consistency and coherence. In this case Member States collected and produced information about GES descriptors as national reports which showed the gaps of the input monitoring data systems.

In the EC report completeness is intended as an evaluation of missing information for a particular GES descriptor or for key elements of the initial assessment. Adequacy was intended as an assessment of reported information to meet the objectives of the Directive and the technical requirements of Articles 8, 9 and 10[2]. Consistency was defined as the logical flow of reporting of one Member State for the different Articles, including the identification of missing links, conflicts and gaps. Coherence was defined as the assessment of the relationships between the reports of the Member States, firstly within one marine region or sub-region and secondly across the EU, i.e. between the marine regions. In Chapter 3 it will be seen that the Commission definitions are perfectly coherent with the ISO based definition defined in this report.

Regarding some of the important characteristics related to Challenges, the EC report states that:

1) Highly mobile species groups (fishes): The most frequently reported pressures on species groups in the Mediterranean were extraction of species and biological disturbance.
2) Seabed and water column habitats: In general qualitative assessments of the distribution, extent and condition of habitats were provided. Most MS reported a qualitative/descriptive judgement on the current status for certain habitats or for certain assessment criteria. Some Member States provided conclusive assessments on current status, although not always for all habitats.
3) Ecosystems: In many cases, these assessments were understandably limited and qualitative, due mainly to a lack of assessment techniques at this level. Often the assessments were limited to specific species or functional groups and did not provide an integrated assessment across all species and habitats in each ecosystem. The main pressures on habitats and ecosystems were reported in the Mediterranean, physical loss and physical damage were again the main pressures, whilst some MS also cited extraction of fish and shellfish and the introduction of non-indigenous species. In addition, a few Member States also reported hazardous substances and nutrient enrichment as being important and, the introduction of non-indigenous species, litter and the extraction of species as being relevant pressures.
4) Physical loss and damage: The main causes of physical loss reported were: construction and maintenance of ports and other coastal developments, land claim, tourism, beach regeneration, wind farms, oil and gas installations, cables and pipelines, aquaculture and artificial reefs. The main causes of physical damage reported were: bottom-trawling fisheries, aggregate extraction, waste dumping, coastal defence, ports and navigational dredging, construction works, mussel dredging, hydraulic activities and shipping. Bottom trawling is often cited as causing the most extensive damage. Assessments of loss and damage were given primarily in a qualitative manner.

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[1] The first phase of implementation of the Marine Strategy Framework Directive (2008/56/EC) - The European Commission's assessment and guidance. CELEX_52014SC0049_EN_TXT
[2] Adequacy does not necessarily mean, for instance, that if the defined GES is assessed as adequate it automatically means that this is the required quality level of the marine waters.

1.3 Policy Framework

The relevant European Directives, International conventions and policy frameworks for the Mediterranean Sea are:

1) the United Nation Convention on the Law of the Sea;

2) the Marine Strategy Framework Directive (MSFD);

3) the Barcelona Convention and its programmes;

4) the Water Framework Directive (WFD) and requirements from the European Environment Agency's (EEA) guidelines for transitional, coastal and marine waters;

5) the Integrated Maritime Policy Framework.

6) the Habitat Directive;

7) the Birds Directive, with particular respect of Art. 1, 2 and 3;

8) the Flood Directive.

In the following the critical aspects of all these policy frameworks will be overviewed.

1.3.1 International legislative framework for marine waters

According to the United Nations Convention on the Law of the Sea (UNCLOS) it is possible to distinguish five marine territorial waters, measured from a baseline which is normally taken to be the low water limit on the land side of the coastal area. The areas are as follows:

<div align="center">Internal waters</div>

Covers all water and waterways on the landward side of the baseline. The coastal state is free to set laws, regulate use, and use any resource. Foreign vessels have no right of passage within internal waters.

<div align="center">Territorial waters</div>

Out to 12 nautical miles (22 kilometres) from the baseline, the coastal state is free to set laws, regulate use, and use any resource. Fishing, polluting, weapons practice, and spying are not "innocent", and submarines and other underwater vehicles are required to navigate on the surface and to show their flag. Nations can also temporarily suspend innocent passage in specific areas of their territorial seas, if doing so is essential for the protection of its security.

<div align="center">Contiguous zone</div>

Beyond the 12-nautical-mile (22 km) limit, there is a further 12 nautical miles (22 km) from the territorial sea baseline limit, the contiguous zone, in which a state can continue to enforce laws in four specific areas: customs, taxation, immigration and pollution, if the infringement started within the state's territory or territorial waters, or if this infringement is about to occur within the state's territory or territorial waters.

<div align="center">Exclusive economic zones (EEZs)</div>

These extend from the edge of the territorial sea out to 200 nautical miles (370 kilometres; 230 miles) from the baseline. Within this area, the coastal nation has sole exploitation rights over all natural resources. In casual use, the term may include the territorial sea and even the continental shelf. The EEZs were introduced to halt the increasingly heated clashes over fishing rights, although oil was also becoming important.

<div align="center">Continental shelf</div>

<div align="center">14</div>

The continental shelf is defined as the natural prolongation of the land territory to the continental margin's outer edge, or 200 nautical miles (370 km) from the coastal state's baseline, whichever is greater. A state's continental shelf may exceed 200 nautical miles (370 km) until the natural prolongation ends. However, it may never exceed 350 nautical miles (650 kilometres; 400 miles) from the baseline; or it may never exceed 100 nautical miles (190 kilometres; 120 miles) beyond the 2,500 meter isobath (the line connecting the depth of 2,500 meters). Coastal states have the right to harvest mineral and non-living material in the subsoil of its continental shelf, to the exclusion of others. Coastal states also have exclusive control over living resources "attached" to the continental shelf, but not to creatures living in the water column beyond the exclusive economic zone.

1.3.2 The MFSD

The MSFD[3] provides the framework for European Member States to adopt marine monitoring strategies. The MSFD reads:

"Each Member State should (…) develop a marine strategy for its marine waters which, while being specific to its own waters, reflects the overall perspective of the marine region or subregion concerned. Marine strategies should culminate in the execution of programmes of measures designed to achieve or maintain Good Environmental Status (GES)."

And more:

"Coastal waters, including their seabed and subsoil, are an integral part of the marine environment, and as such should also be covered by this Directive, in so far as particular aspects of the environmental status of the marine environment are not already addressed through the Water Framework Directive or other Community legislation, so as to ensure complementarity while avoiding unnecessary overlaps."

And more:

"Member States having borders on the same marine region or subregion covered by this Directive, where the status of the sea is critical to the extent that urgent action is needed, should endeavour to agree on a plan of action including the earlier entry into operation of programmes of measures. In such cases, the Commission should be invited to consider providing supportive action to Member States for their enhanced efforts to improve the marine environment by making the region in question a pilot project."

Finally it is mentioned that:

"Provision should be made for the adoption of methodological standards for the assessment of the status of the marine environment, monitoring, environmental targets and the adoption of technical formats for the purposes of transmission and processing of data in line with Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)"

Methodological standards for the assessment of all relevant GES characteristics or indicators of large marine areas are not scientifically developed yet, neither common throughout Europe but there is a need to start from the most consolidated knowledge and update in different phases. Annex I of the MSFD specifies the 11 qualitative descriptors for determinign GES, they are:

1. Biodiversity (quality and occurrence of habitats and the distribution and abundance of species).
2. Non-indigenous species.

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[3] DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

3. Populations of all commercially exploited fish and shellfish.
4. Marine food webs and their components.
5. Human-induced eutrophication.
6. Seafloor integrity.
7. Hydrographical conditions.
8. Concentrations of contaminants.
9. Contaminants in fish and other seafood.
10. Marine litter.
11. Energy introduction, including underwater noise.

Furthermore Annex III of MSFD provides an indicative list of *Characteristics* to be considered in the monitoring plans to characterize the 11 descriptors above, reported here in Table 2.

Table 2: Indicative list of Characteristics from Annex III of the MSFD

	Characteristics
Physical and chemical features	Topography and bathymetry of the seabed,
	annual and seasonal temperature regime and ice cover, current velocity, upwelling, wave exposure, mixing characteristics, turbidity, residence time
	spatial and temporal distribution of salinity
	spatial and temporal distribution of nutrients (DIN, TN, DIP, TP, TOC) and oxygen
	pH, pCO2 profiles or equivalent information used to measure marine acidification
Habitat types	The predominant seabed and water column habitat type(s) with a description of the characteristic physical and chemical features, such as depth, water temperature regime, currents and other water movements, salinity, structure and substrata composition of the seabed,
	Identification and mapping of special habitat types, especially those recognised or identified under Community legislation (the Habitats Directive and the Birds Directive) or international conventions as being of special scientific or biodiversity interest
	habitats in areas which by virtue of their characteristics, location or strategic importance merit a particular reference. This may include areas subject to intense or specific pressures or areas which merit a specific protection regime
Biological features	A description of the biological communities associated with the predominant seabed and water column habitats. This would include information on the phytoplankton and zooplankton communities, including the species and seasonal and geographical variability
	information on angiosperms, macro-algae and invertebrate bottom fauna, including species composition, biomass and annual/seasonal variability
	information on the structure of fish populations, including the abundance, distribution and age/size structure of the populations
	a description of the population dynamics, natural and actual range and status of species of marine mammals and reptiles occurring in the marine region or subregion
	a description of the population dynamics, natural and actual range and status of species of seabirds occurring in the marine region or subregion,
	a description of the population dynamics, natural and actual range and status of other species occurring in the marine region or subregion which are the subject of Community legislation or international agreements
	an inventory of the temporal occurrence, abundance and spatial distribution of nonindigenous, exotic species or, where relevant, genetically distinct forms of native species, which are present in the marine region or subregion
Other features	A description of the situation with regard to chemicals, including chemicals giving rise to concern, sediment contamination, hotspots, health issues and contamination of biota (especially biota meant for human consumption),
	a description of any other features or characteristics typical of or specific to the marine region or subregion

Furthermore the MSFD acknowledges the fact that:

"The Directive should contribute to the fulfilment of the obligations and important commitments of the Community and the Member States under several relevant international agreements relating to the protection of the marine environment from pollution: ….. the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, and its amendments from 1995, as well as its Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources, and its amendments from 1996."

1.3.3   The Barcelona Convention and its programmes

The relevant Programmes of the Barcelona Convention are: 1) MED POL; 2) CAMP; 3) REMPEC and they will be overviewed here.

The MED POL Programme (the marine pollution assessment and control component of MAP, the Mediterranean Action Plan of the Barcelona Convention) coordinates the implementation of the Land Base Sources (LBS) Protocol, the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (1980, as amended in 1996), and of the dumping and Hazardous Wastes Protocols. MED POL arrived now at its IV Phase of implementation where monitoring activities respond to the above needs:

a) Monitoring, assessment and pollution control activities, as well as data quality assurance, data collection and handling, reporting and data management policies and procedures, to be functionally harmonized with those adopted by the European Union and other UN Agencies and programmes;

b) MED POL assessment and reporting schedules to be synchronised, and the assessment and reporting procedures harmonised, with the schedules and procedures which will be adopted for the evolving global assessment of the state of the marine environment;

c) Monitoring and assessment of the environmental effects and ecological implications of fisheries management, including aquaculture, on ecosystems (as advocated by the ecosystem approach to the management of human activities and practised by other Europe-based regional seas programmes) as well as of sea water desalination activities;

d) Monitoring and assessment of environmental effects associated with energy production and maritime transport, in cooperation with other competent international and regional bodies;

e) Assessment of the health risk associated with the quality of bathing and shellfishgrowing waters, tourist establishment and facilities.

The Coastal Area Management Programme (CAMP) of MAP is oriented at the implementation of the Integrated Coastal Zone Management (ICZM) protocol, adopted in 2008 by most of the Contracting parties of the Barcelona convention.

Preventive measures against pollution from ships are addressed by the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC). REMPEC is administered by the International Maritime Organization (IMO) in cooperation with UNEP/MAP. The objective of REMPEC is to contribute to preventing and reducing pollution from ships and combating pollution in case of emergency. In this respect, the mission of REMPEC is to assist the Contracting Parties in meeting their obligations under Articles 4(1), 6 and 9 of the Barcelona Convention; the 1976 Emergency Protocol; the 2002 Prevention and Emergency Protocol and implementing the Regional Strategy for Prevention of and Response to Marine Pollution from Ships, adopted by the Contracting Parties in 2005 which key objectives and targets are reflected in the Mediterranean Strategy for Sustainable Development (MSSD).

1.3.4 The WFD

The Water Framework Directive (WFD)[4] is a complementary directive to the MSFD insofar it concerns the inland waters and the marine waters up to 1 mile (1.8 km) from the coasts. In addition the directive aims at the enhancement of the quality of drinking waters and the protection of the environment from urban waste-water pollution in the inland waters.

It concerns the chemical, physical and biological status of:

1. surface freshwater (including lakes, streams and rivers)
2. groundwaters
3. groundwater dependant ecosystems
4. estuaries
5. coastal waters out to one mile from low-water

Article 8 of the WFD sets out the requirements for the monitoring of surface water status, groundwater status and protected areas: "Monitoring programmes are required to establish a coherent and comprehensive overview of water status within each river basin district".

Closely related to the WFD and of particular relevance to us, a new European legislation on bathing water was adopted in 2006[5]. The 'New Bathing Water Directive' updates the measures of the 1975 legislation and simplifies its management and surveillance methods. It also provides a more proactive approach to informing the public about water quality using four quality categories for bathing waters — 'poor', 'sufficient', 'good' and 'excellent'. The new European legislation was transposed into national law in 2008 but Member States have until December 2014 to implement it.

The WFD covers part of the MSFD marine space and thus in this area it is the relevant directive. In Fig. 2 we show the different areas covered by WFD, MED POL and MSFD. It is important to manage an information system that will merge information from all these relevant directories and agreements since they are complementary and overlapping in terms of specific measurements to be carried out. In terms of pressure and impacts, the MED POL and WFD monitoring requirements supply upstream information for the evaluation of GES for the marine environment.
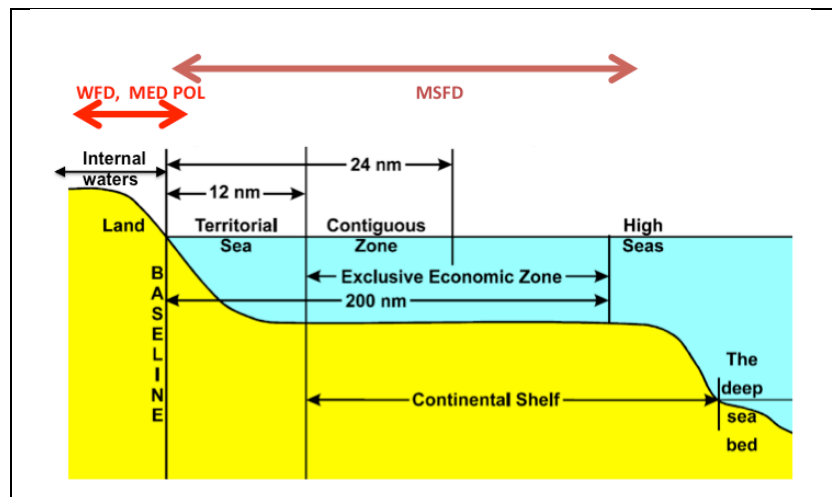
Fig. 2 The different marine territorial waters as defined by UNCLOS and the area extension for the international agreements and directives

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[4]Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive)
[5] Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

1.3.5 The Integrated Maritime Policy

The European Council endorsed the Integrated Maritime Policy (IMP)[6] and the Action Plan on 14 December 2007 (Meiner, 2010). Policy's action plan provides approaches for maritime governance, research and planning relevant to information.

Meiner (2010) describes the IMP as the policy that applies to the oceans and seas a holistic, integrated approach and promise replace compartmentalised resource management approach with an ecosystem based management view. New policy aims to tackle all maritime activities and sustainable development aspects of the oceans and seas, including the marine environment, in an overarching fashion:

- Applying the integrated approach to maritime governance
- Developing tools for integrated policy-making
- Maximising the sustainable use of the oceans and seas
- Building a knowledge and innovation base for the maritime policy
- Delivering the highest quality of life in coastal regions
- Promoting Europe's leadership in international maritime affairs
- Raising the visibility of maritime Europe

IMP Blue paper is announcing some strategic initiatives that serve as foundation for more detailed implementation steps in the Actions plan:

- Create barrier-free European Maritime Transport Space.
- Overall strategy for EU ports.
- Commission's Communication on strategic reflection on the future of EU Maritime Transport in the horizon 2008–2018.
- European Strategy for Marine and Maritime Research.
- EU funding for Europe's coastal regions.
- Planning of coastline (ICZM).
- Environmentally-friendly shipping, ecosystem-based fisheries, eliminate illegal fisheries.
- New Maritime Planning Tools (MSP).
- Surveillance systems, compliance and law enforcement.

The European Marine Observation and Data Network (EMODnet) is a network of organisations supported by the EU's integrated maritime policy.

1.3.6 The Habitats Directive

The Habitats Directive (together with the Birds Directive) forms the cornerstone of Europe's nature conservation policy. It is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection. All in all the directive protects over 1.000 animals and plant species and over 200 so called "habitat types" (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance.

The Reference Portal for NATURA 2000 is part of the Standard Data Form (SDF). The portal provides those elements of the SDF which are subject to change over time and subject to changes due to technical developments. These elements are reference documents (e.g. the coding of species), technical support material (e.g. data-model, applications) as well as guidelines to ensure a consistent use of the SDF by all Member States and to outline the technical and administrative procedures on how to submit data to the Commission.

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[6] COMMISSION IMPLEMENTING DECISION of 12.3.2012 concerning the adoption of the Integrated Maritime Policy work programme for 2011 and 2012

1.3.7 The Birds Directive

Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (this is the codified version of Directive 79/409/EEC as amended) is the EU's oldest piece of nature legislation and one of the most important, creating a comprehensive scheme of protection for all wild bird species naturally occurring in the Union. The directive recognises that habitat loss and degradation are the most serious threats to the conservation of wild birds. It therefore places great emphasis on the protection of habitats for endangered as well as migratory species (listed in Annex I), especially through the establishment of a coherent network of Special Protection Areas (SPAs) comprising all the most suitable territories for these species. Since 1994 all SPAs form an integral part of the NATURA 2000 ecological network.

1.3.8 The Floods Directive

Directive 2007/60/EC on the assessment and management of flood risks entered into force on 26 November 2007. This Directive now requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. With this Directive also reinforces the rights of the public to access this information and to have a say in the planning process. The Directive shall be carried out in coordination with the Water Framework Directive, notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans. All assessments, maps and plans prepared shall be made available to the public.

1.4 Structure of the document

This document is structured around six major parts:

1) the terminology and the framework for input data collection from the project internal survey carried out during the first nine months of the project (Section 2);

2) the overall analysis of the internal input data survey that produces a consolidated list of Characteristics needed by the Challenges (Section 3);

3) an overall survey on the Mediterranean Sea observational capacities and monitoring systems (Section 4);

4) a survey of relevant Use Cases as a substitute of Challenges outputs (Section 5);

5) an assessment of data appropriateness, availability and preliminary fitness for purpose based upon the Use Cases (Section 6).

Section 7 concludes with a synthesis of findings and three Appendices are integral part of the Literature survey but they appear as separate documents.

2   Terms of reference for the literature survey

The methodology to carry out the Literature survey for the EMODNET MedSea Checkpoint was established early in the project and consisted of two major components:
1) the definition of a common terminology and nomenclature across the different basin monitoring data sets;
2) a framework for information collection which consisted in an internal project survey to characterize the input data sets in terms of appropriateness, availability and fitness for purpose. These two major methodological components are described in the two sections below.

2.1   Terminology and nomenclature

For the purposes of the project and to avoid confusion with other uses of the terms listed below, the following definitions apply in this literature survey and in the follow-up project activities. These definitions   are based on the methodology adopted by the project partners for classifying the existing upstream data of the challenges and to assess their fitness for use (see Annex 1).

- ## Characteristic

In this document, a "characteristic" is a distinguishing feature which refers :
  - either to a variable derived from the observation, the measurement or the numerical model output of a phenomenon or of an object property in the environment
  - or to the geographical representation of an object on a map (ie a layer such as a protected area, a coastline or wrecks) by a set of vectors (polygon, curve, point) or a raster (a spatial data model that defines space as an array of equally sized cells such as a grid or an image).

- ## Environmental matrices

This concept is introduced to avoid ambiguities when using a characteristic name such as "temperature".

The environment matrix is the environment to which a characteristic is related and we define them to be:

1. Air,

2. Water (Marine or Fresh),

3. Biota/Biology,

4. Seabed,

5. Human activities.

- ## Data

Reinterpretable representation of information in a formalised manner suitable for communication, interpretation or processing (ISO 19115)

- ## Dataset

![MODnet logo] European Marine Observation and Data Network

Growth and innovation in ocean economy
Gaps and priorities in sea basin observation and data

D1.3
Version: V10
Date: 26/09/2014

A "dataset" is an identifiable collection of data (ISO 19115)

It can be a time series, a lithological description of a marine sample, a gridded dataset such as a DTM, an hydrodynamic model output, a GIS dataset or a feature layer of a GIS dataset, a data base or a table of values in a publication. A data set can be constituted of several files (eg the set of seismic data files recorded along the same line**).**

- **Collection of datasets**

A collection of datasets is a set of datasets.

- **Dataset series**

A dataset series is a collection of datasets sharing the same specifications of production. This is the concept in use on the Inspire Geoportal.

- **Input Dataset**

This is the collection of existing data to be input to the Challenges

- **Assessment criteria**

The criteria are focused on two questions : "what" is made available to the challenges and "how" ? They are derived from the quality principles of the ISO19113 standard for geographic information which concerns 99% of the data needed by the challenges and additional criteria related to services recognized in literature as key elements for the establishment of the fitness for use.

"What" **is also defined as 'appropriateness'** and it includes :
   ✓ *Spatial extent* covered by the dataset or the collection
      Box or geographic region bounding the datasets
   ✓ *Spatial resolution* :
      Size of the smallest object that can be resolved on the ground. In a raster dataset, the resolution is limited by the cell size.
   ✓ *Time extent* covered by the dataset or the collection:
      Time interval represented by the dataset or by the collection.
   ✓ *Time resolution*
      Size of the smallest interval of time that can be resolved.
   ✓ *Purpose* (ISO19113 overview element of quality)
      Describes the rationale for creating a dataset (product specification)
   ✓ *Lineage* (ISO19113 overview element of quality)
      Describes the history of a dataset from collection and acquisition (source information) through compilation and derivation to its current form (process steps)
   ✓ *Usage*
      Describes the application(s) for which a dataset has been used by the data producer or by other, distinct, data users.
   ✓ *Completeness* (ISO19113 quality element)
      Degree of absence or of excess of data in a dataset
   ✓ *Consistency* (ISO19113 quality element)
      Degree of adherence to rules (concept, value domain, format...)
   ✓ *Accuracy* (ISO19113 quality element) including
      - absolute or relative **positional accuracy :**

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- **temporal accuracy** including correctness of the temporal references of an item and the correctness of ordered events and temporal validity
- **thematic accuracy** including classification correctness

"How" **is also referred to as 'availability'** and it refers to :

✓ *Visibility*

Ability to identify and to get quickly on the appropriate site delivering the desired datasets from existing EU catalogues**.**

✓ *Accessibility*

Conditions in which users can obtain data :
- *services* **:** manual ordering, discovery, downloading, advanced services
- *data policy*: restricted, accessible under moratorium, unrestricted
- *pricing policy* : no charge, at cost, cost charge depends on intented use and category of users
- *formats* (including semantic conventions**)**
- *interoperability* of on-line services: (OGC standards…)

✓ *Performance*
- *responsiveness* is the timeliness or ability to process a request in a deterministic and acceptable amount of time
- *reliability* ie the ability of the services (to request data) to keep operating over time and operates correctly and either does not fail or reports any failure to the service user for compensation

- ## Fitness for use or fitness for purpose

Within ISO 8402 framework, fitness for purpose is understood as the "totality of a product characteristics that bear on its ability to satisfy stated and implied needs" and it includes the ease with which a user can obtain data. The geographical information standards developed 'to describe geographic information'" (ISO 19115) and "to assists a data user in determining a product's ability to satisfy the requirements for their particular application" (ISO 19113, ISO 19157) appear as an appropriate basis for the establishment of their fitness for use.

2.2 Framework for information collection

In order to build a database for the literature survey and later the EMODNET Checkpoint GIS Portal, two metadata templates have been designed and provided with guidelines to each challenge partner to collect the elements needed for the classification of the input data.
The first template collected a preliminary list of input characteristics needed by the challenges, subdivided into relevant environmental matrices. The second template elements have been grouped in seven categories :

1/ Characteristics and categories needed by the challenges using the SeaDataNet classifications (see below).

2/ Data sources of these characteristics : provider, originating programme and dataset/dataset series including identification in catalogues or directories and data access web site ("Visibility")

3/ ISO 19113 overview elements of data sources : production purpose (including processing level and production mode), uses and relevant documents related to the fitness of the data sources for uses

4/ Spatial extent

5/ Temporal extent

6/ Accessibility and performance conditions to get data

7/ ISO 19113 quality elements (completeness, consistency, accuracy)

Categories 1,2 and 3 are required to identify datasets or dataset collections needed by the challenges as well as to identify the catalogues and documentations where to find metadata describing data, how they can be discovered (visibility).

The elements of categories 4 to 6 are assessment criteria (eg coverage, resolution …) to be extracted from catalogues or from data providers information (production specifications) for later establishment of the fitness for purpose of data.

The elements of category 7 are not expected to be frequently available (eg spatial accuracy) from datasets metadata or from data provider information but when available, it has been asked to the challenge partners to report it in the template.

This initial work emphasized the need to adopt common vocabularies for their classification. This an important prerequisite towards data sharing and communication between data providers, data users and other stakeholders especially for projects dealing with a high number of datasets. In particular, the concept of checkpoint requires to group characteristics in accurate, consistent and controlled semantic categories for a better overview of what is needed or available and to make appear the common potential synergies among users of the same data sets.

For the purpose of the project, the SeaDataNet classification lists (P01 to P03) initially designed for marine data have been adopted because they offer :

-       the vocabularies are governed by a Governance Group ensuring the vocabulary is consistent with the needs and the practices of the marine community through time.

-       they are designed for discovery services

-       the SDN classification offers three different levels of granularity : the variables (SDN parameter list P01), the categories (SDN P02 list) and thes group of categories (SDN P03 list) allowing to navigate from the more general level of information to the most detailed one

-       the   vocabularies   and   definitions   are   available   on-line http://www.seadatanet.org/Standards-Software/Common-Vocabularies .

It   must   be   noted   that   the   classification   available   on http://www.eionet.europa.eu/gemet/inspire_themes will be mapped with the SDN classification to be compliant with the Inspire directive when cataloguing the data sets and collections needed by the challenge.

3 Identification and classification of the input data to Challenges

The results from the initial internal survey with the two templates (see section 2.2) are presented in the sections below.

3.1 Input Characteristic identification

The input Characteristics useful to the seven Challenges have been identified and they are described in the sections below.

3.1.1 Input characteristics for Ch. 1 : windfarm siting

- Air
  Wind speed (10, 40, 80, 120 and 180m), wind direction (10, 40, 80, 120 and 180m), air pressure (10, 40, 80, 120 and 180m), air density(10,40,80,120 and 180m), specific humidity (10, 40, 80, 120 and 180m), air temperature (10, 40, 80, 120 and 180m).

- Marine water
  Sea level, water temperature (several depths), water salinity (several depths), water velocity (several depths), wave spectra, wave height, wave direction, mean and peak wave period, swell wave height, maximum expected wave height.

- Seabed
  Bathymetry, seabed characteristics and substrate, sedimentary evolution, evolution of the coastline, energy at the seabed, angiosperms, macro-algae, invertebrate bottom fauna, seismic structure and events.

- Biota/Biology
  Bird, marine mammals, reptiles, fish: species, protected status and migratory patterns.

- Human activities
  Fishing activities, maritime traffic, radar infrastructures, port traffic, coastal land use, nautical activities, coast guards locations, national Grid Network (transmission and electric), capacity available on the line, regulatory constraints, landscape characteristics, port facilities, touristic or residential area ahead of the turbines, nautical activities, presence of infrastructure in the area (port with enough depth to assemble the turbines, logistical access for large and heavy items, towing capacity).

3.1.2 Input characteristics for Ch 2 : Marine Protected Areas

- Air

  Wind speed (10 m), wind direction(10m) , air pressure, air density(2m), specific humidity (2m), air temperature(2m).

- Marine water

  Water dissolved oxygen, pollutants in the water, water transparency, sea level, water temperature (several depths), water salinity (several levels), water velocity (several depths), light penetration or water transparency, Chlorophyll, wave spectra at predefined grid points, wave height, mean wave direction, wave mean period, peak wave period, swell wave height.

- Seabed

Bathymetry, seabed substrate, angiosperms, macro-algae, invertebrate bottom fauna, energy at the seabed, pollutants in sediments.

- Biota/biology

Bird, marine mammals, reptiles, fish: species, protected status and migratory patterns, pollutants in biota, phytoplankton abundance and species, zooplankton, invasive species.

- Human activities

Maritime traffic, Cultural heritage, Dredging, Fisheries zones, Hydrocarbon extraction, Major ports, Mariculture, Ocean energy facilities, Pipelines and cables, Protected areas, Waste disposal, Wind farms.

3.1.3 Input characteristics for Ch 3 : oil platform leak

- Air

Wind direction and amplitude, air temperature.

- Marine water

Water velocity direction and amplitude, water temperature, wave direction and amplitude, Stokes drift, oil API, oil slicks area and thickness.

- Seabed

Bathymetry, Coastline and coastal types, sedimentology, sea bed habitats, Environmental Sensitivity.

- Human activities

Marine and coastal infrastructures, mariculture, MPA, and transport routes, use of coastal areas.

3.1.4 Input characteristics for Ch 4 : climate and coastal protection

- Marine water
Sea surface elevation daily mean of the water body, sea surface elevation monthly mean of the water body, sea surface elevation hourly mean (Normal Low Water datum) of the water body by inverted echo sounder and averaging of higher frequency data, Temperature of water column (72 arbitrary depth levels), Sea surface temperature in situ-data, Sea surface temperature, remote sensing data.
- Seabed
Shoreline erosion trend, coast type.
- Human activities
Defence works, NUTS (Nomenclature of territorial units for statistics) area classification.

3.1.5 Input characteristics for Ch 5 : fisheries management

- Human activities
Fish catch, discard and by-catch per species (invasive species in particular)and by GSA (Geographical Sub-Areas) and/or by nations, Discard and by-catch per species (mammals, reptiles and sea-birds), Fishing fleet capacity, fishing time limitations and vessel types, localisation of fishing grounds (VMS, AIS, etc.).

3.1.6 Input characteristics for Ch 6 : marine environment

- Fresh water
River discharge location, Sewer discharge location, Freshwater discharge and temperature.

- Marine water
  Marine water dissolved oxygen, dissolved nitrogen (nitrate, nitrite, ammonia, DON), dissolved phosphorus (ortho-phosphate, DOP), silicates, total nitrogen (Tot_N), total phosphorus (Tot_P), Chlorophyll (Chl), water salinity, water temperature, water transparency, water currents at several depths, wave spectra, wave height , wave direction, mean and peak wave period, swell wave height; sea level, tidal range, marine litter, noise, contaminants.
- Seabed
  Bathymetry, sediments, granulometry, redox, benthic organisms.
- Biota/biology
  Primary Production, phytoplankton biomass and species, HAB species, mussels watch data', invasive species.

3.1.7 Input characteristics for Ch 7 : river inputs

- Fresh water:
  Freshwater discharge and temperature, Nutrient loads (nitrates, total nitrogen, phosphates, total phosphorous).
- Seabed
  Sediment loads.
- Biota/biology
  Eels abundance.

3.2 Challenges needs : consolidated list of characteristics

The results presented below are based on the collection of information on the upstream data needed by the challenge updated on the 15th of June 2014. This work carried out with the collaboration of the partners of each challenge is an iterative process. The identification of new datasets and the collection of metadata relevant for the classification will continue during the development of the challenge outputs.

The choice of the classification of the upstream data and the methodology adopted to collect information relevant to establish their fitness for purpose showed that :

- 99% of the upstream data needed by the challenges concern geo-referenced data.
- Less than 5% concern land surfaces, the other being related to the marine environment

The initial work to collect the preliminary list of upstream data showed that a "characteristic" refers to 3 kinds of entities :

- variables which result from an observation at given places of a property of an object or of a phenomenon
- gridded outputs from numerical models
- map layers representing the geographical features (position and geometry) of natural or man-made objects such as land use extents, protected areas, coastline or locations of wrecks defined by a set of vectors (polygon, curve, point) or by a raster.

Table 3 gives the list of the categories of characteristics grouped by environmental matrix and ordered alphabetically by Challenge, Environmental matrix, group of characteristic categories (P03 list), categories of characteristics (P02 list) and characteristics (P01 list when the characteristic is available) using the SeaDataNet Common vocabularies (http://www.seadatanet.org/Standards-Software/Common-Vocabularies).

For better understanding, Annex 2 provides the full definition of each of the 73 SDN categories of characteristic appearing in this table.

Challenge	Matrix		SDN P03 group		SDN P02 category of characteristic		Characteristic (SDN P01 codes and definitions in italic)
CH1	Air	M010	Meteorology	CAPH	Air pressure	CAPHZZ01	*Pressure (measured variable) exerted by the atmosphere*
CH1	Air	M010	Meteorology	CDTA	Air temperature and density		*Air density*
CH1	Air	M010	Meteorology	CDTA	Air temperature and density	CTMPZZ01	*Temperature of the atmosphere*
CH1	Air	M010	Meteorology	CHUM	Atmospheric humidity	CHUMSS01	*Specific humidity of the atmosphere*
CH1	Air	M010	Meteorology	EWSB	Wind speed and direction	ESEWZZXX	*Eastward wind velocity in the atmosphere (Zonal wind component)*
CH1	Air	M010	Meteorology	EWSB	Wind speed and direction	ESNSZZXX	*Northward wind velocity in the atmosphere (Meridional wind component)*
CH1	Biology/ biota	B070	Biota abundance, biomass and diversity	FABD	Fauna abundance per unit area of the bed		Marine Mammals : migratory routes
CH1	Biology/ biota	B070	Biota abundance, biomass and diversity	FABD	Fauna abundance per unit area of the bed		Marine Mammals : size
CH1	Biology/ biota	B070	Biota abundance, biomass and diversity	FABD	Fauna abundance per unit area of the bed		Marine Mammals : species
CH1	Biology/ biota	B015	Birds, mammals and reptiles	GP088	Bird behaviour		Birds : migratory patterns
CH1	Biology/ biota	B015	Birds, mammals and reptiles	BRDA	Bird counts		Birds : abundance
CH1	Biology/ biota	B015	Birds, mammals and reptiles	BRDA	Bird counts		Birds : species
CH1	Biology/ biota	B015	Birds, mammals and reptiles	GP04	Bird reproduction		Birds : reproduction area
CH1	Biology/ biota	B020	Fish	FABD	Fauna abundance per unit area of the bed		Fishes : species
CH1	Biology/ biota	B020	Fish	FAXT	Fish abundance in water bodies		Fishes : abundance
CH1	Biology/ biota	B020	Fish	FREP	Fish reproduction		Fishes : reproduction area
CH1	Human activities	H001	Anthropogenic contamination	LITT	Litter abundance and type		UXO : UneXploded Ordnance
CH1	Human activities	H002	Construction and structures	HZNV	Hazards to navigation		Underwater objects : presence of cables, wrecks, ...
CH1	Human activities	H002	Construction and structures	MMST	Man-made structures		Landscape : wind turbine visibility from shore
CH1	Human activities	H004	Fisheries	GP087	Fishery characterisation		Fishing : fishing area
CH1	Human activities	H004	Fisheries	GP087	Fishery characterisation		Fishing : fishing boat trafic
CH1	Human activities	H004	Fisheries	GP087	Fishery characterisation		Mariculture area
CH1	Human activities	H005	Human activity	ADUN	Administrative units		Military activities: exercice area
CH1	Human activities	H005	Human activity	ADUN	Administrative units		Reglementory : protected area (nearshore domain)
CH1	Human activities	H005	Human activity	IACT	Industrial activity		Extraction area
CH1	Human activities	H005	Human activity	MARC	Marine archaeology		Reglementory : historic/archeology site (WorldWar II)
CH1	Human activities	H005	Human activity	MARC	Marine archaeology		Reglementory : historic/archeology site (Wrecks)
CH1	Human activities	H005	Human activity	MLES	Marine environment leisure usage		Recreational activites : covered area
CH1	Human activities	H005	Human activity	TRAN	Transport activity		Coastal infrastructure : harbour storage capacity
CH1	Human activities	H005	Human activity	TRAN	Transport activity		Navigation : floating structures
CH1	Human activities	H005	Human activity	TRAN	Transport activity		Navigation : Maritime trafic route
CH1	Human activities	H005	Human activity	TRAN	Transport activity		Radar : covered area
CH1	Human activities	H005	Human activity	TRAN	Transport activity		Recreational activites :related trafic
CH1	Human activities	H005	Human activity	ZZZZ	Unspecified		Military activities: location of military bases
CH1	Human activities	H005	Human activity	ZZZZ	Unspecified		Other professional activites areas ...

CH1	Marine water	D30	Currents	RFVL	Horizontal velocity of the water column (currents)	LCEWZZ01	Eastward current velocity in the water body (Water zonal velocity component)
CH1	Marine water	D30	Currents	RFVL	Horizontal velocity of the water column (currents)	LCNSZZ01	Northward current velocity in the water body (Water meridional velocity component)
CH1	Marine water	D032	Sea level	ASLV	Sea level	ASLVZZ01	Surface elevation (unspecified datum) of the water body (Sea level)
CH1	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	ODSDM021	Salinity of the water body
CH1	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01	Temperature of the water body
CH1	Marine water	D034	Waves	WVSP	Spectral wave data parameters		2-dimensional Wave spectra over frequencies and directions
CH1	Marine water	D034	Waves	GWDR	Wave direction	GWDRZZ01	Direction of waves on the water body (Mean wave direction)
CH1	Marine water	D034	Waves	WVST	Wave height and period statistics	GHSWZZ01	Height of swell waves on the water body
CH1	Marine water	D034	Waves	WVST	Wave height and period statistics	GCMXVA01	Maximum height of waves on the water body by waverider (Maximum expected wave height)
CH1	Marine water	D034	Waves	WVST	Wave height and period statistics		Mean (Energy) wave period
CH1	Marine water	D034	Waves	WVST	Wave height and period statistics	GTPKZZ01	Period at spectral maximum of waves on the water body (Peak wave period)
CH1	Marine water	D034	Waves	WVST	Wave height and period statistics	GTDHZZ01	Significant height of waves {Hs} on the water body
CH1	Seabed	G045	Rock and sediment lithology and mineralogy	LITH	Lithology		Sediments spatial distribution
CH1	Seabed	G045	Rock and sediment lithology and mineralogy	LITH	Lithology		Sediments nature
CH1	Seabed	GSED	Rock and sediment sedimentology	SSTR	Sedimentary structure		Sediments thickness
CH1	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features	MBANMODL	Sea-floor depth (below unspecified datum) {bathymetric depth} in the water body by modelling of satellite altimetry and sounding data Bathymetry from basin scale model
CH1	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Coastal infrastructure : acces channel depth
CH1	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Coastal infrastructure : port depth
CH2	Biology/ biota	Z005	Positioning, references and data management	ALAT	Horizontal spatial co-ordinates (tracking included)		Wildlife tracking
CH2	Biology/ biota	B015	Birds, mammals and reptiles	BRDA	Bird counts		Seabirds (counts ?)
CH2	Biology/ biota	B070	Biota abundance, biomass and diversity	CETA	Cetacean abundance		Cetacean (abundance ?)
CH2	Biology/ biota	B070	Biota abundance, biomass and diversity	FABD	Fauna abundance per unit area of the bed		Endangered species (invertebrates)
CH2	Biology/ biota	B070	Biota abundance, biomass and diversity	FABD	Fauna abundance per unit area of the bed		Invasive species
CH2	Biology/ biota	B020	Fish	FATX	Fish abundance in water bodies		Fish : demersal, pelagic (fish abundance ?)
CH2	Biology/ biota	B070	Biota abundance, biomass and diversity	FOCA	Seal abundance		Monk seal (seal abundance ?)
CH2	Biology/ biota	B070	Biota abundance, biomass and diversity	GP068	Reptile abundance		Marine turtles (abundance ?)
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Coastal lagoons and estuaries
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Coralligenous formations
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Cystoseira
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Feeding, breeding, wintering or resting areas
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Maerl beds
CH2	Biology/ biota		Habitat	HBEX	Habitat extent		Populations of protected species at any stage of their life cycle and migratory patterns
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Posidonia oceanica
CH2	Biology/ biota	B050	Habitat	HBEX	Habitat extent		Seagrass distribution
CH2	Biology/ biota	B055	Macroalgae and seagrass	PU02	Macroalgae generic abundance in water bodies		Endangered species (macroalgae)

CH2	Fresh water	D30	Currents	RVDS	River flow and discharge		Runoff water
CH2	Human activities	T001	Terrestrial (including bathymetry and undersea features)	COAS	Terrestrial mapping		Urbanization (coastal cities, major ports)
CH2	Human activities	H001	Anthropogenic contamination	GP001	Pollution events		Oil spill
CH2	Human activities	B020	Fish	GP087	Fishery characterisation		Aquaculture/ Mariculture
CH2	Human activities	B020	Fish	GP087	Fishery characterisation		Fisheries zones
CH2	Human activities	H002	Construction and structures	HZNV	Hazards to navigation		Pipelines and cables
CH2	Human activities	H005	Human activity	IACT	Industrial activity		Dredging
CH2	Human activities	H005	Human activity	IACT	Industrial activity		Hydrocarbon extraction
CH2	Human activities	H005	Human activity	IACT	Industrial activity		Industry
CH2	Human activities	H005	Human activity	IACT	Industrial activity		Ocean energy facilities
CH2	Human activities	H001	Anthropogenic contamination	LITT	Litter abundance and type		Waste disposal
CH2	Human activities	H005	Human activity	MARC	Marine archaeology		Cultural heritage
CH2	Human activities	H005	Human activity	MLES	Marine environment leisure usage		Tourism
CH2	Human activities	H002	Construction and structures	MMST	Man-made structures		Offshore Wind farms
CH2	Human activities	H005	Human activity	TRAN	Transport activity		Anchoring zones
CH2	Human activities	H005	Human activity	TRAN	Transport activity		Maritime traffic
CH2	Human activities	H005	Human activity	ZZZZ	Unspecified		Trawling
CH2	Marine water	H005	Human activity	ADUN	Administrative units		Existing MPAs (e.g. EU Nationally Designated Areas, Fisheries Restriction Areas, Natura 2000, SPAMI, National MPAs, Ramsar, etc.)
CH2	Marine water	H005	Human activity	ADUN	Administrative units		Fisheries Restricted Areas
CH2	Marine water	H005	Human activity	ADUN	Administrative units		Proposed MPAs (e.g. ACCOBAMS, Oceana, Greenpeace etc.)
CH2	Marine water	B035	Pigments	CPWC	Chlorophyll pigment concentrations in the water column	CHLTVOLU	*Concentration of chlorophyll per unit volume of the water body* (Chlorophyll mean)
CH2	Marine water	C015	Dissolved gases	DOXY	Dissolved oxygen parameters in the water column	DOXYZZ01	*Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by in-situ senso.* Dissolved oxygen (bottom)
CH2	Marine water	C015	Dissolved gases	DOXY	Dissolved oxygen parameters in the water column	DOXYZZ01	*Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by in-situ sensor.* Dissolved oxygen (surface)
CH2	Marine Water	H001	Anthropogenic contamination	NOYS	Acoustic noise in the water column		Noise pollution,
CH2	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	ASLTZZ01	*Absolute salinity of the water body* (bottom)
CH2	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	ASLTZZ01	*Absolute salinity of the water body* (mean)
CH2	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	ASLTZZ01	*Absolute salinity of the water body* (surface)
CH2	Marine water	C005	Carbon, nitrogen and phosphorus	SAMO	Nutrient fluxes between the bed and the water column	SAMOISSS	*Steady-state flux (into water) of ammonium {NH4} per unit time per unit area of the bed by in-situ incubation and calculation from rate of change of concentration in overlying water.* Nutrients (mean)
CH2	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01	*Temperature of the water body* (bottom))
CH2	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01	*Temperature of the water body* (mean)
CH2	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01	*Temperature of the water body* (surface)
CH2	Marine water	D30	Currents	VDFC	Transport in the water column		Strait fluxes
CH2	Marine water	D30	Currents	VDFC	Transport in the water column		Upwelling areas
CH2	Marine water	Z005	Positioning, references and data management	ZZZZ	Unspecified		ARGOS collected parameters not defined

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CH2	Seabed	G060	Sedimentation and erosion processes	BEST	Sediment resuspension		Coastal erosion
CH2	Seabed	G060	Sedimentation and erosion processes	BEST	Sediment resuspension		Energy at the seabed
CH2	Seabed	GSED	Rock and sediment sedimentology	DPEV	Depositional environment		Description of depositional environment type of sediment by classification to a term from CGI Event Environment Vocabulary (TypeDepEnvSed)
CH2	Seabed	G045	Rock and sediment lithology and mineralogy	LITH	Lithology		Seabed characteristics and substrate
CH2	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Bathymetry
CH2	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Deep sea canyons
CH2	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Hydrothermal vents and cold seeps
CH2	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Sea caves
CH2	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features		Sea mounts
CH2	Seabed	G060	Sedimentation and erosion processes	RACC	Sediment accumulation rate		Coastal deposition
CH2	UN	H001	Anthropogenic contamination	ZZZZ	Unspecified		Pollution
CH3	Air	M010	Meteorology	EWSB	Wind speed and direction	WINDXMOD	Wind velocity (10m along x-axis) in the atmosphere by model prediction
CH3	Air	M010	Meteorology	EWSB	Wind speed and direction	WINDYMOD	Wind velocity (10m along y-axis) in the atmosphere by model prediction
CH3	Biology/biota	B050	Habitat	HBEX	Habitat extent		Seabed Habitats
CH3	Human activites	H002	Construction and structures	MMST	Man-made structures		Defence works
CH3	Human activities	H001	Anthropogenic contamination	GP001	Pollution events		Oil API (note : American Petroleum Institute gravity)
CH3	Human activities	H001	Anthropogenic contamination	GP001	Pollution events		Oil Slick Area
CH3	Human activities	H001	Anthropogenic contamination	GP001	Pollution events		Oil Slick Thickness
CH3	Human activities	H005	Human activity	TRAN	Transport activity		AIS density
CH3	Human activities	H005	Human activity	ZZZZ	Unspecified		Environmental Sensitivity of the coastline
CH3	Human activities	T001	Terrestrial (including bathymetry and undersea features)	COAS	Terrestrial mapping		Use of coastal areas
CH3	Marine water	D30	Currents	RFVL	Horizontal velocity of the water column (currents)	LCEWZZ01	Eastward current velocity in the water body
CH3	Marine water	D30	Currents	RFVL	Horizontal velocity of the water column (currents)	LCNSZZ01	Northward current velocity in the water body
CH3	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01	Temperature of the water body
CH3	Marine water	D034	Waves	GWDR	Wave direction	GWDRTO01	Direction (towards) of waves on the water body
CH3	Marine water	D034	Waves	WVST	Wave height and period statistics	GTZAM2ZZ	Period (at second spectral moment) of waves on the water body
CH3	Marine water	D034	Waves	WVST	Wave height and period statistics	HMZEZZ01	Spectral significant height of waves {Hm0} on the water body
CH3	Seabed	G045	Rock and sediment lithology and mineralogy	LITH	Lithology		Seabed substrate
CH3	Seabed	G040	Rock and sediment physical properties	MNGS	Sediment grain size parameters		Seabed substrate
CH3	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features	MBANMODL	Sea-floor depth (below unspecified datum) {bathymetric depth} in the water body by modelling of satellite altimetry and sounding data
CH3	Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features	MBANESND	Sea-floor depth (below unspecified datum) {bathymetric depth} in the water body by echo sounder
CH3	SeaBed	T001	Terrestrial (including bathymetry and undersea features)	COGE	Coastal geomorphology		Coast type
CH4	Human activites	H002	Construction and structures	MMST	Man-made structures		Defence works
CH4	Marine water	D032	Sea level	ASLV	Sea level	ASLVMNDY	Surface elevation daily mean (unspecified datum) of the water body
CH4	Marine water	D032	Sea level	ASLV	Sea level	ASLVMNMO	Surface elevation monthly mean (unspecified datum) of the water body
CH4	Marine water	D032	Sea level	ASLV	Sea level	ASLVNL60	Surface elevation hourly mean (Normal Low Water datum) of the water body by inverted echo sounder and averaging of higher frequency data
CH4	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01	Temperature of the water body
CH4	Seabed	T001	Terrestrial (including bathymetry and undersea features)	COGE	Coastal geomorphology		Coast type
CH4	Seabed	T001	Terrestrial (including bathymetry and undersea features)	COGE	Coastal geomorphology		Shoreline erosion trend

CH5	Biology/biota	B020	Fish	FCST	Fish and shellfish catch statistics		Mass of discards of fish by species, country, year and fleet segment (escluding shellfish)
CH5	Biology/biota	B020	Fish	FCST	Fish and shellfish catch statistics		Mass of landings of fish by species, country and year (escluding shellfish)
CH5	Biology/biota	B020	Fish	FCST	Fish and shellfish catch statistics		Mass of landings of fish by species, country, year and fleet segment (escluding shellfish)
CH5	Biology/biota	B020	Fish	FCST	Fish and shellfish catch statistics		Number of discards of fish by species, country, year and fleet segment (escluding shellfish)
CH5	Biology/biota	B020	Fish	FCST	Fish and shellfish catch statistics		Number of landings of fish by species, country, year and fleet segment (escluding shellfish)
CH5	Biology/biota	B020	Fish	GP080	Fishing by-catch		Mass of bycatch of mammals by species, country and year
CH5	Biology/biota	B020	Fish	GP080	Fishing by-catch		Mass of bycatch of reptiles by species, country and year
CH5	Biology/biota	B020	Fish	GP080	Fishing by-catch		Mass of bycatch of sea birds by species, country and year
CH5	Biology/biota	B020	Fish	GP080	Fishing by-catch		Number of bycatch of mammals by species, country and year
CH5	Biology/biota	B020	Fish	GP080	Fishing by-catch		Number of bycatch of reptiles by species, country and year
CH5	Biology/biota	B020	Fish	GP080	Fishing by-catch		Number of bycatch of sea birds by species, country and year
CH5	Human activities	Z005	Positioning, references and data management	ACYC	Reference numbers		Tracking AIS raw data Italy
CH5	Human activities	Z005	Positioning, references and data management	ACYC	Reference numbers		Tracking GPS logger data Italy
CH5	Human activities	Z005	Positioning, references and data management	ACYC	Reference numbers		Tracking VMS raw data Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, Spain
CH5	Human activities	Z005	Positioning, references and data management	ALAT	Horizontal spatial co-ordinates		Tracking GPS logger data Italy
CH5	Human activities	Z005	Positioning, references and data management	ALAT	Horizontal spatial co-ordinates		Tracking AIS raw data Italy
CH5	Human activities	Z005	Positioning, references and data management	ALAT	Horizontal spatial co-ordinates		Tracking VMS raw data Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, Spain
CH5	Human activities	Z005	Positioning, references and data management	APDA	Horizontal platform movement		Tracking AIS raw data Italy
CH5	Human activities	Z005	Positioning, references and data management	APDA	Horizontal platform movement		Tracking GPS logger data Italy
CH5	Human activities	Z005	Positioning, references and data management	APDA	Horizontal platform movement		Tracking VMS raw data Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, Spain
CH5	Human activities	H005	Human activity	FEFF	Fishing effort		Effort data (N. boat x Fishing days) by year, counry and fleet segment
CH6	Marine water	C005	Carbon, nitrogen and phosphorus	AMON	Ammonium concentration parameters in the water column	AMONAAD1	Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate]
CH6	Marine water	D032	Sea level	ASLV	Sea level	ASLVZZ01	Surface elevation (unspecified datum) of the water body
CH6	Marine water	D015	Optical properties	ATTN	Transmittance and attenuance of the water column		Daily Attenuation Coefficient at 490nm
CH6	Marine water	D015	Optical properties	ATTN	Transmittance and attenuance of the water column		Monthly Attenuation Coefficient at 490nm
CH6	Marine water	D015	Optical properties	ATTN	Transmittance and attenuance of the water column		Weekly Attenuation Coefficient at 490nm
CH6	Marine water	D015	Optical properties	ATTN	Transmittance and attenuance of the water column		Attenuation Coefficient
CH6	Marine water	D015	Optical properties	ATTN	Transmittance and attenuance of the water column		Diffuse attenuation coefficient at 490nm
CH6	Marine water	D015	Optical properties	ATTN	Transmittance and attenuance of the water column		Transmittance and attenuance of the water columnn
CH6	Marine water	D015	Optical properties	CNTX	Phytoplankton generic biomass in water bodies	CTPPCVXX	Carbon biomass of phytoplankton per unit volume of the water body by optical microscopy and abundance to carbon conversion
CH6	Marine water	B035	Pigments	CPWC	Chlorophyll pigment concentrations in the water column	CHLAMSAT	Concentration of chlorophyll-a {chl-a} per unit volume of the water body by synthesis from multiple satellite sensors
CH6	Marine water	B035	Pigments	CPWC	Chlorophyll pigment concentrations in the water column	CPHLZZXX	Concentration of chlorophyll-a per unit volume of the water body [particulate >unknown phase]

CH6	Marine water	D30	Currents	LRZA	Vertical velocity of the water column (currents)			Vertical velocity in the water column
CH6	Marine water	C005	Carbon, nitrogen and phosphorus	NTOT	Particulate total and organic nitrogen concentrations in the water column	MDMAP013		*Concentration of nitrogen (total) per unit volume of the water body [particulate >unknown phase]* N concentration in water ?
CH6	Marine water	C005	Carbon, nitrogen and phosphorus	NTRA	Nitrate concentration parameters in the water column	CHEMM012		*Concentration of nitrate {NO3} per unit volume of the water body [dissolved plus reactive particulate phase] by colorimetric autoanalysis and correction for nitrite*
CH6	Marine water	C005	Carbon, nitrogen and phosphorus	NTRI	Nitrite concentration parameters in the water column	NO2FLTIC		*Concentration of nitrite {NO2} per unit volume of the water body [dissolved plus reactive particulate]*
CH6	Marine water	C005	Carbon, nitrogen and phosphorus	PHOS	Phosphate concentration parameters in the water column	PHOSAAD1		*Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate*
CH6	Marine water	C005	Carbon, nitrogen and phosphorus	PHOS	Phosphate concentration parameters in the water column	PHOSZZXX		*Concentration of phosphate {PO4} per unit volume of the water body [unknown phase]* P concentration in water
CH6	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	ODSDM021		*Salinity of the water body*
CH6	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	PSLTZZ01		*Practical salinity of the water body*
CH6	Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	SSALST01		*Salinity of the water body by CTD*
CH6	Marine water	D025	Water column temperature and salinity	PSST	Skin temperature of the water column	TEMPAV01		*Skin temperature of the water body by advanced very high resolution radiometer (AVHRR)*
CH6	Marine water	D025	Water column temperature and salinity	PSST	Skin temperature of the water column			Sea Surface Temperature (Multisensor)
CH6	Marine water	D025	Water column temperature and salinity	PSST	Skin temperature of the water column			Sea Surface Temperature anomaly
CH6	Marine water	D30	Currents	RFVL	Horizontal velocity of the water column (currents)	LCEWZZ01		*Eastward current velocity in the water body*
CH6	Marine water	D30	Currents	RFVL	Horizontal velocity of the water column (currents)	LCNSZZ01		*Northward current velocity in the water body*
CH6	Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	TEMPPR01		*Temperature of the water body*
CH7	Biota	B020	Fish	FATX	Fish abundance in water bodies			Eels abundance
CH7	Fresh water	C005	Carbon, nitrogen and phosphorus	NTOT	Dissolved total and organic nitrogen concentrations in the water column	MDMAP013		*Concentration of nitrogen (total) per unit volume of the water body [particulate >unknown phase]* Total dissolved nitrogen concentrations in the water column*
CH7	Fresh water	C005	Carbon, nitrogen and phosphorus	NTRA	Nitrate concentration parameters in the water column			Nitrate concentration in filtered sample (dissolved phase) of the water column*
CH7	Fresh water	C005	Carbon, nitrogen and phosphorus	PHOS	Phosphate concentration parameters in the water column			Phospate concentration in filtered sample (dissolved phase) of the water column*
CH7	Fresh water	D30	Currents	RVDS	River flow and discharge	RFDSCH01		
CH7	Fresh water	C005	Carbon, nitrogen and phosphorus	TDPX	Dissolved total or organic phosphorus concentration in the water column			Total dissolved phosphorus concentration in the water column*
CH7	Fresh water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	PSSTZZ01		*Temperature of the water body*
CH7	Fresh water	G015	Suspended particulate material	TSED	Concentration of suspended particulate material in the water column	TSEDZZZZ		*Concentration of suspended particulate material {SPM} per unit volume of the water body*

Table 2 : list of characteristics by Challenge, Environmental matrix, SDN group and SDN category

The combination of the environmental matrices and the SDN classification allows the standardization of the needs expressed by the Challenges (Table 3) and graphical comparisons between Challenges in terms of required characteristics.

From Table 3 it is interesting to note that Challenges require 73 different characteristic categories and in particular: 4 in the Air matrix, 16 in the Biology/Biota matrix, 7 in the Fresh water and 22 in the Marine water matrix, 8 in the Seabed matrix and 16 in the Human Activities matrix.

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Matrix	SDN P03 code	SDN P03 name	SDN P02 code	SDN P02 name	CH1	CH2	CH3	CH4	CH5	CH6	CH7
Air	M010	Meteorology	CAPH	Air pressure	1						
Air	M010	Meteorology	CDTA	Air temperature and density	1						
Air	M010	Meteorology	CHUM	Atmospheric humidity	1						
Air	M010	Meteorology	EWSB	Wind speed and direction	1		1				
Biology/biota	B070	Biota abundance, biomass and diversity	FABD	Fauna abundance per unit area of the bed	1	1					
Biology/biota	B015	Birds, mammals and reptiles	GP088	Bird behaviour	1						
Biology/biota	B015	Birds, mammals and reptiles	BRDA	Bird counts	1	1					
Biology/biota	B015	Birds, mammals and reptiles	GP04	Bird reproduction	1						
Biology/biota	B015	Birds, mammals and reptiles	CETA	Cetacean abundance		1					
Biology/biota	B015	Birds, mammals and reptiles	GP068	Reptile abundance		1					
Biology/biota	B015	Birds, mammals and reptiles	FOCA	Seal abundance		1					
Biology/biota	B020	Fish	FATX	Fish abundance in water bodies	1	1					1
Biology/biota	B020	Fish	FREP	Fish reproduction	1						
Biology/biota	H004	Fisheries	FCST	Fish and shellfish catch statistics					1		
Biology/biota	H004	Fisheries	GP080	Fishing by-catch					1		
Biology/biota	B050	Habitat	HBEX	Habitat extent		1	1				
Biology/biota	B055	Macroalgae and seagrass	PU02	Macroalgae generic abundance in water bodies		1					
Biology/biota	Z005	Positioning (animal monitoring)	ACYC	Reference numbers		1					
Biology/biota	Z005	Positioning (animal monitoring)	ALAT	Horizontal spatial co-ordinates		1					
Biology/biota	Z005	Positioning (animal monitoring)	APDA	Horizontal platform movements		1					
Fresh water	C005	Carbon, nitrogen and phosphorus	NTOT	Dissolved total and organic nitrogen concentrations in the water column							1
Fresh water	C005	Carbon, nitrogen and phosphorus	TDPX	Dissolved total or organic phosphorus concentration in the water column							1
Fresh water	C005	Carbon, nitrogen and phosphorus	NTRA	Nitrate concentration parameters in the water column							1
Fresh water	C005	Carbon, nitrogen and phosphorus	PHOS	Phosphate concentration parameters in the water column							1
Fresh water	D30	Currents	RVDS	River flow and discharge		1					1
Fresh water	G015	Suspended particulate material	TSED	Concentration of suspended particulate material in the water column							1
Fresh water	D025	Water column temperature and salinity	TEMP	Temperature of the water column							1
Human activities	H001	Anthropogenic contamination	LITT	Litter abundance and type	1	1					
Human activities	H001	Anthropogenic contamination	GP001	Pollution events		1	1				
Human activities	H002	Construction and structures	HZNV	Hazards to navigation	1	1					
Human activities	H002	Construction and structures	MMST	Man-made structures	1	1	1	1			
Human activities	H004	Fisheries	GP087	Fishery characterisation	1	1					
Human activities	H004	Fisheries	FEFF	Fishing effort					1		
Human activities	H005	Human activity	ADUN	Administrative units	1	1	1				
Human activities	H005	Human activity	IACT	Industrial activity	1	1					
Human activities	H005	Human activity	MARC	Marine archaeology	1	1					
Human activities	H005	Human activity	MLES	Marine environment leisure usage	1	1					
Human activities	H005	Human activity	TRAN	Transport activity	1	1	1				
Human activities	H005	Human activity		Trawling activityc and impact	1	1	1		1		
Human activities	Z005	References and positioning	APDA	Horizontal platform movement (and tracking)		1			1		
Human activities	Z005	References and positioning	ALAT	Horizontal spatial co-ordinates (and tracking)		1			1		
Human activities	Z005	References and positioning	ACYC	Reference numbers (and tracking)		1			1		
Human activities	T001	Terrestrial (including bathymetry and undersea features)	COAS	Terrestrial mapping	1	1					
Marine water	H001	Anthropogenic contamination	NOYS	Acoustic noise in the water column		1					
Marine water	C005	Carbon, nitrogen and phosphorus	AMON	Ammonium concentration parameters in the water column					1		
Marine water	C005	Carbon, nitrogen and phosphorus	NTRA	Nitrate concentration parameters in the water column					1		
Marine water	C005	Carbon, nitrogen and phosphorus	NTRI	Nitrite concentration parameters in the water column					1		
Marine water	C005	Carbon, nitrogen and phosphorus	SAMO	Nutrient fluxes between the bed and the water column		1					
Marine water	C005	Carbon, nitrogen and phosphorus	NTOT	Particulate total and organic nitrogen concentrations in the water column					1		
Marine water	C005	Carbon, nitrogen and phosphorus	PHOS	Phosphate concentration parameters in the water column					1		
Marine water	D030	Currents	RFVL	Horizontal velocity of the water column (currents)	1		1		1		
Marine water	D030	Currents	VDFC	Transport in the water column		1					
Marine water	D030	Currents	LRZA	Vertical velocity of the water column (currents)					1		
Marine water	C015	Dissolved gases	DOXY	Dissolved oxygen parameters in the water column		1					
Marine water	H005	Human activity	ADUN	Administrative units		1					
Marine water	D015	Optical properties	ATTN	Transmittance and attenuation of the water column					1		
Marine water	B030	Phytoplankton	CNTX	Phytoplankton generic biomass in water bodies					1		
Marine water	B035	Pigments	CPWC	Chlorophyll pigment concentrations in the water column		1			1		
Marine water	D032	Sea level	ASLV	Sea level	1			1	1		
Marine water	D025	Water column temperature and salinity	PSAL	Salinity of the water column	1	1			1		
Marine water	D025	Water column temperature and salinity	PSST	Skin temperature of the water column					1		
Marine water	D025	Water column temperature and salinity	TEMP	Temperature of the water column	1	1	1	1	1		
Marine water	D034	Waves	GWDR	Wave direction	1		1				
Marine water	D034	Waves	WVST	Wave height and period statistics	1		1				
Marine water	D034	Waves	WVSP	Spectral wave data parameters	1						
Seabed	G045	Rock and sediment lithology and mineralogy	LITH	Lithology	1	1	1				
Seabed	G040	Rock and sediment physical properties	MNGS	Sediment grain size parameters			1				
Seabed	GSED	Rock and sediment sedimentology	DPEV	Depositional environment		1					
Seabed	GSED	Rock and sediment sedimentology	SSTR	Sedimentary structure	1						
Seabed	G060	Sedimentation and erosion processes	RACC	Sediment accumulation rate		1					
Seabed	G060	Sedimentation and erosion processes	BEST	Sediment resuspension		1					
Seabed	T001	Terrestrial (including bathymetry and undersea features)	MBAN	Bathymetry, elevation and undersea features	1	1	1				
SeaBed	T001	Terrestrial (including bathymetry and undersea features)	COGE	Coastal geomorphology		1	1	1			

Table 3: Overview of the characteristic categories (P02 column) required by the Challenges ordered by environmental matrix and group of categories (P03 column)

Each challenge has its own spectrum of needs and associated sources of data appropriate to its output: in figure 3 we show the number of characteristics for each challenge, subdivided among the environmental matrices. Challenge 1 and 2 are clearly having the broader spectrum in term of matrices and the highest number of different characteristics categories making the two Challenges 'similar' while Challenge 6 with the lowest number of matrices and the limited number of categories seems to be very different from all the others .
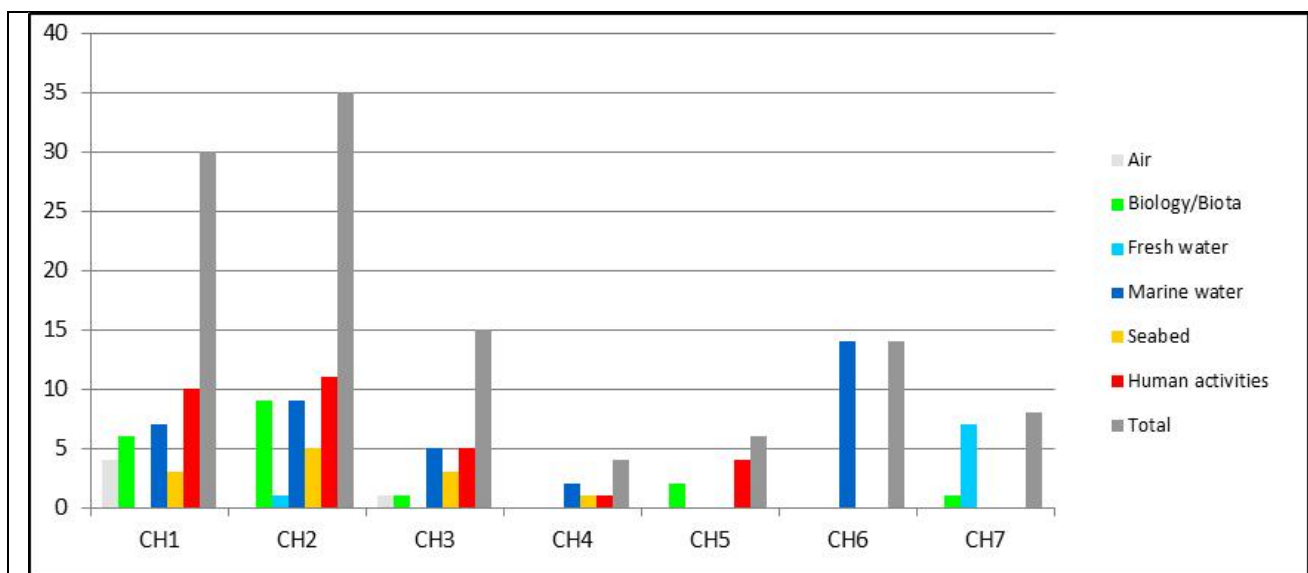

Figure 3 : number of characteristic categories by challenge and by environmental matrix

This standardization offers a powerful visual solution to identify applications sharing common needs in term of data requirements. This in turn suggests to explore this way to route end-users and stakeholders towards sources of data which could be relevant for a new application using viewing tool to show the similarities of needs after transformation in a common vocabulary.

In addition, this standardization allows to give an overview of the categories most frequently requested by the Challenges and this is reported in Table 4.

Growth and innovation in ocean economy
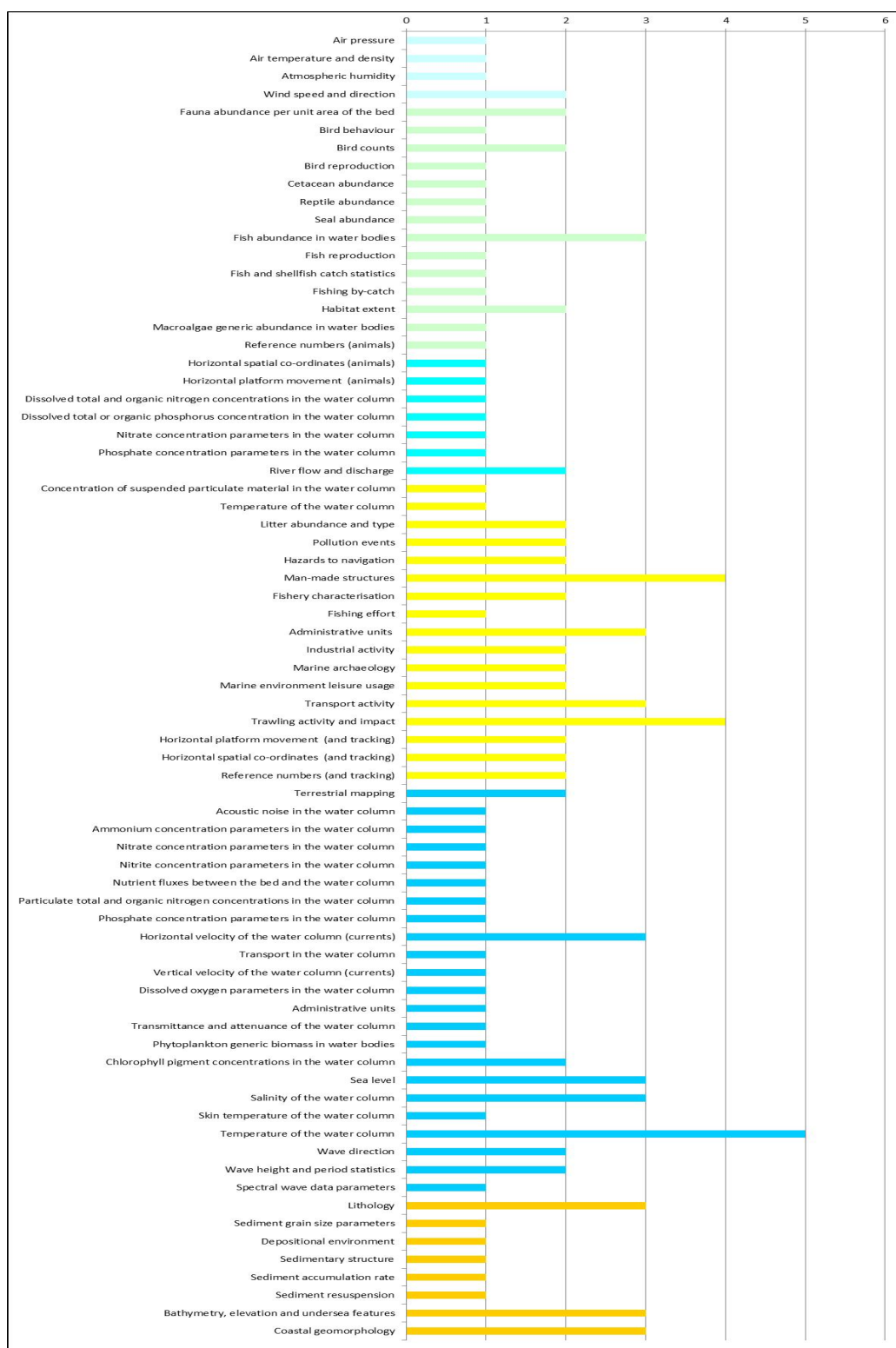**Gaps and priorities in sea basin observation and data**

Table 4 : Number of times a characteristic category is required (colors correspond to the environmental matrices : orange = seabed, deep blue = marine water, yellow = human activities, turquoise = fresh water, green = biology/biota, light blue = air)

Based on the number of times a characteristic category is requested, Table 5 highlights, extracting it from Table 4, the recurrent needs in terms of characteristics required more than twice by the Challenges.

Environmental Matrix	Characteristic category
Seabed	Bathymetry Lithology Coastal geomorphology
Marine water	Temperature Salinity Sea level Currents
Biology/ biota	Fish abundance
Human activities	Man-made structures Administrative units (MPAs…) Transport activities Trawling activities and impact

Table 5 : Characteristic categories being requested more than twice by the Challenges. See also Table 4.

3.3 Data sources and providers needed by the Challenges

An important result of the survey is the identification of the data sources and datasets needed by the Challenge for each characteristic category. The detailed results (greater than 500 entries) are given in the Annex 3. The web links associated to the sources of data have been added when appropriate and possible.

One of the difficulties to analyse the upstream data sources is the lack of unique identifiers of the dataset collections. They are identified most frequently by end-users using the name of a website in combination with the characteristic, the web site being either the one from the data provider organization or the one from a project, less frequently a specific data access website (eg data.shom.fr) or the dataset or collection name when very well known (eg Corine Land Cover) or an editorial company for publications.

Nevertheless, the Annex 3 of the present document gives an overview of the characteristics needed by the challenges and their input data sources. This has been carried out in spite of the lack of a catalogue containing all the identified sources of data because EU catalogues (INSPIRE Geoportal, EDMED) are not up-to-date and because they are not designed for datasets held in non EU states (INSPIRE Geoportal) or for datasets related to land surfaces (EDMED). One must emphasize the complexity of the Geoportal to search datasets which may have discouraged partners to look for the description of collections in it.

Table 6 below summarizes the 112 data providers that are needed to collect the characteristics required by the Challenges. From Annex 3 it is also evident that the same characteristic is accessed by the different challenge from a different data provider. The data collection for these input characteristics is under the responsibility of different actors, from national agencies and institutions (eg Hydrographic office), EU organizations to program consortia, International bodies and a few US organizations (mainly for satellite data).

1	ACCOBAMS	57	Med-Hycos
2	AEMET	58	MEDISEH
3	Aires Marines Protegees	59	MEDPAN
4	AIS (Automatic Identification System)	60	MEDPAN/MAPAMED
5	ARGOS wildlife tracking project ?	61	MNHN data ?
6	ARPEGE	62	MONGOOS - AFS
7	AVISO CLS	63	MONGOOS - ALERMO
8	Awsassets.panda.org	64	MONGOOS - CYCOFOS Levantine 1
9	BIRDLIFE	65	MONGOOS - CYCOFOS Levantine 2
10	Boussole	66	MONGOOS - CYPPOM Aegean-Levantine
11	CETACEANALLIANCE	67	MONGOOS - IBI-MFC model
12	CETACEANALLIANCE (Pelagos Sanctuary)	68	MONGOOS - MARIA/WAM Central Med
13	CISL Research Data Archive	69	MONGOOS - MFC-Currents
14	COASTCOLOUR	70	MONGOOS - POSEIDON 3
15	COCONET	71	MONGOOS - POSEIDON 4
16	Community Surface Dynamics Modeling System (CSDMS)	72	MONGOOS - POSEIDON 7
17	Corine Land Cover 2006 seamless vector data	73	MONGOOS - POSEIDON 8
18	CSDMS (Community Surface Dynamics Modeling System)	74	MONGOOS - PREVIMER-MENOR
19	Data Collection (DCR - DCF) for the Common Fisheries	75	MONGOOS - ROSARIO
20	data.shom.fr	76	MONGOOS - Sicily Channel Regional sub-Model Forecasting System
21	EEA - EIONET	77	MONGOOS - Western Mediterranean sub-Regional Model Forecasting System
22	EEA Geology_Geomorphology_ErosionTrend	78	MONGOOS - CNR-ISAC
23	EMODNET Physics	79	MONGOOS - SAMPA
24	EMODNET Bathymetry	80	MYOCEAN
25	EMODNET Biology	81	MYOCEAN CNR-ISAC
26	EMODNET Chemistry	82	NAUSICAA
27	EMODNET Geology	83	NOAA CLASS
28	EMODnet Seabed Habitats	84	Oceana 2011
29	European Centre for Medium-Range Weather Forecasts (ECMWF)	85	Oceancolor
30	European Sediment Network (SedNet)	86	PANGAEA
31	EUROWATERNET	87	Permanent Service for Mean Sea Level_tide gauge sea level (PSMSL)
32	Existing and Proposed Protected Areas : Micheli et al. 2014	88	Perseus
33	FAO capture and aquaculture database	89	POODAC
34	FAO FishStat	90	POSEIDON
35	FAO GFCM (General Fisheries Commission for the Mediterranean)	91	PREMAR
36	FAO World River Sediment Yields	92	PROTECTEDPLANET
37	FIRST MARINE WORLD HERITAGE	93	RAC-SPA
38	French Army data	94	RAMSAR
39	FRIEND	95	REMPEC oil type database
40	GEBCO (General Bathymetric Chart of the Oceans)	96	REMSS (Remote Sensing Systems)
41	Giakoumi, et. Al, 2013	97	RivDIS
42	GPS Logger Italy	98	SACOSTA
43	GRDC (Global Runoff Data Center)	99	SeaBASS
44	HadISST	100	SEADATANET
45	HIRLAM, WRF	101	SESAME
46	HyMeX	102	SIH (French Fisheries Information System)
47	ICES Oceanography	103	SKIRON
48	Idromare	104	SONEL
49	International Commission for the Conservation of Atlantic Tunas (ICCAT)	105	SPAMI
50	Inter-regional direction of Mediterranean Sea (DIRM) data ?	106	UNEP Medpol
51	Inventaire National du Patrimoine Naturel MNHN	107	University of Hawaii Sea Level Center (UHSLC) ?
52	ISPRA	108	VMS (Vessel monitoring systems)
53	IUCN Marine Protected Areas	109	Water Programme Directory
54	MALTA/Maria ETA Model	110	Water Systems Analysis Group (WSAG)
55	MARBEF	111	WISE
56	MEDAR/MEDATLAS	112	WWF

Table 6: providers of upstream data identified by the challenges. See detailed list by matrix and characteristics in Annex 3.

4 Basin monitoring systems overview

In this section we will overview some of the key data sources that are listed in Table 6 as upstream source of data. However we will not perform any 'appropriateness' and availability analysis of Table 6 input data sources since we have not yet practically accessed the data to generate the challenge outputs. The initial monitoring quality assessment will be based upon the Use Cases of sections 6 and 7 that consider some of the characteristic categories and data sources described in Section 3.

In the last twenty years the Mediterranean Sea has been the focus of many international, European and national projects which set the basis and partially implemented a basin monitoring system for some of the characteristics listed in Table 3 and the data sources listed in Table 6.

Literature surveys for the existing monitoring systems in the Mediterranean Sea have been carried out in the past three years by several European projects and international networks in the Mediterranean Sea mainly considering observational data sets. In particular:

1) PERSEUS (http://www.perseus-net.eu/site/content.ph) pursued a review of ocean observing systems in the Southern European Seas (Mediterranean and Black Sea) and recommended upgrades to serve PERSEUS needs (PERSEUS, 2012);

2) JERICO (http://www.jerico-fp7.eu/) also produced a report where the Mediterranean observing system was listed and reviewed (JERICO, 2012);

3) FixO3 (http://www.fixo3.eu/) delivered a report including a detailed compilation of open ocean observatories information (Bensi and Cardin, 2014).

4) the GMES In Situ Coordination (GISC) project (http://gisc.ew.eea.europa.eu/) delivered a report that evaluated the in situ data requirements and the costs of an European in situ data collection and management system in support of Copernicus (EEA-GISC, 2012);

5) the EC Expert Group on Marine Research Infrastructure drafted a strategy paper on the observing system requirements toward an integrated European ocean observing system (EC-MRI, 2013) that contained the description of the basic monitoring systems for the European Seas including the Mediterranean Sea.

6) IRIS-SES (http://iris-ses.eu/) pursued a review and gap analysis on the existing monitoring programs of MSFD descriptors in the Mediterranean and Black Sea

In the following two sections we will overview separately the international, European and intergovernmental monitoring programs and projects and the national monitoring systems.

4.1 European and international monitoring programs and projects

The major European, Intergovernmental and International data collection/management programs active in the Mediterranean Sea are listed in Table 7. Some of them are only in the Mediterranean Sea but the majority are pan-European and have the Mediterranean Sea as one of the activity areas. The choice for the Projects has been to take only the FP7 and Territorial cooperation projects from the 2007-2013 period. We are aware that more projects could have been missing but the list certainly covers some of the essential data sources for upstream data listed in Table 6.

Name/Web site	Type of initiative	Main range of activities
COCONET www.coconet-fp7.eu	FP7 project	Marine Protected Areas study and integration
Copernicus Marine Environment Service http://www.myocean.eu/	Copernicus regolation prototype service	Monitoring and Forecasting of the Mediterranean Sea
Data Collection Framework for Fisheries http://datacollection.jrc.ec.europa.eu/	JRC and DG-MARE Joint activity	Fishery data collection and management service
EGO-European Glider Observatory http://www.ego-network.org/dokuwiki/doku.php?id=start	International network	Glider data collection, management and training network
Euro-ARGO http://www.euro-argo.eu/	European Research Infrastructure Consortia	ARGO floats acquisition, upgrade and deployment
EMODNET Data Portals http://www.EMODnet.eu/	DG-MARE consortia for marine data assembling	Historical data assembling and management service
EMSO www.**emso**-eu.org	ESFRI-European Strategy Forum on Research Infrastructures Project	Fixed point, deep sea observatory
E-SURFMAR http://www.eumetnet.eu/e-surfmar	EUMETNET Project	EEIG sponsored program for data collection and management
FixO3 http://www.fixo3.eu/	FP7 Project	Integrating infrastructure initiative for European open ocean fixed point observatories
GEBCO http://www.gebco.net/	UNESCO-IOC program	Bathymetric data collection, analysis and management
GEOSEAS http://www.geo-seas.eu/	European Partnership	e-infrastructure for gelogical and geophysical data
GFCM http://www.gfcm.org/gfcm/en	United Nation Contracting Party International agreement	Fisheries conservation and management
GRDC http://www.bafg.de/GRDC/EN/01_GRDC/grdc_node.html	WMO hydrological and meteorological center	Repository for world's river discharge data
JERICO http://www.jerico-fp7.eu/	FP7 Project	Integrating infrastructure initiative for an European Research Infrastructure network of coastal observatories
MEDESS4MS http://www.medess4ms.eu/	European territorial cooperation MED PROGRAMME project	Oil spill risk mitigation through advanced monitoring and forecasting systems

MEDPAN http://www.medpan.org/home	Network of Marine Protected area managers	Network to promote, implement and sustain MPAs
MONGOOS http://www.mongoos.eu/	Unesco GOOS Regional Alliance	Coordination and assessment of data collection networks
OceanSites http://www.oceansites.org/	International network	Network of operators and data managers for deep ocean multidisciplinary fixed stations
PERSEUS http://www.perseus-net.eu/site/content.php?locale=1&locale_j=en&sel=1	FP7 Project	Design of a research governance framework for the MSFD
SEADATANET-II http://www.seadatanet.org/	FP7 Project	Historical data assembling and management service
TOSCA http://www.tosca-med.eu/	European territorial cooperation MED PROGRAMME project	Improvement of the decision-making process in case of maritime accident
UNEP MAP http://www.unepmap.org/	Agreement between 21 Contracting Parties from countries around the Mediterranean Sea.	Data assembling to monitor pollution and support Contracting Parties to set national programs for the protection of the environment
VOS http://www.wmo.int/pages/prog/amp/mmop/JCOMM/OPA/SOT/vos.html	International network-JCOMM core observing program	Surface meteorological and temperature profile production and management service

Table 7: European, international and intergovernmental monitoring programs and projects

4.1.1 COCONET

The Project aims to identify interconnected Marine Protected Areas (MPAs) in the Mediterranean and the Black Seas, shifting from local (single MPA) to regional (Networks of MPAs) and basin (network of networks) scales. Connectivity is assessed by the identification of physical and biological connections that govern patterns of biodiversity distribution. These activities will also individuate areas where Offshore Wind Farms (OWF) can be established, avoiding too sensitive habitats but acting as stepping stones through MPAs. Socioeconomic studies will integrate to knowledge-based environmental management aiming at both environmental protection (MPAs) and clean energy production (OFW). The project will produce the guidelines to design, manage and monitor network of MPAs, and an enriched wind atlas for both the Mediterranean and the Black Seas. Current legislations are crucial to provide guidelines to find legal solutions to problems on the use of maritime space. Pilot projects in the Mediterranean and Black Sea will test in the field the assumptions of theoretical approaches.

Major outputs of the project will be: 1) Wind Atlas of the Mediterranean and Black Sea (Menendez et al., 2014); 2) WebGIS applications on MPAs location and distribution in the the Mediterranean and Black Sea; 3) WebGIS applications on habitat mapping and classification in the Mediterranean

and Black Sea (Leenhardt et al., 2013); 4) WebGIS applications on priority habitats in the Mediterranean and Black Sea (Mariani et al., 2014); 5) WebGIS applications on threats on MPAs in the Mediterranean and Black Sea (Suaria and Aliani, 2014); 6) Guidelines to design, manage and monitor network of MPAs (Levin et al., 2014); 7) Biodiversity database for the Mediterranean and Black Sea; 8) Impact of offshore wind farms (Bat et al., 2013) on benthos, plankton, fish, marine mammals, seabirds.

4.1.2 Copernicus Marine Environment service

The Copernicus Marine Environment Monitoring Service is part of the Copernicus Programme (previously known as GMES), which is an EU Programme implemented by the European Commission jointly with the European Space Agency (ESA) and the European Environment Agency (EEA). It is aimed at developing a set of European information services based on satellite Earth Observation and in-situ data. The Copernicus Marine Environment Monitoring Service provides regular and systematic information about the physical state and dynamics of the ocean and the marine ecosystems for the global ocean and the European regional seas. This data covers analysis of the current situation, forecasts of the situation a few days in advance and the provision of retrospective data records (re-analysis).

Copernicus Marine Service is composed of 4 Thematic Assembly Centres (Sea Level, Ocean Colour, Temperature – Sea Ice – Wind, In Situ) and 7 Monitoring and Forecasting Centres (Global Ocean, Arctic Ocean, Baltic Sea, Atlantic NWS, Atlantic IBI, Mediterranean Sea, Black Sea) each delivering a set of environmental information products in real time and delayed mode, with a 'click-and-download' system. The pre-operational service is currently provided through the FP7 project MyOcean-2 (follow-up of the former MyOcean). The main products are described in the Table 8 below:

Name/Acronym	Main products delivered
MyOcean Sea Surface Temperature, sea ice and winds Thematic Assembly Center	Satellite SST data production and management service
MyOcean Sea Level Thematic Assembly Center	Satellite Sea Level data production and management service
MyOcean Ocean Color Thematic Assembly Center	Satellite Chlorophyll, light attenuation within the water column (water clarity) data production and management service
MyOcean In Situ Thematic Assembly Center	In situ Real Time physical measurements data management service
MyOcean Mediterranean Monitoring and Forecasting Center	Pan-European standard analyses, re-analyses and short term forecast data production and management service

The products delivered by the Copernicus marine environment monitoring service today are provided free of charge to registered users through an Interactive Catalogue available on the marine.copernicus.eu web portal. These products support marine and maritime applications and related EU policies, e.g. in the fields of: Marine safety; Marine and coastal environment; Marine resources; Weather, seasonal forecasting and climate. The added value of the project is that the Copernicus data policy promotes the access, use and sharing of Copernicus information and data on a full, free and open basis.

4.1.3 Data Collection Framework for Fisheries

Since 2000, an EU framework for the collection and management of fisheries data is in place. This framework was reviewed in 2008 resulting in the Data Collection Framework (DCF). Under this framework the Member States (MS) collect, manage and make available a wide range of fisheries data needed for scientific advice.

Data are collected on the basis of National Programmes in which the MS indicate which data are collected, how they are collected and the resources allocated for the collection. MS must report annually on the implementation of their National Programmes and the Scientific, Technical and Economic Committee for Fisheries (STECF) evaluates these Annual Reports.

Part of the data collected by the MS is uploaded in databases managed by the JRC in response to data calls issued by DG MARE. These data are analysed by experts of the STECF and form the basis for scientific opinions and recommendations formulated in STECF reports. The resulting scientific advices are used to inform the CFP decision making process.

JRC assembles the data, stores them in databases, analyses their quality and coverage and makes them available to the STECF Working Groups (STECF, 2014a,b,c,d). Once the STECF reports are finalised the data are disseminated in aggregated form for a target audience of experts for further use in scientific analyses and policy.

In the JRC website it is possible to find the necessary information and data related to the above described process including:

- latest news in relation to data calls, deadlines, variable definitions, disaggregation levels and uploading procedures;
- National Programs and Annual Reports prepared by the MS;
- access to the uploading facilities and data dissemination platforms for the experts and general public;
- coverage reports on the data provided by the MS in response of the data calls managed by JRC;
- DCF technical documents, guidelines and legislation.

The Data Collection Framework is strictly linked with the Control Regulation. In particular, the assessment of commercial landings and effort (transversal variables) must be made on the basis of the exhaustive data gathered under the Council Regulation (EEC) No 2847/93 and of the Council Regulation (EC) No 104/2000. For the data not covered by these Regulations assessment of commercial landings and fishing effort has to be made by sampling and statistical procedures, in such a way that the estimates achieve certain precision of level both for stocks subject to TAC and quota and for stocks not subject to TACs and quotas.

4.1.4 EGO

The EGO community is a worldwide community of practise focused on the use of gliders (USA, Australia, Canada, South Africa,Chile, Peru, Mexico and several EU countries) in oceanography. Gliders are buoyancy driven autonomous underwater vehicles and use very little power (~2W) to travel through the oceans and sample the upper water column continuously over long distances and periods of time. The data are transmitted in near real time back to the laboratories when the glider is at the surface. Gliders collect high resolution oceanographic data and fill gaps left by more classical observing platforms that are deployed in the context of the Global Ocean Observing System. Used along repeat-sections, they are able to monitor key areas (like the boundary currents, straits, and water formation areas) that are crucial for the ocean functioning but could not be conveniently monitored by other means (Testor et al 2010).

The EGO community (Testor et al., 2009) develops a new observational capacity for process studies in oceanography and the global observation of the ocean. It promotes glider applications through coordination, training, liaison between providers and users, advocacy, and provision of expert advice. This work has been supported in particular by the ESF through the EGO COST Action ES0904 (http://www.ego-cost.eu) during the last years and now, a glider component of the GOOS is really emerging, mainly as a juxtaposition of numerous monitoring programs of the ocean physics and biogeochemistry at the regional/coastal scale that is coordinated and in particular, in

terms of data management. In addition, EGO promotes glider applications addressing all challenges identified in EMODNET. Gliders are unique oceanographic platforms, that could be used with great benefit on a wide range of scales (from the very local to the global scale) and equipped with multidisciplinary scientific payloads.

4.1.5 Euro-ARGO

The official inauguration of Euro-Argo ERIC was hosted by the French Permanent Representation in Brussels on 17th July 2014. Euro-Argo is now the European research infrastructure that coordinates the procurement and deployment of about 250 floats per year, to monitor these foats and ensure that all the data can be processed and delivered to users (both in real-time and delayed-mode).

Called the "Central-RI", has its registered office in France for the first 5 years. The official address of the Euro-Argo ERIC is Euro-Argo ERIC Office, Ifremer, Z.I de la Pointe du Diable, CS 10070, 29280 Plouzané, France. The Euro Argo infrastructure is made up of a central infrastructure based in the Host Member country which is owned and controlled by the Euro-Argo ERIC (the "Central Infrastructure"). The Central Infrastructure will coordinate Euro-Argo activities under arrangements with independent distributed national legal entities and facilities.

The Euro-Argo ERIC shall have the following organs, possessed of the powers as defined in the following sub-sections :

-a Council
-a Management Board
-a Programme Manager
-a scientific and technical advisory group (STAG)

Members are States and Intergovernmental organisations.The Members shall have the power to vote on all the questions raised during the Council meetings and mentioned in the agenda. The Members are Finland, France, Germany, Greece, Italy, Netherlands, UK. They will contribute to the Euro-Argo ERIC with a subscription fee and the minimum deployment of 3 Argo floats.

Observers may be Member States, agencies, institutes, public entities, including regions or private entities with a public service mission, or third parties contributing to the Euro-Argo ERIC. The observers are Norway and Poland. They will contribute to the Euro-Argo ERIC with a subscription fee.

4.1.6 EMODNET Data Portals

The European Marine Observation and Data Network (EMODnet) has the objective to unlock fragmented and hidden marine data resources and to make these available to individuals and organisations, both public and private, and to facilitate investment in sustainable coastal and offshore activities through improved access to quality-assured, standardised and harmonised marine data. EMODnet is an initiative from the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) as part of its Marine Knowledge 2020 strategy. Presently, there are six sub-portals in operation that provide access to marine data from the following themes: bathymetry, geology, physics, chemistry, biology, and seabed habitats. One further portal covering human activities is currently under construction. Through the prototype websites of the European Marine Observation and Data Network (EMODNET), engineers and scientists can see what data are available for a given sea basin, and download both original observations and derived data products such as digital terrain models, sediment distributions and marine habitats. At the same time work is ongoing to help EU countries to optimise their programmes for observing the sea.

4.1.6.1 EMODnet Bathymetry

The overall objective of this Lot is a dedicated portal that will provide access by browsing and downloading to a at a harmonised medium resolution Digital Terrain Model (1/8 of minute of arc, approximately 250m of resolution) of all sea basins in European waters and access by discovery and shopping process to the underlying and assembled bathymetric surveys over the European seas held by public and private bodies in an uniform way. The Bathymetry portal was developed by adopting SeaDataNet standards and services. The Lot has resulted in gathering and providing access to metadata and data from more than 10730 bathymetric survey datasets from 24 data centres from 14 countries and originated from more than 114 institutes. Digital Terrain Model (DTM) are based on 3 types of bathymetric data sources:

- Bathymetric surveys, such as LIDAR surveys, single and multibeam echosounder surveys, and even historic leadline soundings. These data sets are most preferred as data source because of their high resolution and of the possibility to apply the processing specified by the project for the production of the depth and associated statistics.
- Composite data sets, giving a gridded bathymetry. In practice it appears that Hydrographic Offices (HO's) do not want or cannot deliver primary surveys but composite data sets from the Digital Terrain Models that they maintain themselves for producing, maintaining their nautical charts and following international IHO procedures.
- GEBCO 30" grid derived from a combination of altimetric data and soundings.

The portal offers access to the following metadata layers delivered with the data source, Minimum cell water depth, maximum cell water depth, average cell water depth, standard deviation of cell water depth, number of values used for interpolation of cell water depth, Source dataset used at each point. The horizontal coordinate reference system is the WGS 84. The depth reference system is the Lowest Astronomical Tide (LAT).

4.1.6.2 EMODnet Geology

The geology portal provides access to data and metadata held by each organisation based on standards developed in the Geo-Seas project and data products compiled at a scale of 1:250,000 using the standards developed during the early-stage of EMODnet. The data and map products include information on the sea-bed substrate including rate of accumulation of recent sediments; the sea-floor geology and all boundaries and faults that can be represented at the 1:250,000 compilation scale with information on the lithology and age of each geological unit at the seabed; geological events and probabilities and minerals. In addition to sea-bed sediment information, EMODnet Geology is also compiling information on the Quaternary geology of the sea floor (sediments deposited during the last approximately 2 million years). Links are being established through common partners with the COST Action SPLASHCOS to consider drowned paleolandscapes that would be of value to marine archaeologists. SPLASHCOS aims to bring together archaeologists, marine geophysicists, environmental scientists, heritage agencies, and commercial and industrial organizations interested in researching, managing and preserving the archives of archaeological and palaeoclimatic information locked up on the drowned prehistoric landscapes of the European continental shelf, and to disseminate that knowledge to a wider public.

The portal offers access to the following datasets: Seabed Substrate, Sediment Accumulation Rate, Sea-floor Geology, Seabed Lithology, Stratigraphy, Coastline Migration, Aggregate Resources, Geological Events

4.1.6.3 EMODnet Sea Bed Habitats

The Preparatory action was based on the EUNIS (European Nature Information System) broad scale seabed habitat map project. It was a preliminary attempt at covering a few European marine basins with a broad-scale map representing the upper levels of EUNIS referred to as "physical habitats". Today the lot has the general objective of the EUSeaMap 2 project, to create a homogeneous seabed habitat map covering all European seas with enhanced validation, and to complement this with the collation of any survey habitat maps available from Member States, their translation into EUNIS, and their storage in an attractive portal designed to meet users' needs fully and effectively. Such a physical habitats map, featuring complete coverage of European seas, will be made available through the former EUSeaMap webGIS offering enhanced capabilities. The broadscale map will be completed locally with detailed maps sourced by the Partners and/or other adjacent countries that have not been made widely available so far. It falls within the brief of this tender to enable Member States to 'plug in' their data, facilitating the publishing of this data with the implementation of bespoke tools.

The portal offers access to the following datasets: Seabed Substrate, Biological zones, Energy, Salinity, Light, Bathymetry

4.1.6.4 EMODnet Chemistry

This LOT is strongly based on the SeaDataNet project. The objectives are:

- gather all measurements of a particular chemical species with their appropriate metadata within a given space and time window
- include the physical conditions under which the measurements were made (from EMODnet physical parameters portal or the GMES marine core service)
- visualise the measurement density in a given time and space window
- visualise a time evolution of a selected group of measurements
- show concentration plots for a given time and space window and also along the coast
- show inflows from rivers of nutrients. The user should be able to select a section of coast, a country or a region (NUTS3) and obtain time series of inflows of parameters expressed as mass or moles per unit time per river (or section of coast)
- calculate spatially distributed data products specifically relevant for Marine Strategy Framework Directive Descriptors 5 (eutrophication), 8 (chemical pollution) and 9 (contaminants in seafood) based on guidance provided by the Marine Strategy Framework Directive Common Implementation Strategy. For eutrophication, it is not necessary to calculate a eutrophication indicator but to provide the relevant data layers concerning water column chemistry that enable eutrophication to be calculated. In particular it is necessary to provide spatial and temporal distribution of hypoxia and anoxia in water column and seabed.

The portal offers access to the following datasets: Pesticides & Biocides (DDT, PCB), Antifoulants (TBT, TPT), Pharmaceuticals (Oxytetracycline), Mercury, Cadium, Lead, Mercury, Cadium, Lead, Cs137, Pu239, Nitrogen (Din, TN), Phosphorus (DIP, TP), Organic Matter from swers or mariculture (TOC), Oxygen, Carbon Dioxide, Polyethylene, Polypropylene, Chlorophyll, Silicates, pH.

4.1.6.5 EMODnet Biology

Marine biodiversity data are essential to measure and study the ecosystem health of maritime basins. These data are often collected with limited spatial and temporal scope and are scattered over different organizations in small datasets for a specific species group or habitat. The aim of this Lot is to assemble individual datasets, and process them into interoperable biological data products for assessing the environmental state of overall ecosystems and complete sea basins. The main elements of the Lot are:

- provide access to specified monitoring data from the EMODnet biological data portal, by building on a detailed inventory and gap analysis of existing holdings of biological marine monitoring data that was created during the pilot project.
- to create specific biological data products to illustrate the temporal and geographic variability of occurrences and abundances of marine phytoplankton, zooplankton, macro-algae, angiosperms, fish, reptile, benthos, bird and sea mammal species.
- to seek the harmonisation of differing methodologies and strategies for data management under common protocols, data formats and quality control procedures (by adopting EMODnet and INSPIRE standards), and ensure that data can be consistently distributed, by making use of relevant, open webservices for user applications including regional data interpretation, environmental assessments and modelling.
- To execute spatial, temporal, and taxonomic queries. The spatial queries will be made possible by entering exact coordinates, by selecting a region on a geographic map or by selecting standardized sea areas; e.g. Exclusive Economic Zone's (EEZs) of European countries from the Maritime Boundaries Geodatabase (MARBOUND, VLIZ), IHO seas or European regional and sub-regional seas, as currently defined by MSFD.

The portal offers access to the following datasets / species groups: Biomass, Abundance, Gridded abundance, phytoplankton, zooplankton, angiosperms, macro-algae, invertebrate bottom fauna, birds, mammals, reptiles, fish

4.1.6.6 EMODnet Physics

The Physics preparatory action had the overall objectives to provide access to archived and near real-time data on physical conditions as monitored by fixed stations and Ferrybox lines in European sea basins and oceans and to determine how well the data meet the needs of users. The existing EMODnet-Physics portal makes layers of physical data and their metadata available for use and contributes towards the definition of an operational European Marine Observation and Data Network (EMODnet). It is based on a strong collaboration between EuroGOOS associates and its regional operational systems (ROOSs), MyOcean and SeaDataNet consortia. The EMODnet Physics portal is giving access to two major data streams:

- Near-real-time (NRT: within 24 hours from acquisition) data, collected for operational needs, collected at fixed measuring stations (e.g. moored buoys, rigs/platforms, coastal stations) and by automatic observatories at sea (e.g. profiling floats, drifting buoys, ferrybox, ships of opportunity, research vessels) which are transmitted in near real-time to the shore, and
- Archived data derived from further elaboration and validation of the near real time (NRT) data .

The access to the first data stream is ensured by the EuroGOOS - ROOSs and the MyOcean in-situ TAC system; the second data stream is organised through the SeaDataNet infrastructure. The

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Coriolis infrastructure plays an important role for giving access to the supplementary data from Argo floats (EuroArgo) and glider observations. The portal offers access to the following datasets: Sea water salinity, Sea water temperature, Water currents, Oxygen, Fluorescence, pH, Turbidity, Sea level, Waves, Horizontal wind speed, Wind direction, Atmospheric pressure, Atmospheric pressure hourly tendency, Dew point temparature, Air temperature in dry, Relative humidity, Light irradiance, Daily Ice cover.

4.1.6.7 EMODnet Human Activities

Human Activities is a new Lot not covered in EMODnet Phase I. Its main objective is to disseminate information on the geographical position, spatial extent, and attributes of a wide array of human activities related to the sea and its bed. Particular attention is given to providing historical time series (when possible) to indicate the temporal variation of activities. Through a single entry portal it is possible to view, query and download data and metadata from public and private sources all across Europe. The data is harmonised into interoperable formats that include agreed standards, common baselines or reference conditions; assessments of their accuracy and precision. Users can view, query, and download datasets or subsets of them, via web GIS. Metadata are also available for download.

The portal offers access to the following datasets: Aggregate extraction, Commercial shipping, recreational shipping, Cultural heritage, Dredging, Fisheries zones, Hydrocarbon extraction, Major ports, Mariculture, Ocean energy facilities, Pipelines and cables, Protected areas, Waste disposal (solids, including dredge material, dumped munitions, marine constructions), Wind farms, Other forms of area management/designation

4.1.7 EMSO

EMSO (European Multidisciplinary Seafloor and Water Column Observatory) is a large-scale European Research Infrastructure (RI). It is a European network of fixed point, deep sea observatories with the basic scientific objective of real-time, long-term monitoring of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere. It is a geographically distributed infrastructure composed of several deep-seafloor and water-column observatories, which will be deployed at key sites in European waters, spanning from the Arctic, through the Atlantic and Mediterranean, to the Black Sea. The project, after a preparatory phase, is currently in the phase1 (5 years, from 2012) and the activities focus on:

-EMSO-ERIC foundation: establishment of the central managing organisation;

-Construction and/or upgrading of EMSO sites: 7 sites (Arctic, Porcupine, Azores, PLOCAN, Eastern Sicily, Hellenic Arc, Ligurian Sea) will be those to start their implementation from year 1;

-Setting up of a distributed data management system that will guarantee an open access to EMSO observatories data to scientists and other stakeholders.

The vision of EMSO is to allow scientists all over the world to access observatories data following an open access model. EMSO will deliver multiparametric, long-term (years) time series addressing the seabed and the water column. A first prototype of EMSO data portal can be accessed at the following link: http://dataportals.pangaea.de/emso.

One of the core services of the EMSO-ERIC is defined as the capacity to deliver basic, established, standardized data products and services. Data will be collected from the surface ocean, through the water column, the benthos, and the sub-seafloor. A set of variables that are measured at all sites and depths: temperature, conductivity (salinity), pressure (depth), turbidity, dissolved oxygen, ocean currents, and passive acoustics. As sensor development progresses

other variables can be added, such as the remaining ECV (Essential Climate Variables) sensors (e.g. Chl-a, pH, CO2, CH4, H2S, Eh, and hydrocarbons).

4.1.8 E-SURFMAR

E-SURFMAR (Surface Marine Operational Service) is a project of EUMETNET (http://www.eumetnet.eu/about-us) that has the main objective of coordinating, optimise and progressively integrate European activities for surface observations over the sea in support of Numerical Weather Predictions.

The main objective of E-SURFMAR is to formulate an optimum overall surface marine network design, to implement it and to regularly revise it according to data user's requirements. The first design study (2004) led to:

- an operational network of about 100 drifting buoys measuring air pressure and sea surface temperature in the North Atlantic and which make their data available in real time onto the Global Telecommunication System of WMO.
- The financial and technical support for the operation of 4 moored buoys as a baseline for the calibration and the validation of satellite-derived wind and wave observations.
- the support of the activities of Voluntary Observing Ships (VOS) in order to better coordinate and harmonise practices. This support includes compensation to participating members for the observations and the communications related to this component.
- both the operation of an increasing fleet of Shipborne Automated Weather Stations (S-AWS) in support of the network design and, in parallel, the automation of the observation aboard ships through the development of such stations.

4.1.9 FixO3

Funded by the European Commission, FP7 Infrastructures, the Fixed point Open Ocean Observatory network (FixO3) seeks to integrate European open ocean fixed point observatories and to improve access to these key installations for the broader community. These will provide multidisciplinary observations in all parts of the oceans from the air-sea interface to the deep seafloor. Coordinated by the National Oceanography Centre (UK) FixO3 is building on the significant advances largely achieved through the FP7 programmes EuroSITES, ESONET and CARBOOCEAN.

The network includes 9 observatories in the Mediterranean Sea (http://www.fixo3.eu/observatory/) and provides access to data products and knowledge derived from most of the observatories which comprise the network (Bensi et al., 2014). A metadata catalogue has been implemented for data description and download (Behnken and Huber, 2014).

4.1.10 GEBCO

GEBCO aims to provide the most authoritative publicly-available bathymetry of the world's oceans. It operates under the joint auspices of the Intergovernmental Oceanographic Commission (IOC) (of UNESCO) and the International Hydrographic Organization (IHO).The regional groups that GEBCO collaborates with are:

1. Intergovernmental Oceanographic Commission (IOC) Regional Mapping Projects
2. International Hydrographic Organization (IHO) regional coordination work
3. GEBCO's regional mapping projects
4. GEBCO/Nippon Foundation Indian Ocean Bathymetric Compilation (IOBC) Project
5. European Marine Observation and Data Network (EMODnet) Bathymetry

GEBCO produces a range of bathymetric data sets and products. This includes global gridded bathymetric data sets a global set of digital bathymetric contours; the GEBCO Gazetteer of Undersea Feature Names; the GEBCO Digital Atlas; the GEBCO world map and the IHO-IOC GEBCO Cook Book— a reference manual on how to build bathymetric grids.

The GEBCO_08 Grid is a global 30 arc-second grid largely generated by combining quality-controlled ship depth soundings with interpolation between sounding points guided by satellite-derived gravity data. However, GEBCO's global elevation models are generated by the assimilation of heterogeneous data types. In areas where they improve on the existing grid, data sets generated by other methods have been included. Land data are largely based on the Shuttle Radar Topography Mission (SRTM30) gridded digital elevation model. A 'source identifier', SID, grid is also available to download to accompany the GEBCO_08 Grid. This shows which grid cells have been constrained by bathymetry data during the gridding process.

It is assumed that all data sources refer to mean sea level. However, in some shallow water areas, the grids include data from sources having a vertical datum other than mean sea level. The grid is available to download from the British Oceanographic Data Centre (BODC). The format is either ASCII or netCDF.

4.1.11 GEOSEAS

Geo-Seas is an e-infrastructure of 26 marine geological and geophysical data centres, located in 17 European maritime countries. Users are enabled to identify, locate and access pan-European, harmonised and federated marine geological and geophysical datasets and derived data products held by the data centres through a single common data portal (http://www.geo-seas.eu/).

Geo-Seas has expanded the existing SeaDataNet marine and ocean data management infrastructure to handle marine geological and geophysical data, data products and services, creating a joint infrastructure covering both oceanographic and marine geoscientific data.

4.1.12 GFCM

The General Fisheries Commission for the Mediterranean and Black Sea (FAO-GFCM) integrates cooperative efforts by 24 members in seeking to optimize fish harvesting. The terms of reference of the FAO-GFCM have undergone a series of revisions over the last 15 years, searching for a better structure and mode of functioning to accomplish their main purpose. This is to manage the fisheries of the international waters of the Mediterranean, which extend beyond the territorial seas of its Member countries. Unlike most coastal countries in the world, these have not declared Exclusive Economic Zones, and the importance of the FAO-GFCM mechanism stems from this lack of an EEZ extension. The geographical configuration of the Mediterranean is characterized by several linked basins having different ecological/environmental conditions and harvested by a wide variety of fishing gears, by countries with widely different political, economic conditions and languages. Such complicate situation has hindered a sustainable exploitation of the resources (especially shared) in a common fisheries framework, which is the main purpose of FAO-GFCM.

Since its establishment in 1952, FAO-GFCM has been collecting data on fisheries in the different countries of the Mediterranean and Black Sea. Fisheries statistics (e.g. declared catches per species, area and country) are currently available through the GFCM portal (http://www.fao.org/figis/servlet/TabSelector). The FAO-GFCM Task 1 concept is an outcome of the transversal Workshop on Stock Assessment and Operational Units (GFCM, 2006), and essentially comprises a compilation of Operational Units (a group of fishing vessels practicing the same type of fishing operation, targeting the same species or group of species and having a similar economic structure) data into matrices and associated tables, also providing the procedures required for the identification of Operational Units within fishing fleets. At present GFCM is

developing a major revision of its Task 1 with the objective of harmonizing the production of fisheries statistics for all the countries around the Mediterranean and Black Seas, but currently it faces difficulties to gather this information for several reasons. A review of the different methods and data collection programs in place within GFCM Member Countries is publicly available (GFCM, 2010).

In order to fight Illegal, Unreported and Unregulated (IUU) fisheries, GFCM constituted an Authorised vessel list which is available online. This later source of information is comprehensive and accurate for commercial vessels longer than 15 meters, but fails to meet its goal for the extensive small scale fleet (<12 m, EC 2005) of the Mediterranean and Black Seas.

The technical disaggregation per gear types, fleet segment or operational unit (fleet segment crossed with gear type and targeted species) is an ongoing process initiated within the GFCM Task 1 (GFCM 2007). GFCM is requiring this type of information annually for respectively the EU Member States and all the other Mediterranean and Black seas countries but it is facing compliance difficulties for obtaining the needed statistics.

4.1.13 GRDC

The Global Runoff Data Centre (GRDC) is an International data centre operating under the auspices of the World Meteorological Organization (WMO) and is internationally manded by the United Nations. Established in 1988 to support the research on global and climate change and integrated water resources management, the GRDC has been serving for twenty years successfully as a facilitator between the producers of hydrologic data and the international research community. GRDC is a key partner in a number of data collection and data management projects on a global scale. Its primary objective consists in supporting the water and climate related programmes and projects of the United Nations, its specialised agencies and the scientific research community by collecting and disseminating hydrological data across national borders in a long-term perspective.

River discharge is one of the Essential Climate Variables (ECVs) and needs to be systematically observed to characterise the state of the global climate system, its variability and vulnerability. National services are called by the "Second Report on the Adequacy of the Global Climate Observing System for Climate" (2AR) to ensure that their observations and associated metadata, including historical observations, are available at the established international data centres.

Against the background of increasing data loads and the wide range of data formats and transfer protocols in use, the standardisation and harmonisation of data became essential to efficient data exchange. The GRDC contributes to the process of developing a metadata profile applicable to the description of hydrologic data and based on the relevant ISO standards.

4.1.14 JERICO

Funded by the European Commission, FP7 Infrastructures, JERICO is an Integrating Activities action contributing to the international and global effort on climate change research (GEOSS), to provide coastal data inputs for operational ocean observing and forecasting, and also to answer the needs of the environmental research and societal communities.

The JERICO approach for data management is strongly based on the "use of what exists" through the creation of suitable partnerships with ongoing European data management initiatives for the minimization of duplication of efforts (Fanara et al., 2013). Thus, the JERICO data management framework for delayed-mode data uses the SeaDataNet (SDN) infrastructure, while real-time data are being handled through MyOcean (MyO). The JERICO approach is driven by the great importance that MyO and SDN initiatives have had in the last few years, since both systems

proved to be robust and successful in the archiving and distribution of marine data, and correspond to a perspective of long-term sustainability for the European marine infrastructures.

Continuous interaction with MyOcean/EuroGOOS and SDN takes place in order to facilitate seamless integration with both these established infrastructures for managing the JERICO data stream.

4.1.15 MEDESS4MS

Funded by the European Regional Development Fund in the framework of the MED Programme, MEDESS-4MS (Mediterranean Decision Support System for Marine Safety; www.medess4ms.eu) provides an integrated operational multi model oil spill prediction service for the management of environmental emergencies related to oil pollution in the Mediterranean.

MEDESS-4MS uses well established oil spill models (MEDSLIK - Zodiatis et al., 2007, MEDSLIK-II - De Dominicis et al. 2013, MOTHY - Daniel et al., 2003, POSEIDON-OSM - Nittis et al., 2006) and met-ocean data from the Copernicus Marine Core Service and national ocean forecasting systems. The system has also the ability to be interfaced with other monitoring systems such as the Automatic Identification System (AIS) installed on ships and also satellite monitoring systems, such as CleanSeaNet of the European Maritime Safety Agency (EMSA).

The aim of MEDESS-4MS is to create a system that can be used by different users to run simulations of oil spills at sea, even in real time, through a web portal. Starting from the information about the slick, as location and characteristics of the oil, the MEDESS-4MS system provides information about the future evolution of the pollution at sea, which can be helpful for an efficient management of oil pollution emergencies.

4.1.16 MEDPAN

The MedPan (www.medpan.org) is a network of MPA managers in the Mediterranean involving partners from 18 Mediterranean countries representing more than half of the existing MPAs in the Mediterranean (Gabrié et al., 2012). MedPan aims to make the current system of MPAs in the Mediterranean more representative and coherent, to reinforce the sustainability, political support and financial resources; to improve the management of MPAs and the network of MPAs; to strengthen synergies between all stakeholders; to effectively manage and improve the efficiency of existing Mediterranean MPAs; enhance MPAs and the network of MPAs in their role as a laboratory and for innovation; integrate progress made in ecosystem management and Integrated Coastal Zones Management with the inclusion of MPAs adjacent territory and players.

The MAPAmed database (www.mapamed.org) contains information about experts, best practice, management solutions and tools for marine conservation and MPA management. The MAPAMED database contains nearly 170 sites. MAPAmed is a GIS database of Marine Protected Areas in the Mediterranean. Users can locate and visualise spatial data on MPAs and detailed information about the governance of the site, its management objectives, regulations, staff, equipment, or the monitoring of habitats and species. The profile also provides access to specific documents related to the MPA, such as creation decrees, management plans or presentation brochures

4.1.17 MONGOOS

MONGOOS (Mediterranean Oceanography Network for the Global Ocean Observing System) is a partnership among Mediterranean Institutions established in 2012 through a Memorandum of Agreement. MONGOOS comprises the previous activities of MOON and MEDGOOS. More than 30 Institutions belong to the network.

MONGOOS shall engage in activities related to the production and use of operational oceanography services in furtherance of four principal objectives:

1. Improved Fitness for Purpose. Continuously advance the scientific understanding and technological development upon which the Services are based.
2. Greater Awareness. Promote the visibility and recognition of the Services with governmental agencies and private companies, encourage their integration at national, regional, European and global levels.
3. Increased Downstreaming. Enhance the usability of the Services and their usefulness for policy implementation, societal needs and science.
4. Improved Capacity. Support the planning and implementation of international initiatives involving operational oceanography and promote the participation of non-EU Mediterranean countries in producing the Services.

MonGOOS will elaborate a continuous working framework with EuroGOOS and GOOS Africa in order to define common roles and activities in the Mediterranean Sea, and foster collaboration with Black Sea GOOS and global ocean GOOS initiatives.

4.1.18 Oceansites

OceanSITES is a worldwide system of long-term, open-ocean reference stations measuring dozens of variables and monitoring the full depth of the ocean from air-sea interactions down to the seafloor. It is a network of stations or observatories measuring many aspects of the ocean's surface and water column using, where possible, automated systems with advanced sensors and telecommunications systems, yielding high time resolution, often in real-time, while building a long record. Observations cover meteorology, physical oceanography, transport of water, biogeochemistry, and parameters relevant to the carbon cycle, ocean acidification, the ecosystem, and geophysics.

The OceanSITES data flow is carried out through three organizational units: Principal Investigators (PI), Data Assembly Centers (DAC), and Global Data Assembly Centers (GDAC). In general, a PI provides the data and metadata information to a DAC, which formats this information into the OceanSITES file format and passes it on to the GDACs, These are the primary portal for OceanSITES data and are established at IFREMER Coriolis (ftp://ftp.ifremer.fr/ifremer/oceansites/) and US NDBC (ftp://data.ndbc.noaa.gov/data/oceansites/).

4.1.19 PERSEUS

One of the aims of PERSEUS is to upgrade and expand the present observing capacity in the Mediterranean and Black Sea in responds to policy and science. Capacity building in key Mediterranean areas will be specifically addressed by implementing re-locatable multi-platform observatories during periods of several months to address well identified scientific, technological and/or society driven objectives, and gradually develop the local skill to operate such systems. Observing platforms are the pillar of the strategy for implementing the PERSEUS observing systems. New sensors such as acoustic sensors will be tested, i.e. the upgrade of the north Aegean POSEIDON buoy with PAL (Passive Acoustic Listener) sensor for the estimations of noise levels. The Continuous Plankton Recorder (CPR) will be used for the first time in the Mediterranean Sea. A pilot Program for the monitoring of the fishing fleet will be implemented to establish the grounds for more sustainable fisheries and ensure compliance with conservation features and management measures.

4.1.20 SEADATANET-II

The initiative for developing a Pan-European infrastructure for ocean and marine data management started as Sea-Search project under FP5 (2002 - 2005) with a focus on metadata and was continued under FP6 (2006 - 2011) as SeaDataNet with a wider focus including harmonised access to data. It is continued under FP7 (2011 - 2015) as SeaDataNet. It is operating and further developing a Pan-European infrastructure for managing, indexing and providing access

to ocean and marine environmental data sets and data products (e.g. physical, chemical, geological, bathymetric and biological properties) and for safeguarding a long term archival and stewardship of these data sets. Data are derived from many different sensors installed on board of research vessels, satellites and in-situ platforms, that are part of the various ocean and marine observing systems. Data resources are quality controlled and managed at distributed data centres, that are interconnected by SeaDataNet infrastructure and accessible for users through a central portal. Already 90 data centres from 35 European countries are connected to the SeaDataNet infrastructure and giving overview and access to their data resources! More connections are underway in the frame of associated projects that have adopted the SeaDataNet standards and services for marine data management.

SeaDataNet maintains pan-European discovery services with overviews of marine organisations in Europe and their engagement in marine research projects, managing large datasets, and data acquisition by research vessels and monitoring programmes for the European seas and global oceans:
•European Directory of Marine Organisations (EDMO)
•European Directory of Marine Environmental Data (EDMED)
•European Directory of Marine Environmental Research Projects (EDMERP)
•Cruise Summary Reports (CSR)
•European Directory of Oceanographic Observing Systems (EDIOS)
•Common Data Index (CDI)

SeaDataNet develops data products and aggregated data sets on five regions, Mediterranean Sea, Black Sea, Baltic Sea, North Atlantic, and Arctic and North Seas, that can be explored and downloaded by geographical viewing services. Seadatanet infrastructure is based on the following series of standards and conventions:
•Common metadata standards and XML schemas, based on ISO 19115 / 19139
•Standard data transport formats such as ODV ASCII and NetCDF (CF)
•Common QC methods and quality flag scale
•Common Vocabulary Web services, used to mark up metadata and data, covering a broad spectrum of disciplines. Governed by an international board (SeaVox)
•Unified user interfaces for querying Discovery services
•Use of OGC, ISO, and INSPIRE standard

4.1.21 TOSCA- Tracking Oil Spills and Coastal Awareness Network

Funded by the European Regional Development Fund in the framework of the MED Programme. The core objective of TOSCA is to improve the quality, speed and effectiveness of decision-making process in case of marine accidents (oil pollution, SAR Operations), by the development and implementation of technical and decision support tools, through active participation of scientists, in conjunction with local authorities (TOSCA, 2011, 2012). The novelty of TOSCA is to implement an integrated and scientific sustainable monitoring/forecasting design based on state of the art technology (Berta et al., 2014) that will be implemented at the territorial scale and for local needs through the following steps: - analysis of past dramatic events and state-of-the art in terms of methodologies, instruments and response plans, - setting-up of an observational network in the Mediterranean Sea based on HF radar and drifters providing direct information on ocean currents, coupled with other instruments and models, - assessment of the system considering different case scenarios.

4.1.22 UNEP/MAP

In 1975, only three years after the Stockholm Ministerial Conference that set up the United Nations Environment Programme (UNEP), 16 Mediterranean countries and the European Community adopted the Mediterranean Action Plan (MAP). The MAP was the first-ever plan adopted as a Regional Seas Programme under UNEP's umbrella. In 1976 these Parties adopted the Convention

for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention). The main objectives of the MAP were to assist the Mediterranean countries to assess and control marine pollution, to formulate their national environment policies, to improve the ability of governments to identify better options for alternative patterns of development, and to optimize the choices for allocation of resources. Seven Protocols addressing specific aspects of Mediterranean environmental conservation complete the MAP legal framework:

- Dumping Protocol (from ships and aircraft)
- Prevention and Emergency Protocol (pollution from ships and emergency situations)
- Land-based Sources and Activities Protocol
- Specially Protected Areas and Biological Diversity Protocol
- Offshore Protocol (pollution from exploration and exploitation)
- Hazardous Wastes Protocol
- Protocol on Integrated Coastal Zone Management (ICZM)

Today MAP involves 21 countries bordering the Mediterranean as well as the European Union. Together, they are determined to meet the challenges of environmental degradation in the sea, coastal areas and inland, and to link sustainable resource management with development, in order to protect the Mediterranean region and contribute to an improved Mediterranean quality of life.

4.1.23 VOS

The **VOS** Scheme is an international program comprising member countries of the World Meteorological Organization (WMO) that recruit ships to take, record and transmit weather observations whilst at sea. The **VOS** Scheme is a core observing program of the **Ship Observations Team** (SOT) in the Observations Programme Area of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). Meteorological data are required from the seas and oceans for a number of purposes, such as the preparation of marine forecasts and warnings, monitor the state of the oceans, climatological data banks.

Within the VOS programme, the VOS Climate (VOSClim) Fleet is a class of reporting ship that aims to provide a high-quality subset of VOS data in real-time and also in delayed-mode, supplemented by an extensive array of metadata, to support global climate studies and research. The data in particular will be used to input directly into air-sea flux computations, as part of coupled atmosphere-ocean climate models and provide ground truth for calibrating satellite observations.

Although distinguished by VOS, it must be considered also the Ship Of Opportunity Programme (SOOP) that is collecting temperature profiles in the world ocean. In The Mediterranean a SOOP programme is active from September 1999. SOOP presently support research, climate forecasting, numerical weather prediction and maritime safety services amongst other applications.

4.2 Mediterranean Member States data collection/monitoring systems

Here we list the Member States data collection/monitoring systems that are also among the important data sources of Table 6. This information has been collected by the MONGOOS network as part of its networking activities and it is validated each year, at the time of the Members Assembly (Courtesy of Enrique Alvarez-Fanjul and Susana Perez). This information was updated in November 2013 and can also be found at: http://www.mongoos.eu/in-situ-and-forecasts.

Table 8a lists the in situ stations that record at high frequency (minutes to hours) the characteristics at the surface and in the water column: waves, sea level, temperature, salinity, currents and surface atmospheric variables (air wind and temperature, pressure, humidity). This network is partially integrated in the Copernicus Service and in the EMODnet Physics data bases.

It is the major network to validate/calibrate basin-wide and coastal numerical models for the marine condition forecasting. In addition few stations collect also multidisciplinary data such as oxygen, fluorescence and pH in deep regions .

Table 8b illustrates instead the numerical ocean analysis and prediction systems organized by the Member States in the Mediterranean Sea. The models go from resolutions just below 1 km next to the coasts to few km offshore and they produce analyses and forecasts for waves, sea level, temperature, salinity, currents and major biochemical processes and tracers, such as phytoplankton and pelagic bacteria biomass, chlorophyll, dissolved nutrients, pH, oxygen. All the systems release data in near real time, once a day.

MonGOOS in situ station list

Institution	Station name	Type	variables	depths
CETMEF	Nice	Buoy	Waves,SST,Salinity	
CETMEF	Le Planier	Buoy	Waves,SST,Salinity	
CETMEF	Leucate	Buoy	Waves,SST,Salinity	
CETMEF	La Revellata	Buoy	SST, Waves	
CETMEF	Espiguette	Buoy	Waves,SST,Salinity	
CETMEF	Sète	Buoy	Waves,SST,Salinity	
CETMEF	Banyuls	Buoy	Waves,SST,Salinity	
CETMEF	Marseille	Buoy	Waves	
CETMEF	Porquerolles	Buoy	Waves	
CNR-ISMAR	S1	buoy	Pressure, Air	1.6, 20 m
CNR-ISMAR	COR	mooring	Salinity	
CNR-ISMAR	C01	mooring	Currents	
CNR-ISMAR	C02	mooring	Currents	
CNR-ISMAR	PTF Acqua Alta	platform	Level, Waves,	3, 13, 16 m
CNR-ISMAR	PALOMA	mast	Temperature,	3, 15, 24 m
CNR-ISMAR	Molo Sartorio	tide gauge	Sea Level	
CNR-ISMAR	Molo Fratelli Bandiera	station	Temperature,	0.4, 2, 6 m
CNR-ISMAR	BB	mooring	Currents, Sea	m (approx)
CNR-ISMAR	DD	mooring	Currents, Sea	m (approx)
CNR-ISMAR	E1	buoy	Temperature, Air	1.3, 8 m
CNR-ISMAR	Meda Senigallia	buoy	Temperature, SST,	
CNR-ISMAR	Meda Gargano	mast	Temperature,	2, 10, 16 m
CNR-ISSIA	W1M3A	Buoy	Air Pressure, Wind, Air	
HCMR	Zakynthos	Buoy	Wind, Air Pressure, Waves,	
HCMR	Santorini	Buoy	Wind, Air Pressure, Waves,	
HCMR	Mykonos	Buoy	Pressure, Waves, Air Temperature, SST, Salinity,	
HCMR	Lesvos	Buoy	Pressure, Waves, Air Temperature,	
HCMR	Athos	Buoy	Wind, Air Pressure, Waves,	
HCMR	Pylos	Buoy	Wind, Air Pressure, Waves,	
HCMR	E1-M3A	Buoy	Wind, Air Pressure, Waves,	
HCMR	Skyros	Buoy	Wind, Air Pressure, Waves,	
HCMR	Kalamata	Buoy	Wind, Air Pressure, Waves,	
HCMR	Saronikos	Buoy	Currents, Waves, SST, Wind, Air	
Hrvatski Hidrografski Institut	Dubrovnik	Tide Gauge	Sea Level	
Hrvatski Hidrografski Institut	Ploče	Tide Gauge	Sea Level	
Hrvatski Hidrografski Institut	Split	Tide Gauge	Sea Level	
Hrvatski Hidrografski Institut	Vis	Tide Gauge	Sea Level	
Hrvatski Hidrografski Institut	Zadar	Tide Gauge	Sea Level	

Table 8a: National in situ data collection stations composing the Mediterranean Sea monitoring

MonGOOS in situ station list

Institution	Station name	Type	Measured variables	depths
ISPRA	Porto Torres	Tide Gauge	Air Pressure, Wind, Relative	
ISPRA	Ravenna	Tide Gauge	Air Pressure, Wind, Relative	
ISPRA	Reggio Calabria	Tide Gauge	Air Pressure, Wind, Relative	
ISPRA	Salerno	Tide Gauge	Air Pressure, Wind, Relative	
ISPRA	Taranto	Tide Gauge	Air Pressure, Wind, Relative	
ISPRA	San Benedetto del Tronto	Tide Gauge	Level, Air Temperature, Relative	
ISPRA	Sciacca	Tide Gauge	Temperature,Relative Humidity	
ISPRA	Strombolicchio	Tide Gauge	Temperature, Relative Humidity	
ISPRA	Vieste	Tide Gauge	Air Pressure, Relative Humidity,	
Oceanograhpy and	Kastela Bay	Buoy	Air Temperature, Salinity	
Oceanograhpy and	Punta Jurana	Station	Temperature	
LIM/UPC	Badalona Pier	oceanograp	Temperature, Relative Humidity,	
of Biology, Slovenia	Vida	Buoy	Temperature, Salinity, Humidity	
ARSO	Koper-Kapitanija	& Met	Wind, Air Pressure, Solar	
OC-UCY	CYCOFOS-OCB	Buoy	Salinity, SST, Sea Pressure	
OC-UCY	Paphos	Tide Gauge	SST, Sea Level, Air Pressure	
OC-UCY	Larnaca	Tide Gauge	Sea Level, SST	
OC-UCY	Zygi	Tide Gauge	Sea Level, SST	
OC-UCY	Paralimni	Tide Gauge	Sea Level, SST	
OC-UCY	Limassol - LCL06094	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Limassol - LCL06093	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Limassol - LCL06096	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Limassol - LCL06088	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Paphos - LCL06090	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Paphos - LCL06089	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Vasiliko - LCL06091	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OC-UCY	Vasiliko - LCL06092	Multi-parametric probes	Sea Pressure, SST, Salinity, pH, Dissolved Oxygen, Turbidity, Redox	
OGS	E2-M3A	Buoy	Temperature, Hr, Short-Wave Radiation, Long-Wave Radiation,	560m, 760m, 1000m, 1160m,
OGS	MAMBO 1	Buoy	Temperature, Air Humidity, Solar Radiation, SST, Dissolved	
OGS	MAMBO 2	Buoy	Wind, Air Pressure, Air Temperature, Air Humidity, SST, Dissolved Oxygen, Conductibility, pH, Redox Potential, Fluorescence, Hydrostatic Pressure, Currents, Bottom Water Temperature and Water Pressure	
OGS	MAMBO 3	Buoy	Wind, Air Pressure, Air Temperature, Air Humidity, SST,Dissolved Oxygen, Conductibility, pH, Redox	
OGS	MAMBO 4	Buoy	Temperature, Air Humidity, Current, Bottom Water	
OGS	DWRG-1	Buoy	Waves	
OGS	DWRG-2	Buoy	Waves	
OGS	DWRG-3	Buoy	Waves	
OGS	CORR_ISO	River Station	Currents, Water Temperature, Water Pressure	
OGS	CORR_TAG	River Station	Currents, Water Temperature, Water Pressure	
University of Malta	Portomaso	Station	Air Pressure, SST, Sea Level	
University of Malta	Marsaxlokk	Station	Pressure	
University of Malta	Msida	Station	Net Radiation, Solar Radiation,	

Table 8a (cont): National in situ data collection stations composing the Mediterranean Sea monitoring

Growth and innovation in ocean economy
Gaps and priorities in sea basin observation and data

MonGOOS in situ station list

Institution	Station name	Type	Measured variables	depths
Puertos del Estado	Dragonera	Buoy	Temperature, Air Pressure	0
Puertos del Estado	Cabo Begur	Buoy	Air Pressure	0
Puertos del Estado	Tarragona	Buoy	Wind, Air Temperature, Air	0
Puertos del Estado	Valencia	Buoy	Wind, Air Temperature, Air	0
Puertos del Estado	Cabo de Palos	Buoy	Wind, Air Temperature, Air	0
Puertos del Estado	Cabo de Gata	Buoy	Wind, Air Temperature, Air	0
Puertos del Estado	Golfo de Cadiz	Buoy	Waves, SST, Salinity, Currents, Wind, Air Temperature, Air	0
Puertos del Estado	Capdepera	Buoy	Waves, SST	0
Puertos del Estado	Barcelona	Buoy	Waves,SST	0
Puertos del Estado	Tarragona	Buoy	Waves, SST	0
Puertos del Estado	Valencia	Buoy	Waves, SST	0
Puertos del Estado	Alicante	Buoy	Waves, SST	0
Puertos del Estado	Melilla	Buoy	Waves, SST	0
Puertos del Estado	Malaga	Buoy	Waves, SST	0
Puertos del Estado	Ceuta	Buoy	Waves	0
Puertos del Estado	Punta Carnero	Buoy	Waves, SST	0
Puertos del Estado	Tarifa	Buoy	Waves, SST	0
Puertos del Estado	Cadiz	Buoy	Waves, SST	0
Puertos del Estado	Mahon	Tide Gauge	Sea Level	0
Puertos del Estado	Alcudia	Tide Gauge	Sea Level	0
Puertos del Estado	Palma de Mallorca	Tide Gauge	Sea Level	0
Puertos del Estado	Ibiza	Tide Gauge	Sea Level	0
Puertos del Estado	Formentera	Tide Gauge	Sea Level	0
Puertos del Estado	Barcelona	Tide Gauge	Sea Level	0
Puertos del Estado	Tarragona	Tide Gauge	Sea Level	0
Puertos del Estado	Sagunto	Tide Gauge	Sea Level	0
Puertos del Estado	Valencia	Tide Gauge	Sea Level	0
Puertos del Estado	Gandia	Tide Gauge	Sea Level	0
Puertos del Estado	Almeria	Tide Gauge	Sea Level	0
Puertos del Estado	Melilla	Tide Gauge	Sea Level	0
Puertos del Estado	Motril	Tide Gauge	Sea Level	0
Puertos del Estado	Malaga	Tide Gauge	Sea Level	0
Puertos del Estado	Algeciras	Tide Gauge	Sea Level	0
Puertos del Estado	Tarifa	Tide Gauge	Sea Level	0
Puertos del Estado	Bonanza	Tide Gauge	Sea Level	0
Puertos del Estado	Huelva	Tide Gauge	Sea Level	0

Table 8a (cont): National in situ data collection stations composing the Mediterranean Sea monitoring

MonGOOS in situ station list

Institution	Station name	Type	Measured variables	depths
SHOM	Ajaccio-Aspretto	Tide Gauge	Sea Level	0
SHOM	Centuri	Tide Gauge	Sea Level	0
SHOM	Fos-sur-Mer	Tide Gauge	Sea Level	0
SHOM	Marseille	Tide Gauge	Sea Level	0
SHOM	L'Ile Rousse	Tide Gauge	Sea Level	0
SHOM	Port-Ferréol	Tide Gauge	Sea Level	0
SHOM	La Figueirette	Tide Gauge	Sea Level	0
SHOM	Nice	Tide Gauge	Sea Level	0
SHOM	Monaco-Port Hercule	Tide Gauge	Sea Level	0
SHOM	Monaco-Fontvieille	Tide Gauge	Sea Level	0
SHOM	Port-Camargue	Tide Gauge	Sea Level	0
SHOM	Port-La-Nouvelle	Tide Gauge	Sea Level	0
SHOM	Port-Vendres	Tide Gauge	Sea Level	0
SHOM	Sète	Tide Gauge	Sea Level	0
SHOM	Solenzara	Tide Gauge	Sea Level	0
SHOM	Toulon	Tide Gauge	Sea Level	0
SOCIB	Buoy Bahia de Palma	Buoy	Temperature, Air Pressure, Wind, Hr,Chlorophyll, Oxygen	
SOCIB	Station Parc Bit	Weather Station	Air Temperature, Air Pressure, Wind, Humidity	
SOCIB	Station Salines	Weather Station	Air Temperature, Air Pressure, Wind, Humidity	
SOCIB	Station Galfi	Weather Station	Air Temperature, Air Pressure, Wind, Humidity	
SOCIB	Mobims Cala Millor	Coastal Station	Air Temperature, Air Pressure, Wind, Humidity, Waves	
SOCIB	Mobims Playa de Palma	Coastal Station	Air Temperature, Air Pressure, Wind, Humidity, Waves	
SOCIB	Mobims Son Bou Coastal	Coastal Station	Air Temperature, Air Pressure, Wind, Humidity, Waves	
SOCIB	Station La Mola	Coastal Station	Currents, Air Pressure, SST, Water Pressure, Salinity	
SOCIB	Station Sa Rapita	Sea Level	Sea Level	
SOCIB	Station Pollensa	Sea Level	Sea Level	
SOCIB	Station Andratx	Sea Level	Sea Level	
SOCIB	Buoy Canal de Ibiza	Buoy	Air Temperature, Air Pressure, Wind, Humidity, Waves	

Table 8a (cont): National in situ data collection stations composing the Mediterranean Sea monitoring

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Institution	Operational forecasting system name	Modelled variables (analysis, forecast and re-analysis)
CMCC-INGV	AFS	Temperature, Salinity, Sea level, Currents
CNR-IAMC	Sicily Channel Regional sub-Model Forecasting System	Temperature, Salinity, Sea surface height, Currents, Waves
CNR-IAMC	Western Mediterranean sub-Regional Model Forecasting System	Temperature, Salinity, Sea surface height, Currents, Waves
CNR-IAMC	Model	Waves, Currents
CNR-IAMC	Oristano coastal Model	Waves, Currents
CNR-ISMAR	Kassandra - Mediterranean Sea	Sea Level, Waves
CNR-ISMAR	Kassandra - Balck Sea	Sea Level, Waves
CNR-ISMAR	Nettuno - Mediterranean Sea	Waves
CNR-ISMAR	Henetus - Adriatic Sea	Waves
CNR-ISMAR	RISKMED - Mediterranean Sea	Waves
ENEA	Tyrrhenian Sea Forecasting	Temperature, Salinity, Sea surface height, Currents
HCMR	POSEIDON	Temperature
HCMR	POSEIDON	Chlorophyll
HCMR	POSEIDON	Temperature, Salinity, Sea surface height, Currents
HCMR	POSEIDON	Waves
HCMR	POSEIDON	Sea Level
HCMR	POSEIDON	Waves
HCMR	POSEIDON	Temperature, Salinity, Sea surface height, Currents
HCMR	POSEIDON	Waves
IFREMER	PREVIMER-MENOR	Temperature, Salinity, Sea surface height, Currents
IMS-METU	NLEV (POM)	Temperature, Salinity, Sea surface height, Currents
IMS-METU	NLEV (ROMS)	Temperature, Salinity, Sea surface height, Currents
IMS-METU	LEV (ROMS)	Temperature, Salinity, Sea surface height, Currents
IMS-METU	BLACK (POM)	Temperature, Salinity, Sea surface height, Currents
INGV	Copernicus Monitoring and Forecasting Center-Currents (MyOcean2 prototype)	Temperature, Salinity, Sea level, Currents
INGV	Copernicus Monitoring and Forecasting Center-Currents (MyOcean2 prototype)	Stokes Drift
INGV	MFS-RITMARE	Temperature, Salinity, Sea level, Currents
IOLR	SELIPS	Temperature, Salinity, Sea surface height, Currents
IOLR	Mediterranean_Sea-W	Waves
IOLR	Levantine_Basin-W	Waves
IOLR	Israeli_Coast-W	Waves
IOLR	Haifa_Bay-W	Waves
LIM/UPC	Wave forecast at the NW Medirettanean basin	Waves
MERCATOR	PSY2	height, Currents
MERCATOR	PSY3	height, Currents
MERCATOR	PSY4	height, Currents
NIB-MBS	North Adriatic Princeton Ocean Model (NAPOM)	Temperature, Salinity, Sea surface height, Currents

Table 8b: National ocean numerical prediction systems contributing to Mediterranean Sea monitoring

Growth and innovation in ocean economy
Gaps and priorities in sea basin observation and data

Institution	Operational forecasting system name	Modelled variables (analysis, forecast and re-analysis)
OC-UCY	CYCOFOS NE	Temperature, Salinity, Sea surface height, Currents
OC-UCY	CYCOFOS Levantine	Temperature, Salinity, Sea surface height, Currents
OC-UCY	CYCOFOS NE - Glider temperature, salinity assimilation	Temperature, Salinity, Sea surface height, Currents
OC-UCY	CYCOFOS Levantine	Waves
OC-UCY	CYCOFOS Cyprus	Waves
OC-UCY	CYCOFOS Med & Black Sea	Waves
OC-UCY	CYCOFOS Med & Black Sea	Sea Level
OC-UCY	CYPPOM Aegean-Levantine	Temperature, Salinity, Sea surface height, Currents
OGS	Copernicus Monitoring Forecasting Center-Biogeochemistry	Chlorophyll, nutrients, phytoplankton and bacteria biomass
PdE	SAMPA	Temperature, Salinity, Sea Level, Currents
PdE	PdE Waves Forecast for the Med Sea	Waves
PdE	Nivmar	Sea Level
PdE	SAPO Alicante	Waves
PdE	SAPO Almeria	Waves
PdE	SAPO Almeria-Carboneras	Waves
PdE	SAPO Barcelona	Waves
PdE	SAPO Cartagena	Waves
PdE	SAPO Valencia	Waves
PdE	SAPO Tarragona	Waves
PdE	SAPO Algeciras	Waves
PdE-Mercator	IBI-MFC model	Temperature, Salinity, Sea Level, Currents
PdE-SOCIB	SAPO Palma de Mallorca	Waves
RBI	ROMS Adria 2km	Temperature, Salinity, Sea surface height, Currents
RBI	ROMS Kvarner nest 500m	Temperature, Salinity, Sea surface height, Currents
RBI	ROMS West Istria nest 500m	Temperature, Salinity, Sea surface height, Currents
RBI	WWM Adriatic	Waves
SOCIB	Western Mediterranean sea OPerational system (WMOP)	Temperature, Salinity, Sea surface height, Currents
UMT-IOI-POU	MARIA/WAM Central Med	Waves
UMT-IOI-POU	ROSARIO	Temperature, Salinity, Currents
UoA	ALERMO	Temperature, Salinity, Sea surface height, Currents
UoA	North Aegean Forecasting	Temperature, Salinity, Sea surface height, Currents
UoA/IASA	SKIRON, Global	Waves
UoA/IASA	SKIRON	Waves
UoA/IASA	SKIRON	Waves
UoA/IASA	SKIRON	Waves
UoA/IASA	SKIRON	Waves
UoA/IASA	SKIRON	Waves

Table 8b (cont.): National ocean numerical prediction systems contributing to Mediterranean Sea monitoring

5 Use cases related to the Challenge Characteristics

As described in the Introduction our methodology to assess 'appropriateness', 'availability' and 'fitness for purpose' is to analyse 'Use Cases' as substitute of the future Challenge outputs. In this section we describe 18 Use Cases and their input data sets identifying the characteristics described in Section 3 and Table 3. In fact the selected "Use Cases" represent different kind of 'Challenges' used in the literature to extract the appropriateness, availability and fitness for purpose of the input characteristics.

Since the same characteristics is used in many Use Cases we cannot really make a clear distinction, for our purposes a simple way to classify the Use cases is to use the 'Environmental Matrices'. Only the Air, Fesh/Marine Water, Biology/Biota, Seabed are used as monitoring 'matrices' since the characteristics related to human activities are normally concomitant with other caracheristics and seldomly interesting by themselves in environmental assessments.

5.1 Air Matrix Use Cases

This section describes 6 Use cases that consider the main Air Matrix characteristics listed in Table 3. Use Cases, as Challenges, contain many characteristics but in this section we discuss the ones that use 'key characteristics' from the Air Matrix. The 5 Use cases are listed in Table 9 and they have been chosen to discuss 'appropriateness', 'completeness' and 'fitness for purpose' in Section 7.

Use case ID	Long name	Environmental Matrix of interest	Related EMODNET challenges
AM1	**SCREAM (Spatially Continuous Resource Economic Analysis Model)**	Air and human activities	CH-1
AM2	**The MARINA-Platform project**	Air, Marine Waters	CH-1
AM3	**Oil spill forecasting for the Lebanon accident case**	Air, Seabed, Marine waters and human activities	CH-3
AM4	**Storm surge and wave modelling for coastal extreme events**	Air, Marine waters and seabed	CH-4
AM5	**Coastal upwelling indicators**	Air	CH-6, CH-5
AM6	**Oil Spill Decision Support System; Don Pedro vessel spill on Ibiza beaches, July 2007**	Air Marine waters Seabed Biology/biota	CH2, CH3, CH5,CH6

Table 9 Use Cases for Air Matrix Characteristics

Use case AM1 - SCREAM (Spatially Continuous Resource Economic Analysis Model)

At present there are no working wind farms in the Mediterranean Sea. Thus for wind farm siting we have chosen a study case that concerns a GIS based modelling tool, SCREAM (Moller, 2011) that is used to define the optimal siting and functioning of offshore wind energy extraction for the Danish EEZ areas. SCREAM includes three elements: 1) a wind power production calculator which uses a Wind Atlas Analysis and Application Program (WasP, Mortensen et al., 1993, Lange and Ojstrup, 2001) and power technology information (turbine capacity, power curve, average annual availability and turbine spacing) giving as output the cumulative wind power resource harvestable in each km2 cell which is chosen to be the energy resource assessment resolution. WAsP is at the basis of the European Wind Atlas [Troen et al., 1989, EWA, 2014] and all the numerical tools are displayed at: http://www.wasp.dk/. The second element instead calculates the production costs,

excluding profit but including annuity. All investments, operational, electric grid and maintenance costs are included. The third element reduces the EEZ offshore Danish area useful for wind farming excluding the areas already occupied for other uses.

- ➢ Characteristics used in AM1 :
  - o Air :
    - ▪ wind speed and direction
  - o Human activities
    - ▪ EU RAMSAR area
    - ▪ EU Habitat areas
    - ▪ EU Bird protection areas
    - ▪ National conservation areas
    - ▪ Transport activity
    - ▪ Sea cables
    - ▪ Pipelines
    - ▪ Bathymetry, elevation and undersea features
    - ▪ Military ranges
    - ▪ Radio and radar corridors
    - ▪ Visibility zones

Use case AM2- MARINA-Platform project

Research in the MARINA Platform project will establish a set of equitable and transparent criteria for the evaluation of multi-purpose platforms for marine renewable energy (MRE). This project analyses the combined renewable resources from currents, waves and winds in offshore areas and uses wind and wave numerical model outputs to assess the offshore resources, making use of in situ data for validation and assimilation. The general framework is set by Garel et al. (2014) and advancements on the quality of model products for the resource assessment is described in Stathopoulos et al. (2013) and Emmanouhil et al. (2012).

- ➢ Characteristics for AM2:
  - o Air :
    - ▪ wind speed and direction
  - o Marine Waters
    - ▪ Wave direction, height, period and spectral wave parameters

Use case AM3- Oil spill forecasting for the Lebanon accident case

The largest accident occurred in the Eastern Mediterranean Sea is the Lebanon Oil Spill accident which dispersed, from the fuel tanks of Jihe (coastal town south of Beirut), approximately 19000 tons of heavy oil (OSOCC, 2006, GLA, 2007, UNEP/OCHA, 2007) . Coppini et al. (2010) documents the skill of different forecasting/hindcasting models in giving indication of oil pollution at Sea and along the Lebanese and Syrian coasts. Resolution of the weather and ocean prediction models is found to be a key feature to reach skill in the reconstruction of beached oil. In a recent work, Samaras et al. (2014) evaluate the impact of the oil beaching parametrizations in the Lebanon oil spill accident impact on the coasts and found new formulations that could better reporduce the oil pullotion for the accident.

- ➢ Characteristics for AM3:
  - o Air :
    - ▪ wind speed and direction
    - ▪ air temperature
  - o Marine Water

- Currents
  - o Seabed
    - Coastal types
    - Sediment grain size parameters
  - o Human activities
    - Prevention and emergency protocol of REMPEC (Barcelona Convention)

Use case AM4- Storm surge and wave modelling for coastal extreme events

Storm surge and wave models have been available in the Mediterranean Sea for several years (Fanjul et al., 2001, Bajo and Umgiesser, 2010) and here we report about one of the newest implementations (Ferrarin et al., 2013). These models are employed to analyze extreme sea level events and set up early warning systems for coastal flooding. They are essential components of the international JCOMM Disaster Risk Reduction strategy. These models depend in particular from the accuracy of the wind field which forces the sea level and the waves, together with the atmospheric pressure and the tidal astronomical forcing. In addition the sea level monitoring stations help to understand the errors and they are key also for mixed statistical and deterministic forecasting models. These models are part of Member States forecasting systems for the prevention and mitigation of coastal erosion and the protection of coastal infrastructures in general.

- ➢ Characteristics for AM4:
  - o Air :
    - Atmospheric pressure
    - Wind amplitude and direction
  - o Marine Waters
    - Sea level
    - Wave height and direction
  - o Seabed
    - bathymetry

Use case AM5- Coastal Upwelling Indexes

Upwelling indices are requested by the MSFD but they are not well defined for European coastal areas. In the Mediterranean Sea the work of Bakun and Agostini (2001) defined upwelling indices from COADS surface wind data set, following the same formulation of the California Current System (Schwing et al., 1996). SST based upwelling indices can also be analysed (Rinaldi, 2013), as well as new indices calculated from ECMWF analyses (Guarnieri et al., 2014) which add more resolution and accuracy to the traditional computations. Upwelling indices are extracted from winds and the quality of winds near the coasts is of great importance since there is need to derive stress for Ekman transport evaluation and curl of the wind stress for Ekman vertical velocity evaluation. Thus appropriateness of wind data sets is of great importance

- ➢ Characteristics for AM5:
  - o Air :
    - Wind currents and direction

Use case AM6 – Oil Spill Decision Support System: Don Pedro vessel spill on Ibiza beaches, July 2007

At 2:52 am on July 11th 2007, the RORO vessel Don Pedro (ISCOMAR shipping company) sank in the coastal waters close to the Ibiza harbour. The vessel left the harbour on route to Valencia and run aground a small islet -Es Daus-, located less than one nautical mile SE from the port. The vessel finally sank in the vicinity, in position (38º53',08 N - 001º 27',11 E). In the following days (up

to the 18), an important oil spill occurred in the area with impact on the crowded touristic beaches of the area and a natural park. Scientific support was requested from the Balearic Government to help in forecasting spill trajectories and sensitivity of the coastline that could help in making the appropriate decisions in terms of protecting the coast and establishing spill barriers in one area or another.

The Marine Technologies, Operational Oceanography and Sustainability Department (TMOOS) from the Mediterranean Advanced Studies Institute (IMEDEA), located in the island of Mallorca, worked together with Emergency Directorate of the Balearic Islands Government analysing existing information and providing specific reports on (1) oil spill extension (from SAR operator), (2) marine conditions and forecast (currents and waves, Tintoré et al., 2013), (3) oil spill trajectory forecast at 4, 8, 12 and 24 h (Jordi et al., 2006) and (4) Environmental Sensitivity Index (ESI) of the shoreline of the SE of Ibiza. These reports –which included specific recommendations- were a key element of science based decision support system for the clean-up and restoration tasks at the coast.

A specific support web site was designed and can still be found as it was at: http://www.costabalearsostenible.com/donpedro (Sayol et al., 2014). An example of the Reports available at that time on "Adaptation of Coastal Environmental Sensitivity Atlas (SE coasts of Eivissa island)" is also available at SOCIB web site, www.socib.es (ESI were updated in 2012 and are now part of the Sa Costa viewer - http://gis.socib.es/sacosta/composer - from SOCIB; Tintoré et al., 2013). All the related information can be found updated now at: http://www.socib.es/?seccion=siasDivision&facility=applicationandproductsvertidos&language=en_GB#donpedro

➢ Characteristics for AM6
- o Air matrix:
  - ▪ Wind direction and speed
  - ▪ Air temperature
  - ▪ Air pressure
- o Marine Water:
  - ▪ currents
- o Biology/biota
  - ▪ Habitats
- o Seabed
  - ▪ Bathymetry
  - ▪ Coastal geomorphology
- o Human activities
  - ▪ Administrative units

5.2 Fresh and Marine Water Matrix Use Cases

This section describes 3 Use cases that consider the main Fresh and Marine Water Matrix characteristics listed in Table 3. Use Cases, as Challenges, contain many characteristics but in this section we discuss the ones that use 'key characteristics' from the Marine and Fresh Water matrix. The 3 Use cases are listed in Table 10 and they have been chosen to discuss 'appropriateness', 'completeness' and 'fitness for purpose' in Section 7.

Use case ID	Name	Environmental Matrix of Interest	Related EMODNET challenges
MW01	**EEA Climate Change Report Assessment**	Marine Waters	CH2, CH4, CH6

		D1.3
Growth and innovation in ocean economy		Version: V10
Gaps and priorities in sea basin observation and data		Date: 26/09/2014

MW02	Use of global datasets for hydrological predictions	Fresh Water	CH7
MW03	Near-real time in situ data for calibration/validation	Marine waters	CH4, CH3, CH6

Table 10 Use Cases for Fresh and Marine Water Matrix Characteristics

MW01 – EEA Climate change report assessments

The European Environmental Agency publishes periodically assessments and time series indicators related to climate that feed the Climate-Adapt web portal (European Climate Adaptation Portal; http://climate-adapt.eea.euroa.eu/). In many cases, the indicators feature information from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), although several indicators have been updated from other sources more relevant for Europe. Among the different indicators used there are many of them that are of interest for the EMODnet Medsea Checkpoint, as these related with Global and European sea level rise (CLIM012), Sea surface Temperature (CLIM013), Ocean heat content (CLIM9434).

The indicator CLIM012 comprises several metrics to describe past and future sea-level rise globally and in European seas. The indicator includes: first, change in global mean sea level (time series starting in 1880, in mm), based on a reconstruction from various data sources and on satellite altimeter data; second, trend in relative sea level across Europe (map, in mm/year), based on selected European tide gauge stations since 1970 (data provided by the PSMSL, Woodworth and Player, 2003; inverted barometer not included, no correction for local land movement); third, trend in absolute sea level across Europe (map, in mm/year), based on satellite measurements since 1992 (data are provided by the Collecte Localisation Satellite (CLS), http://www.cls.fr/en/; inverted barometer included, seasonal signal removed, Ablain et al., 2009). In addition, this indicator informs about the contributions from various sources to the observed global sea level rise (since 1901). Finally, this indicator presents projections for sea level rise in the 21st century, both globally and for the European seas.

➢ Characteristics for MW01:
   o Marine waters:
      ▪ Sea level
      ▪ Sea surface temperature
      ▪ Temperature of the water column

MW02 Use of water discharge global datasets for hydrological predictions

Hydrological predictive models, such as E-HYPE (Arheimer et al., 2011; http://e-hypeweb.smhi.se/) calculate hydrological variables (e.g. runoff, discharge, snow depth, groundwater level) and nutrient variables (e.g. concentrations and loads), and aims to (or should) take into account important processes including both hydrological and anthropogenic impacts for all regions across Europe (e.g. irrigation, hydropower). E-HYPE, in particular, is validated for a wide range of catchment scales, climatic, physiographic and anthropogenic regions. Availability of input data for hydrological predictions, however, can be limited due to low accessibility and reliability to the datasets or insufficient monitoring efforts. Basic data needs in hydrological modelling normally include long-term meteorological data and information on river basin hydrography. In addition, hydrological observations are needed for calibration and validation (Strömqvist etal., 2009). Water discharge data, in particular, constitute the crucial characteristics for hydrological predictions. Such a dataset is at the base of the definition of biogeochemical and sedimentary fluxes since it quantify their transport and accumulation phenomena. Moreover, a proper collection of water discharge data is strictly linked with a proper assessment of land-ocean interaction processes in terms of river inputs on marine coastal and offshore areas.

➢ Characteristics for MW02
   o Fresh Water :
      ▪ Water discharge

MW03 – Near-real time in situ data for calibration/validation

Near Real Time data is used in several applications for the calibration/validation (Cal/Val) of products, from satellite altimetry to analyses and forecast systems. Examples of such activities are:

1. Altimetry validation with tide gauge networks:

http://www.aviso.altimetry.fr/en/data/calval/in-situ-calibration-and-validation/in-situ-global-statistics.html

The web provides a group of tide gauges, available through http://refmar.shom.fr/, used to perform the validation of satellite altimeter measurements.

2. MyOcean Cal/Val system for the Mediterranean Sea

http://gnoo.bo.ingv.it/myocean/calval/

The system allows the user to compare in situ measurements (temperature, salinity, currents) with different numerical model outputs at the same locations and provides basis statistics such as RMS and bias.

3. SOCIB numerical model online validation system for Western Mediterranean Sea

http://socib.es/?seccion=modelling&facility=wmedindicators

SOCIB numerical model (WMOP) is validated using comparisons with, among others, satellite products (Sea Surface Temperature, altimetry), in situ measurements (fixed moorings, Argo floats, gliders). The validation procedures allow monitoring the performances and certifying the skill of the daily production of the WMOP ocean forecasting system before its distribution to users.

> ➢ Characteristics for MW03:
>> o Marine waters
>>> ▪ Temperature
>>> ▪ Salinity
>>> ▪ Sea level
>>> ▪ Currents

5.3   Biology/Biota Matrix Use Cases

This section describes 4 Use cases that consider the main Biology/Biota Matrix characteristics listed in Table 3. Use Cases, as Challenges, contain many characteristics but in this section we discuss the ones that use 'key characteristics' from the Biota/Biology matrix. The 4 Use cases are listed in Table 11 and they have been chosen to discuss 'appropriateness', 'completeness' and 'fitness for purpose' in Section 7.

Use case ID	Name	Environmental Matrix of Interest	Related EMODNET challenges
BB01	**Assessment of Mediterranean Sea stocks**	Biology/biota and Human activities	CH5
BB02	**Alien species and stocks**	Biology/biota	CH5
BB03	**Fishery impact on the sea floor in the MFSD**	Human activities	CH5
BB04	**Fishery impact on sea turtles in the Mediterranean Sea**	Biology/biota	CH5

Table 11 Use Cases for Biology/Biota Matrix Characteristics

Use case BB01 – Assessment of Mediterranean Sea stocks

D1.3
Version: V10
Date: 26/09/2014

Growth and innovation in ocean economy
Gaps and priorities in sea basin observation and data

MODnet
European Marine
Observation and
Data Network

The number of consistently assessed stocks by GFCM and European Scientific, Technical and Economic Committee for Fisheries (STECF-EWGs: Assessment of Mediterranean Sea stocks) increased significantly in the last 10 years as a result of the enhanced data collection system and commitment of Mediterranean scientists, elucidating the status of fisheries resources in the Mediterranean. In the framework of such EWGs the data employed for the assessment of commercially exploited stocks are mainly related to the characteristics related to the challenge 5, in particular catch statistics and fishing effort data.

> ➢ Characteristics for BB01:
>> o Biology/Biota:
>>> ▪ Fish and shellfish catch statistics
>> o Human activities:
>>> ▪ Fishing effort

Use case BB02 – Alien species and stocks

Alien species (or non-native species) are intentionally or accidentally transported and released into marine ecosystems outside their historic or resident geographical range or habitat (for example through ballast waters or deliberate introductions through the import and release of fish and bivalves for commercial or recreational purposes). Such species can be ecologically and/or economically harmful when they impact the structure and function of marine ecosystems by changing biodiversity and eliminating vital components of the food chain. The study case we have chosen concerns the evaluation of abundances of two alien species, namely *Saurida undosquamis* and *Metapenaeus stebbingi* of GSA 26 (South Levant) made by FAO – EastMed regional project in 2013. The data available on FISHSTAT database related to these species have been also used to assess their abundance and fishing mortality.

> ➢ Characteristics for BB02:
>> o Biology/Biota:
>>> ▪ Fish and shellfish catch statistics:

Use case BB03 – Fishery impact on the sea floor in the MFSD

The main goal of the Marine Strategy Framework Directive is to achieve Good Environmental Status (GES) of EU marine waters by 2020. GES means that the different uses of the marine resources are conducted at a sustainable level, ensuring their continuity for future generations. In particular, Descriptor 6 (seafloor Integrity) considers different kinds of pressures deriving by human activities, that can affect the seafloor, with the aim of ensuring that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. The trawling activity on the sea floor is one of these pressures and the use case we have chosen is the initial assessment of ISPRA (2013) on physical damage induced, among others, by this activity in the northern and southern Adriatic sea. The assessment was carried out using VMS data from the Italian trawlers and following the method described in Russo et al. (2011a,b). The impact on the sea floor can be assessed also employing different methodologies using side scan sonar technology (Lucchetti et al., 2012) and/or video analyses (Weaver et al., 2011) especially for deep fisheries. These higher resolution techniques would provide additional information when associated with VMS data, allowing to better understand the impact of trawling on the seabed. However, at present they can be only used at a local spatial scale due to the effort required either as field-work and costs, while VMS data can provide information at regional level. Other methodologies which can be employed on a large scale are GPS logger and AIS. These two methodologies have been developed for other primary scopes, being the former tested as a new fuel consumption monitoring system and the latter world-wide applied for navigation safety. However, both could provide more detailed information on the fishing grounds more exploited by trawling in respect to VMS as they collect data in shorter time intervals.

➢ Characteristics for BB03:
  o Human activities:
    ▪ Horizontal spatial coordinates (fishing vessels).

Use case BB04 – Fishery impact on sea turtles in the Mediterranean Sea

The Barcelona Convention adopted an Action Plan for the Conservation of Mediterranean Marine Turtles in 1989, revised in 1998–1999 and 2007 (UNEP MAP RAC/SPA, 2007), acknowledges that the impact of fishing activities is one of the most important anthropogenic mortality factors for sea turtles in the Mediterranean Sea and that the conservation of these animals deserves special priority. Several countries (22 Mediterranean and 15 non-Mediterranean) regularly fish in this basin and an undefined number of small boats are active in non-EU countries. Therefore, the fishing effort in the Mediterranean is a key factor to take into account in considering the sea turtle conservation. Lucchetti and Sala (2009) has been selected as use case for such topic. The scientific publication is a review of the gear parameters responsible for loggerhead sea turtle (Caretta caretta) capture and mortality in the Mediterranean Sea. The selected use case takes also into consideration source of data related to the Task 1 of GFCM, in particular Task 1.4: Catch and effort variables (catch, effort, discard, bycacth). However, it is worthy to note that the data on the incidental catches of this species due to the commercial fisheries are quite sparse and heterogeneous. A systematic sampling strategy in the Mediterranean is needed to better estimates the impacts of commercial fisheries on protected species such as sea turtles, marine mammals, endangered sharks, other reptiles and sea birds. The procedure to obtain such estimates of bycatch for protected stocks could derive from the activity carried out for marine mammals in U.S. waters and published in stock assessment reports (NOAA 2013).

➢ Characteristics for BB04:
  o Biology/biota:
    ▪ Fishing by-catch.

5.4 Seabed Matrix Use Cases

This section describes 5 Use cases that consider the main Seabed Matrix characteristics listed in Table 3. Use Cases, as Challenges, contain many characteristics but in this section we discuss the ones that use 'key characteristics' from the Seabed Matrix. The 5 Use cases are listed in Table 12 and they have been chosen to discuss 'appropriateness', 'completeness' and 'fitness for purpose' in Section 7.

Use case ID	Name	Environmental Matrix of Interest	Related EMODNET challenges
SBD01	**RESPONSE Project – LIFE Environment program**	Seabed and Human activities	CH3, CH4
SBD02	**Assessment of Coastal Protection in Europe**	Seabed, Human activities and Marine Water	CH2, CH3, CH4, CH6
SBD03	**Mediterranean Beach Erosion Study Cases**	Seabed	CH4
SBD04	**Tsunami travel time maps**	Seabed	CH4
SBD05	**Relevant bathymetry for biological assemblages of conservation interest in the submarine canyons and numerical cumodelling**	Seabed Marine waters, Biota, Human activities	CH1, CH2, CH3, CH4, CH5

Table 12 Use Cases for Seabed Matrix Characteristics

SBD01 – RESPONSE Project – LIFE Environment program

The RESPONSE project (Response to the Risk from climate change on the coast), funded by the LIFE program, aimed to develop sustainable strategies for management natural hazards in coastal areas taking into account the impact of climate change. In the Mediterranean there where two pilot locations: the Languedoc-Roussillon coast in France and the Marche Coast in the Adriatic, Italy. The project methodology combined different variables in order to map a 'coastal behaviour system' previously explored in southeastern English coasts (Cooper et al., 2002; Hosking and McInnes, 2002). This was conducted using existing data on geomorphology (EUROSION, 2004), coastal processes (Durand, 1999), historical hazards and existing defence works.

- ➢ Characteristics for SBD01:
  - o Seabed :
    - ▪ Coastal type
    - ▪ Shoreline erosion trend
  - o Human activities
    - ▪ Defence works

SBD02 – Assessment of coastal protection in Europe

Last decade has seen a proliferation of studies on ecosystem services as a response to an increase in the demand of policies trying to join awareness on environmental issues and socio-economic aspects (Maes et al., 2012). Among them and in the framework of the PEGASUS project (http://www.europarl.europa.eu/meetdocs/2009_2014/documents/envi/dv/envi20131128_gm-animals_/envi20131128_gm-animals_en.pdf) there is an example that assesses the ecosystem service costal protection at EU scale (Liquete et al., 2013). The conceptual approach of this research integrates the exploitation of different databases that incorporate many characteristics summarized in this literature review.

- ➢ Characteristics for SBD#02:
  - o Seabed :
    - ▪ Coastal type
    - ▪ Bathymetry
    - ▪ Sediment grain size – depositional environment
  - o Marine water
    - ▪ Wave height and direction
    - ▪ Sea level
  - o Human activities
    - ▪ Defence works

SBD03 – Mediterranean Beach Erosion Study Cases

Coastal erosion problems have been growing during past decades because human pressure on coastal settings and wave regime changes, in addition to sea level changes. Recently satellite images, vertical aerial photography and other techniques have been used and improved with the use of the Geographic Information Systems (GIS) and computer-assisted multivariate analysis. There are many local examples along the Mediterranean coastline on beach evolution (Alexandris et al., 2013; Cipriani, 2013; Cipriani et al., 2013; Jiménez et al., 2011; Martínez del Pozo and Anfuso, 2008). Most of these studies deal with aerial photographs integrated into a GIS tool and have been used to unravel the coastline evolution over periods from years to decades. It should be noted that most of these projects does not organize or integrate the collected study case information in regional thematic datasets.

- ➢ Characteristics for SBD#03:
  - o Seabed :

- Shoreline erosion trend

SBD04– Tsunami travel time maps, NEARTOWARN project

The NEARTOWARN project is a project financially supported by the DG Humanitarian Aid and Civil Protection of the European Commission. The main goal is to promote technology to close the gap between the regional tsunami watch services in the Mediterranean and the NE Atlantic Tsunami Warning System. This platform represents from a tsunami source locus the travel time using regular bathymetry grids constructed using the GEBCO database (http://www.neartowarn.ihcantabria.com/).

  ➢ Characteristics for SBD04:
  o Seabed
    - Bathymetry

SBD05: Relevant bathymetry for biological assemblages of conservation interest in the submarine canyons and current modelling

Past and recent high-resolution bathymetric surveys from the upper slope down the abyssal plain have revealed morphological features such as canyons, mud-volcanoes and cold-seeps where high biological activity is present. The size of these features vary from tens of km for canyons to a few meters for seeps. The high biological activity observed seems to contradict a food-poor, metabolically inactive deep seabed and its effects cannot be anymore defined as a minor component of the global carbon cycle (Foucher et al., 2009, IUCN, 2004, Danovaro et al., 2014, Canals et al., 2013, Fabri et al., 2013, Dauvin, 2010, EMODNET-Bathymetry Report, 2014).

High resolution bathymetry together with imagery (acoustic and optical) and lithological information are key components for the identification of these habitats, for the establishment of consistent network of MPAs, for the hydrodynamic modeling of their currents and for impact studies of industrial waste and for geohazards assessment. Initiatives to survey these features exist such the one from the French agency for MPAs (MEDSEACAN, CORSICAN surveys) or the MaGIC project (Marine Geohazards along the Italian Coast) based on the acquisition of high-resolution bathymetry. However large areas of the Mediterranean sea especially from the base of the slope to the head of the canyons are still uncovered by data with the appropriate resolution ie 1/32 (60m) to 1/16 (120m) of minute of arc .

  ➢ Characteristics used in SBD05 :
  o Seabed
    - Bathymetry, elevation and undersea features
    - Seafloor reflectivity (multibeam echosounders, side-scan sonar)
    - Seismic imagery
    - Lithological samples
    - Photos and video (for ground truth)

6 Data appropriateness and availability

In this section we will discuss the appropriateness and availability of the input characteristics required by the Use Cases described in the previous section. We remind the reader that our Use Cases have been chosen as an example of usage of input data sets similar to the ones that will be used by the Challenges to produce outputs (Table 1).

6.1 Data appropriateness

Using the appropriateness criteria definition of Secion 2.1, we discuss here how appropriateness is defined for each Use Case characteristics . This is outlined in Table 13,14, 15, 16 for the four different environmental matrices.

Use Case	Relevant Characteristics	Criteria used for appropriateness
AM1	Winds amplitude and direction	Availability of wind measurements to the area of interest up to 50 meters above sea level.
	EU RAMSAR areas	Info. not available
	EU Habitat areas	Info. not available
	EU Bird protection areas	Info. not available
	National conservation areas	Info. not available
	Sea cables	Info. not available
	Pipelines	Info. not available
	Bathymetry, elevation and undersea features	Info not available but spatial resolution seems to be important
	Military ranges	Info not available
	Radio and radar corridors	Info not available
	Transport activity	Data from AIS, long temporal extesion of record is required to get statistics of ship traffic
	Visibility zones	Info not available
AM2	Winds amplitude and direction	Time extension period (at least 10 years), spatial resolution (less or equal to 1 km),htemporal resolution (hourly), calibration, validation or assimilation of in situ data
	Wave direction, height, period and spectral wave parameters	Time extension period (at least 10 years), spatial resolution (less or equal to 1 km), temporal resolution (hourly), calibration, validation or assimilation of in situ data
AM3	Wind speed and direction	High spatial (less than 5 km) and temporal resolution (hourly) from numerical weather prediction models
	Air temperature	High spatial (less than 5 km) and temporal resolution (hourly) from numerical weather prediction models
	Currents	High spatial (less than 5 km) and temporal resolution (hourly) from numerical ocean predicition models
	Sediment grain size parameters	Information at sufficient spatial resolution (less than 1 km) to set appropriate model parameters for Oil Holding Capacity
	Coastal types	Information at sufficient spatial resolution (less than 1 km) to set appropriate model parameters for Oil Holding Capacity
	Prevention and emergency protocol of REMPEC (Barcelona Convention)	Not applicable
AM4	Wind amplitude and direction	Numerical Weather Prediction winds, analyses and forecasts, at increasing resolution available in operational mode

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	Atmospheric pressure	Numerical Weather Prediction surface atmospheric pressure, analyses and forecasts, at increasing resolution available in operational mode
	Sea level	Coastal tide gauges and numerical model resolution (less than 1 km) toward the coasts
	Wave height and direction	Coastal wave buoys and numerical model resolution (less than 1 km) toward the coasts
	Terrestrial digital terrain model, including bathymetry	High resolution near the coasts
AM5	Wind amplitude and direction	Resolution of winds near the coasts and long time series (10 years minimum) and continuous update
AM6	Wind direction and speed	High spatial (less than 5 km) and temporal resolution (hourly) for numerical weather prediction models
	Air temperature	High spatial (less than 5 km) and temporal resolution (hourly) for numerical weather prediction models
	Air pressure	High spatial (less than 5 km) and temporal resolution (hourly) for numerical weather prediction models
	Currents	High spatial (less than 5 km) and temporal resolution (hourly) for numerical ocean prediction models
	Habitat extent	Local detailed information available, spatial resolution less than 1km
	Bathymetry	Info not available
	Coastal Geomorphology	Local detailed information available, spatial resolution less than 1km

Table 13 Appropriateness for Air Matrix Use Cases

Use case	Relevant characteristics	Criteria used for appropriateness
MW01	Sea level	Time period extension for both satellite altimetry and tide gauges.
	Sea surface temperature	Time period extension
	Temperature of the water column	Time period extension and spatial coverage
MW02	Water discharge	Accessibility, accuracy of measurement and time series extension.
MW03	Temperature	Time series extension and spatial coverage, availability of vertical profiles
	Salinity	Time series extension and spatial coverage, availability of vertical profiles
	Sea level	Time series extension and spatial coverage
	Currents	Time series extension and spatial coverage, availability of vertical profiles

Table 14 Appropriateness for Marine and Fresh Water Matrix Use Cases

Use case	Relevant characteristic	Criteria used for appropriateness
BB01	Fish and shellfish catch statistics	Time series extension and spatial coverage
	Fishing effort	Time series extension and spatial coverage
BB02	Fish and shellfish catch statistics	Time series extension and spatial coverage
BB03	Horizontal spatial coordinates (fishing vessels)	Accessibility, time series extension and spatial coverage
BB04	Fishing by-catch	Time series extension and spatial coverage

Table 15 Appropriateness for Biology/Biota Matrix Use Cases

Use case	Relevant characteristic	Criteria used for appropriateness
SBD01	Coastal geomorphology (coast type)	Fully spatial coverage of the area of interest, spatial resolution (1:100.000)
	Shoreline erosion trend	Time extension period (more than 30-40 years)
	Defence works	Fully spatial coverage of the area of interest, spatial resolution (1:100.000)
SBD02	Coastal geomorphology (coast type)	Large spatial coverage of the area of interest, spatial resolution (1:100.000)
	Bathymetry	Global bathymetric data with a resolution of 30-arc seconds
	Sediment grain size – depositional environment	Info not available but spatial resolution and spatial coverage seems to be of interest
	Wave height and direction	Spatial coverage and resolution and continuous updating
	Sea Level	Time extension period (30-40 years at least) and spatial resolution of 0.3 lat,long deg.
	Defence works	Information not available
SBD03	Shoreline erosion trend	Availability of maps and aerial photographs
SBD04	Bathymetry	Global bathymetric data with a resolution of 30-arc seconds
SBD05	Bathymetry, elevation and undersea features	DTM at 1/32' of arc for the border of the continental shelf and the upper slope and canyons, 1/16 ' for deeper areas (taking into account existing technologies), full coverage (with priority linked to sensitive areas). Consistent reference systems and origin with coastal grids.
	Acoustic imagery of the seafloor	Mosaics in sale reference systems to be draped on DTM using 3D viewing
	Seismic profiles	Access via viewing service for quality assessment and possible draping in 3D viewing systems
	Lithology	Ground truth
	Photo and videos	Ground truth

Table 16 Appropriateness for Seabed Matrix Use Cases

In general we can conclude that the categories:

1) 'Time extent and resolution'

2) 'Spatial resolution and extent'

are the main criteria to discuss appropriateness in the Literature from the characteristics involved in the Use cases.

6.2 Data availability

For the different Use Cases it is now discussed the data availability that consist of the sum of "visibility", "accessibility" and "performance" as defined in the assessment criteria listed in Annex 1 and Section 2.1. Tables 17,18,19,20 illustrate the avaialbility for the different Matrices and Characteristics.

Use Case	Relevant Characteristics	Visibility (1), Accessibility (2), Perfomance (3)
AM1	Winds amplitude and direction	(1) high visibility; (2) manual ordering, restricted, at cost, format not known, no OGC standard; (3) not known
	EU RAMSAR areas	(1) high visibility; (2) advanced web service, unrestricted, no charge, text format, not interoperable; (3) very fast response, totally reliable
	EU Habitat areas	(1) high; (2) discovery service, unrestricted, no charge, format interoperable but not easy to access information; (3) good responsiveness and reliability

	EU Bird protection areas	(1) high visibility; (2) discovery service, unrestricted, no charge, format interoperable but not easy to access information; (3) good responsiveness and reliability
	National conservation areas	Info not available
	Sea cables	Info not available
	Pipelines	Info not available
	Bathymetry, elevation and undersea features	Info not available
	Military ranges	Info not available
	Radio and radar corridors	Info not available
	Transport activity	Info not available
	Visibility zones	Info not available
AM2	Winds amplitude and direction	(1) data difficult to find; (2) discovery service available but not clear data policy; (3) responsiveness for discovery excellent
	Wave direction, height, period and spectral wave parameters	(1) data difficult to find; (2) discovery service available but not clear data policy; (3) responsiveness for discovery excellent
AM3	Wind speed and direction	(1) data difficult to have in operational mode; (2) manual ordering, restricted, both no charge and at cost, depending on the intended use, international forma standards, not interoperable (3) timeliness scarce for first downloading, reliability excellent
	Air temperature	The same as for winds
	Currents	(1) high visibility; (2) services consider discovery and downloading, no charge, international formats, no interoperability of on-line services; (3) responsiveness medium quality, reliability excellent
	Sediment grain size parameters	(1) sufficient visibility; (2) no service available
	Coastal types	(1) sufficient visibility; (2) no service available
	Prevention and emergency protocol of REMPEC (Barcelona Convention)	Not applicable
AM4	Wind amplitude and direction	(1) data difficult to have in operational mode; (2) manual ordering, restricted, both no charge and at cost, depending on the intended use, international forma standards, not interoperable (3) fitness for purpose decided by the producer
	Atmospheric pressure	Same as for winds
	Sea level	(1) tide gauge data visible at the national web servers; (2) manual ordering, partially restricted, not interoperable; (3) responsiveness medium quality, reliability excellent
	Wave height and direction	(1) wave buoy data visible at the national we servers; (2) manual ordering, partially restricted, not interoperable; (3) responsiveness medium quality, reliability excellent
	Terrestrial digital terrain model, including bathymetry	Information not available
AM5	Wind amplitude and direction	(1) high visibility; (2) web service for discovery and downloading; (3) medium responsiveness
AM6	Wind direction and speed	1) high visibility; (2) downloading netCDF format; (3) good responsiveness
	Air temperature	1) high visibility; (2) downloading netCDF format; (3) good responsiveness
	Air pressure	1) high visibility; (2) downloading netCDF format; (3) good responsiveness

	Currents	1) high visibility; (2) downloading netCDF format; (3) good responsiveness
	Habitat extent	1) high visibility; (2) downloading shp format; (3) good responsiveness
	Bathymetry	Info not available
	Coastal Geomorphology	1) high visibility; (2) downloading shp format; (3) good responsiveness

Table 17 Availability for Air Matrix Use Cases

Use case	Relevant characteristic	Visibility (1), Accessibility (2), Performance (3)
MW01	Sea level	Data from PSMSL: (1) high visibility; (2) discovery and downloading service, unrestricted, no charge, ascii format; (3) good responsiveness and reliability
		Data from CLS: (1) no catalogue at the link provided in the EEA assessment report; (2) unknown; (3) unknown
	Sea Surface Temperature	1) high visibility; (2) accessible but restricted depending on the intended use; (3) good responsiveness
	Temperature of the water column	1) high visibility; (2) accessible but restricted depending on the intended use; (3) good responsiveness
MW02	Water discharge	(1) Medium; (2) access to river discharge data is possible agreeing to User Declaration; (3) on line service offers immediate access to data
MW03	Temperature	(1) high visibility; (2) accessible; (3) good responsiveness
	Salinity	(1) high visibility; (2) accessible; (3) good responsiveness
	Sea level	(1) high visibility; (2) accessible; (3) good responsiveness
	Currents	(1) high visibility; (2) accessible; (3) good responsiveness

Table 18 Availability for Marine and Fresh Water Matrix Use Cases

Use case	Relevant characteristic	Visibility (1), Accessibility (2), Performance (3)
BB01	Fish and shellfish catch statistics	(1) Medium; (2) service consider discovery and download of summary data (presently up to 2012), access to raw data is possible only following an official request, no charge applied; (3) on line service offers immediate access to summary data (presently only up to 2012)
	Fishing effort	
BB02	Fish and shellfish catch statistics	(1) medium visibility through FISHSTAT application of FAO; (2) no on-line discovery and download service, software and statistical data and collections should be downloaded from the FAO website to the user's computer, access to raw data is possible only following an official request, no charge applied; (3) immediate access to statistical data through FISHSTAT
BB03	Horizontal spatial coordinates	VMS: (1) no visibility; (2) no discovery and download service, data available only following an official request to national fishery control authority (Coast guard in Italy), no charge applied; (3) data provided after weeks or months from the official request. AIS: (1) low visibility (only RT data of the last 24 hours are accessible on-line); (2) historical series available after request and at cost. GPS: (1) no visibility; (2) data available after request from CNR ISMAR Ancona at no charge.
BB04	Fishing by-catch	(1) no visibility; (2) no discovery and download service, data available only following an official request, no charge applied; (3) data provided after few weeks from the official request.

Table 19 Availability for Biology/Biota Matrix Use Cases

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Use case	Relevant characteristic	Visibility (1), Accessibility (2), Performance (3)
SBD01	Coastal geomorphology (coast type)	(1) high visibility; (2) downloading shp format; (3) good responsiveness
	Shoreline erosion trend	(1) not visible; (2) no service available; (3) not applicable
	Defence works	(1) high visibility; (2) downloading shp format; (3) good responsiveness
SBD02	Coastal geomorphology (coast type)	(1) high visibility; (2) downloading shp format; (3) good responsiveness
	Bathymetry	(1) high visibility (2) unrestricted and OGC standards; (3) good responsiveness
	Sediment grain size – depositional environment	(1) high visibility (2) discover and wms map service; (3) acceptable responsiveness
	Wave height and direction	(1) high visibility; (2) accessible but restricted depending on the intended use; (3) good responsiveness
	Sea Level	(1) high visibility; (2) accessible but restricted depending on the intended use; (3) good responsiveness
	Defence works	(1) not visible; (2) no service available; (3) not applicable
SBD03	Shoreline erosion trend	Information not available
SBD04	Bathymetry	(1) high visibility (2) unrestricted and OGC standards; (3) good responsiveness
SBD05	Bathymetry, elevation and undersea features	(1) recent datasets difficult to find but good effort from EMODnet hydrography for cataloguing them using Seadatanet/Geo-Seas infrastructure; (2) manual ordering, restricted, no homogeneous level of processing, not clear data policy from some providers ; (3) not known
	Seismic data	(1) a lot of data difficult to find in spite of the progress made by Geo-Seas (2) discovery service and advanced viewing service at Geo-Seas to be extended to new producer (3) responsiveness depend on the provider policy but also on technical challenges (big data)
	Lithology	(1) a lot of data difficult to find samples and analyses in spite of the progress made by Geo-Seas to index them (2) various lithological standards and formats, (3) responsiveness depend on the provider policy
	Photos and videos	(1)low visibility ;(2) restricted, at cost , no clear policy from some providers

Table 20 Availability for Seabed Matrix Use Cases

In the case of availability we can see a difference between the different matrices:

1) for marine water availability is high, normally data are free of charge and available;

2) for seabed data availability is high for low resolution data while high resolution is difficult and data are proprietary;

3) for fresh waters and biota/biology the situation is mixed and data availability is medium to low and data have restricted access.

4) for the air matrix characteristics the availability is highly mixed, going from fully open and accessible to closed and difficult. This is related to the difference among real time data and long term reconstructed time series.

7   Discussion and conclusions

This document illustrates the Literature Survey carried out by the EMODnet MedSea Checkpoint during the first nine months of the project. The Task was to try to answer the following questions: is there an overview of the data availability and how complete is the data? Is there any statement for 'fitness for purpose' that can be made?

A MedSea Checkpoint methodology has been defined in order to arrive at a Data Adequacy Report in the future 9 months. It consists of 4 steps (Section 1.2): 1) establish a framework for information collection that is documenting the input data needed for the 7 Challenges; 2) access, catalog and elaborate input data to be used for the Challenge products; 3) document the availability and appropriateness of the input data sets during the production of the Challenge outputs; 4) analyse the fitness for purpose of the input data for the products. In our Literature Survey we cannot carry out step 3 and 4 but we partially completed steps 1 and 2 and analyzed the information collected.

First of all we defined the nomenclature to be used for the input datasets, the 'Assessment Criteria' and the 'Fitness for Purpose' concepts. We selected to characterize data on the basis of 'Characteristics' that are defined as follows:

" *a Characteristics is a distinguishing feature which refers :*
 - *either to a variable derived from the observation, the measurement or the numerical model output of a phenomenon or of an object property in the environment;*
 - *or to the geographical representation of an object on a map (ie a layer such as a protected area, a coastline or wrecks) by a set of vectors (polygon, curve, point) or a raster (a spatial data model that defines space as an array of equally sized cells such as a grid or an image)*."

The Assessment criteria include '*appropriateness*' and '*availability*' of datasets which in turn contain: for 'appropriateness', the spatial extent and resolution, time extent and resolution, purpose, lineage, usage, completeness, consistency, accuracy; for 'availability' the visibility, accessibility and performance. Fitness for purpose can then be thought to be the sum of 'appropriateness' and 'availability' defined either by the producer or the user or both.
This Assessment approach is consistent with those elements considered in the Commission Staff Working Document accompanying the Commission Report on the First Phase of Implementation of the Marine Strategy Framework Directive (COM(2014) 97) that are: completeness, adequacy, consistency and coherence.

The appropriateness includes 'completeness' and 'consistency', but also other important information on spatial and temporal coverage. The term 'adequacy' is coherent with the definition given here to 'fitness for purpose' that has the advantage that it refers to criteria specified by the producer and the user at the same time or distinctly. Coherency (i.e. capability to assess the relationships between the reports of the Member States, firstly within one marine region or sub-region and secondly across the EU, i.e. between the marine regions) is not included yet but it could be in the future. Thus our first conclusion is that the MedSea CheckPoint Assessment methodology is coherent with Commission documents on the assessments of MSFD.

By means of metadata survey templates, described in section 2.2, information was collected from Project partners and used to build the database for the Literature Survey. For the purpose of characterizing the input characteristics, the SeaDataNet classification list (P01 to P03) designed for marine data was adopted. This allowed to statistically investigate the input data sets and

classify them on the basis of five environmental monitoring matrices: air, marine and fresh waters, biology/biota, seabed and human activities.

The results show that 73 characteristics categories are requested by the 7 Challenges (Table 3). It was found that Challenges require about 72 different *characteristic* categories and in partiular: four in the Air matrix, 16 in the Biology/Biota matrix, 7 in the Fresh water and 22 in the Marine water matrix, 8 in the Seabed matrix and 16 in the Human Activities matrix.
Differentiating among Challenges, Challenge 1 (Wind farming) and 2 (Marine Protected Areas) request about 30 Characteristics each across all environmental matrices while Challenge 4 (Climate and coastal protection) requests less than 5, mainly because of the limited scope of the Challenge.
There are characteristic categories recurrently needed by the Challenges such as:
1) for Seabed Matrix: bathymetry, lithology,coastal geomorphology;
2) for Marine/Fresh water Matrix: temperature, salinity, sea level and currents;
3) for Biology/Biota Matrix: Fish abundance;
4) for Human Activities Matrix: man-made structures, adminisrative units (MPAs..), transport activities, trawling activities and impact.

For the 73 characteristics requested by the Challenges more than 500 upstream data source names are listed in the Literature Survey database (Annex 3). The number of data providers is about 112, i.e. about 10 data providers on average for each Challenge. This number of data sources and data providers is probably not exhaustive because some data sources correspond to portals that themselves give access to datasets which have not always been detailed at this stage of the project and because the information can sometimes be difficult to find or identified precisely. There is at this point no possibility to have an overview of data appropriateness and availability for such a large input data source list and we will have to leave this analysis when the Challenges will actually use the information from the different data sources to produce the outputs.

To advance in the understanding of the monitoring capacity at the Mediterranean Sea level, even if not for all the upstream data sources indicated by the Challenges, we have overviewed twentythree European, International and Member State programs that partially sample the input data sources required by the Challenges. It is evident that the Mediterranean is well inserted in many European and International programs and networks and its contribution to the build up of common data bases is noticeable. The Member States monitoring systems are part of the many networks, they contribute to Copernicus and EMODnet Portals, data are visible both to the Member State and European/International users. To be noticed is also the high degree of development of monitoring and forecasting system, downscaling the open ocean information to the coasts.

In order to progress toward an assessment of the 'fitness for purpose' and without having yet Challenge products to work with, we selected 18 Use Cases that utilize the major characteristics of the Challenges. We tried to document how the Use cases defined 'appropriateness' and 'availability' of input data sources. In general it was found that, for characteristics similar to the one listed by the Challenges, the 'appropriateness' is most of the times related to:

1) 'Time extent and resolution'

2) 'Spatial resolution and extent'

of the characteristics.

For 'availability' instead we found that there is a large difference between environmental matrices. In particular:

1) for marine water availability is high, normally data are free of charge and available;

2) for seabed data availability is high for low resolution data while high resolution is difficult and data are proprietary;

3) for fresh waters and biota/biology the situation is mixed and data availability is medium to low and data have restricted access.

4) for the air matrix characteristics the availability is highly mixed, going from fully open and accessible to closed and difficult. This is related to the difference among real time data and long term reconstructed time series.

If fitness for purpose can be defined simply as the sum of appropriateness and availability for our Use Cases, it seems that the fitness for purpose is:
1) Medium to low for Air Matrix Characteristics since space-time resolution is medium to low and availability could be low.
2) High for Marine and Fresh Waters because data space-time resolution is adequate and availability if high, with discovery and downloading with 'a click'.
3) Medium to low for Biology/Biota Matrix characteristics since space-time resolution is still inadequate and visibility if medium to low.
4) Low to high for Seabed Matrix characteristics because resolution is insufficient and coverage poor and access restricted and not visible.

In conclusion we have demonstrated that we have an overview of the data types and sources that should be at the basis of the Challenge products in the Mediterranean Sea. For some of the most important characteristics, it was found that biology/biota, air and seabed matrix data sources could still have low visibility and accessibility while the marine and fresh water matrix characteristics are visible and performant. This methodology will be used to establish the Data Adequacy Report that will start to assess the fitness for purpose of the same input data sets for the Challenge products.

At this final stage, it is worth to emphasize that assessments and Literature Surveys should be done periodically because conclusions rapidly become obsolete due to the fast development of the technologies and the increasing development of ocean economy.

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