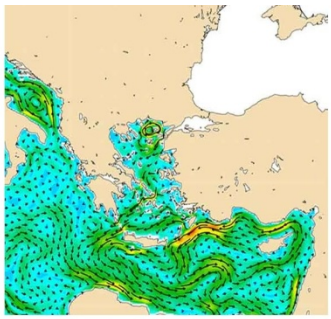
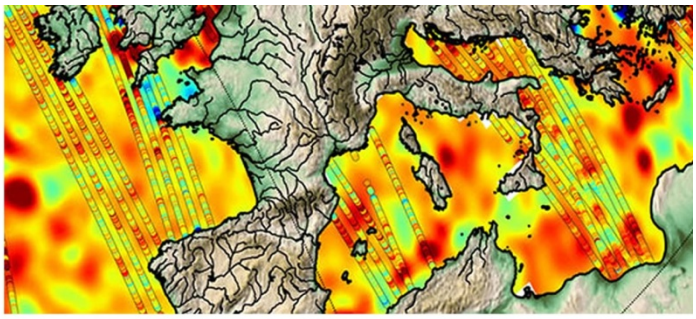

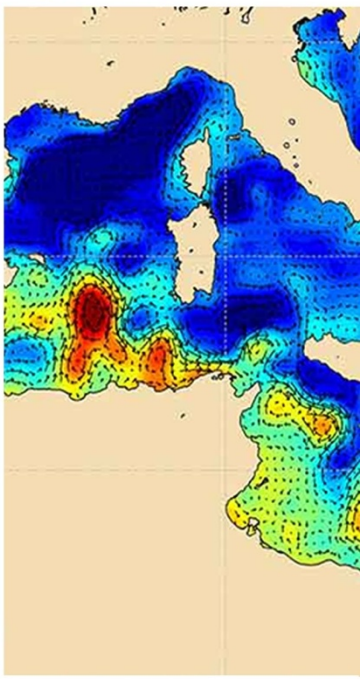

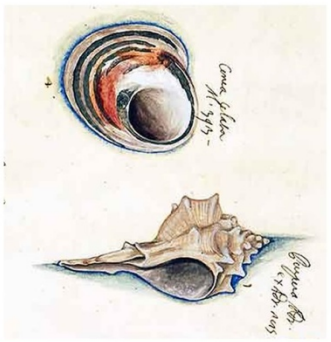

EMODnet MedSea Checkpoint
Data Adequacy Report

EMODnet
European Marine Observation and Data Network

MedSea Checkpoint

http://www.emodnet-mediterranean.eu/

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

EMODnet MedSea CheckPoint

Second Data Adequacy Report

Total number of pages: 71

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MARITIME POLICY ATLANTIC, OUTERMOST REGIONS AND ARCTIC**

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Glossary

AIS: Automatic Identification System
BODC: British Oceanographic Data Centre
CFP: Common Fisheries Policy
CH: Challenge
Chl: Chlorophyll
CLS: Collecte Localisation Satellites (FR)
CLU: CLU s.r.l. (IT)
CMCC: Euro-Mediterranean Centre for Climate Change (IT)
CMEMS: Copernicus Marine Environment Monitoring Service
CNR: National Research Council (IT)
CNR-ISAC: CNR Institute of Atmospheric Sciences and Climate
CNR-ISMAR: CNR Institute of Marine Sciences (IT)
CoConet: Towards COast to COast NETworks of marine protected areas
Copernicus: European Programme for the establishment of a European capacity for Earth Observation
CSW: Catalogue Service for Web
CYCOFOS: Cyprus Coastal Ocean Forecasting and Observing System
CZCS: Coastal Zone Colour Scanner
DAC: Data Assembly Center
DAR: Data Adequacy Report
DCR: Data Collection Regulation
DCF: Data Collection Framework
DG-MARE: Directorate-General for Maritime Affairs and Fisheries
DIN: Dissolved Inorganic Nitrogen
DO: Dissolved Oxygen
DPS: Data Product Specification
EC: European Commission
ECMWF: European Centre for Medium-Range Weather Forecast
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
EIONet: European Environment Information and Observation Network
EMODnet: European Marine Observation and Data Network
EMSA: European Maritime Safety Agency
ESA: European Space Agency
ESIF: Energy Saving In Fisheries
ETA: Estimated Time of Arrival
ETP: Endangered Threatened Protected species
EU: European Union
EUMETNET: European National Meteorological Services
EU MS : EU Member State
EUNIS: European Nature Information System
EUROGOOS: European Global Ocean Observing System
FAO: Food and Agriculture Organization
FEM: Association de Préfiguration de l'IEED France Energies Marines (FR)
FP7: Seventh Framework Programme

GEBCO: General Bathymetric Chart of the Oceans
GES: Good Environmental Status
GEO: Group on Earth Observation
Geoportal: type of web portal used to find and access geographical information
GEOSS: Global Earth Observation System of Systems
GFCM: General Fisheries Commission of the Mediterranean and Black Sea
GIS: Geographic information system
GMES: Global Monitoring for Environment and Security
GOOS: Global Ocean Observing System
GPS: Global Positioning System
GSA: FAO-GFCM Geographical Subarea
GT: Gross Tonnage
HCMR: Hellenic Centre for Marine Research (GR)
HO: Hydrostatic Office
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
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: Integrated Regional monitoring Implementation Strategy in the South European Seas
ISCOMAR: Isleña Marítima de Contenedores
ISO: International Organization for Standardization
ISO/IEC: ISO and International Electrotechnical Commission
ISO/IEC JTC: ISO/IEC Joint Technical Committee
ISO NP: ISO New Proposal
ISO NP TS: ISO NP Technical Specification
ISPRA: Italian National Protection Agency
JCOMM: Joint WMO-IOC Commission on Marine Meteorology
JRC: Joint Research Centre
LOA: Length OverAll
MAP: Mediterranean Action Plan
MERIS: MEdium Resolution Imaging Spectrometer
MODIS: Moderate Resolution Imaging Spectroradiometer
MPA - Marine Protected Areas
MS: Member States
MSFD: Marine Strategy Framework Directive
MSP: Maritime Spatial Planning
MSSD: Mediterranean Strategy for Sustainable Development
NRT: Near Real Time
NKUA: National and Kapodistrian University of Athens
NMEA: National Marine Electronics Association
OCEANS-CAT: OCEANS Catalonia International SL (ES)
OPL: Oil Platform Leak

OOCS: Operational Observatory of the Catalan Sea
OSSE: Observing System Simulation Experiments
OSE: Observing System Experiment
OTB: Bottom Otter Trawl
P01: BODC Parameter Usage Vocabulary
P02: SeaDataNet Parameter Discovery Vocabulary
P03: SeaDataNet Agreed Parameter Groups
SeaWiFS: Sea-viewing Wide Field-of-view Sensor
SFTP - SSH File Transfer Protocol
SHOM: Service hydrographique et océanographique de la marine
SMOS: Soil Moisture and Ocean Salinity
SOCIB: Balearic Islands Coastal Observing and Forecasting System (ES)
SOG: Speed Over Ground
SPAMI: Specially Protected Areas of Mediterranean Importance.
SSH: Secure Shell
SST: Sea Surface Temperature
TBB: Beam Trawl
TP: Total Phosphorous
TPD: Targeted Product Description
TRIX: Trophic Index
UCY: University of Cyprus (CY)
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
VHF: Very High Frequency
VLIZ: Flanders Marine Institute
VMS: Vessel Monitoring System
WISE: Water Information System for Europe
WFD: Water Framework Directive
WGS84: World Geodetic System 1984
WMO: World Meteorological Organisation
WMOP: SOCIB Western Mediterranean Sea Operational forecasting system
VMS: Vessel Monitoring System
WWF: World Wildlife Fund

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Executive Summary

This second Mediterranean Data Adequacy Report (DAR) is completing the development of concepts and methodologies initiated in the Literature Review and in the first Data Adequacy Report. The aim of this DAR is to document the reliability and utility of the existing monitoring system at the sea basin level and it identifies the gaps, prioritizing them.

This DAR describes the final methodological approach for the MedSea Checkpoint based upon ISO[1] and INSPIRE principles and the development of indicators. The indicators are constructed directly from the Checkpoint metadatabase, which contains information on the upstream data used to construct the Challenge products. For each Challenge product, Checkpoint information on "What, Why, Where, When, How" data have been used to develop targeted products is given and statistically analysed.

The metadatabase contains 266 data set descriptors related to 45 characteristics, i.e. monitoring environmental and human activity information. These descriptors identify potentially usable information for the construction of the Challenge products. Only 90 of the 266 data set descriptors will then be used for the fulfilment of the Challenge products.

For communication and cataloguing purposes, we used the SeaDataNet Common Vocabulary that identifies monitoring characteristics by a code, giving a definition for each code at different levels of aggregation.

The assessment methodology is providing quantitative and qualitative information on **How** the input data sets are made available to Challenges (Availability Indicators) and **What** is the quality of the monitoring data for the Challenge products (Appropriateness Indicators). The assessment methodology has been based on five elements:

1. the potential input data sets metadatabase and the availability indicators,
2. the Data Product Specification (DPS) and related quality elements,

[1] Technical Committee ISO/TC 176 "Quality management and quality assurance" for ISO 9004 (Managing for the sustained success of an organization - A quality management approach)

Tecnical Committee ISO/TC 211, Geographic information/Geomatics for ISO19157 Geographic Information - Data Quality , ISO 19115 Geographic Information - Metadata, ISO 19131 Geographic Information - Data Product specifications...)

3. the Targeted Data Products (TDP - requested by the call) information and the related quality elements;
4. the Ustream Data (UD) used for the products and the related quality elements,
5. the calculation of appropriateness indicators from the DPS, UD and TDP quality elements.

Indicator values have been grouped in three colour codes in order to increase the readability of the results. Results are presented separately for the availability and appropriateness indicators and then they are combined to extract the monitoring gaps. Nineteen monitoring characteristics are found not adequate for the availability indicators (see Table 5.2.1 and Table 5.2.2). Fifteen are instead found not adequate for appropriateness indicators (see Table 6.2 and 6.3).

Combining the availability and appropriateness indicator analysis, the emerging gaps for the monitoring system at the basin scales, in view of the 7 prescribed Challenges, are:

1) **sediment mass balance monitoring data, the targeted product could not be realized, data are only available in the literature and after the last EUROSION project, terminated in 2004, no INSPIRE catalogue and database was constructed from the data collected.**

2) **the fishery management data, such as fish catch and by-catch, are totally inadequate to cover the required targeted products needs from all the indicators point of view. The key inadequate quality attributes for this monitoring are: visibility, EU INSPIRE catalogue, data policy visibility, readiness, data delivery and data policy, horizontal and temporal coverage, temporal validity. Another major point is the scarcity of the data collected in 2 years search.**

3) **the habitat extent input data sets, such as Posidonia oceanica, Coralligenous and Maerl habitats and seabed sensible habitats, are totally inadequate in terms of Data Policy and Responsiveness, Vertical and horizontal coverage, temporal and horizontal resolution.**

4) **the wave height, period, direction and spectral parameters input data sets are totally inadequate because of negative scores for visibility, INSPIRE Catalogue, Data Policy, Pricing, responsiveness, temporal coverage, horizontal and temporal resolution.**

5) **The Maritime traffic (Platform movement) input data sets are totally inadequate because of negative scores for visibility, INSPIRE Catalogue, responsiveness, horizontal and temporal coverage, temporal validity**

Recommendations and actions are suggested to remove these gaps in the short to medium term time range.

1. Introduction

The DGMARE tender "Gaps and priorities in Sea Basin Observation and Data" asked for:

"*determining gaps in data and observation systems and priorities for an observation system that supports the delivery of sustainable growth and innovation. The objective is to support the deployment of a marine observation infrastructure that offers the most effective support to the blue economy. The cost effectiveness, reliability and utility of the existing monitoring infrastructure will be assessed by developing products based on these data and determining whether the products are meeting the needs of industry and public authorities.*"

General aim of the assessment

The concept of a Data Adequacy Report (DAR) was then formulated i.e.:

The DAR concept

"*the DAR is an annual report providing an annual view of the monitoring effort in the sea basin."*

All the European sea basins, including the Arctic, Atlantic, Baltic, Black Sea, Mediterranean and North Sea, are now developing the framework for the DAR and this report is concerned with the Mediterranean Sea assessment.

In the past three years a Literature Survey[2] and a first DAR[3] have been released. The second DAR is completing the assessment allowing the final gap analysis and suggesting the improvements.

The Med Sea previous reports

1.1 The Challenge Targeted products

The monitoring system assessment done in the DAR is quite an innovative concept because it is done by analysing the "fitness for use" or "adequacy" of input data sets in order to create specific products for seven Challenges, that are: 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.

DGMARE defined the following specific challenge products:

Tender Challenge products

- CH1-Windfarm siting
    - Suitability of sites for wind farm development
- CH2-Marine Protected Areas
    - Representativeness and coherency of existing European network of

[2] https://webgate.ec.europa.eu/maritimeforum/node/3646
[3] http://www.emodnet-mediterranean.eu/wp-content/uploads/2015/06/D11.2-revised-V11.pdf

marine protected areas (national and international sites) as described in article 13 in the Marine Strategy Framework Directive.

- CH3-Oil Platform leak
  - Likely trajectory of a leak from an oil platform and the statistical likelihood that sensitive coastal habitats or species or tourist beaches will be affected within 24 hours and after 72 hours.
- CH4-Climate and Coastal Protection
  - Spatial data layers for the following parameters for the past 10 years, the past 50 years and the past 100 years
    - average annual change in temperature at surface, midwater and sea-bottom
    - average annual sea-level rise at the coast (absolute and relative to the land)
    - sediment mass balance at the coast
  - Time plots for the following parameters for the whole sea basin
    - average annual sea temperature over sea-basin at surface, mid-water column and bottom.
    - average annual changes in internal energy of sea
- CH5-Fisheries Management
  - tables for the whole sea-basin of mass and number of landings of fish by species and year
  - mass and number of discards and bycatch (of fish, mammals, reptiles and seabirds) by species and year
  - data layers (gridded) showing the extent of fisheries impact on the sea floor
  - area where bottom habitat has been disturbed by bottom trawling (number of disturbances per month)
  - change in level of disturbance over past ten years
- CH6-Marine Environment
  - data layers (gridded) showing
    - Seasonal averages of eutrophication in the basin for past ten years
    - Change in eutrophication over past ten years (i.e. where eutrophication has reduced and where it has increased)
- CH7-River inputs
  - for each river bordering the sea basin, the country where it enter the sea and a time series of annual inputs from rivers of
    - water
    - sediment
    - total nitrogen
    - phosphates
    - eels
  - monthly averages, maxima and minima for these parameters over the past ten years

Tender Challenge products

Tender Challenge products

These specifications have been transformed by each Challenge into “Targeted Products” with well-defined input datasets. A metadata archive has been developed where quality elements have been defined and assigned to both the targeted products and the input datasets. The assessment is done on the basis of indicators extracted from the metadatabase or calculated from the metadatabase information. This assessment framework is described in the next section.

1.2 The assessment framework

The Mediterranean Sea Checkpoint developed a completely new framework to carry out the data adequacy assessment. This framework is based upon three methodological pillars:

The CheckPoint framework

1) use of the ISO principles for the methodological development and the metadata definition;
2) design of a metadatabase containing the information about the input data sets, the Targeted products and the quality indicators;
3) definition of indicators for the objective assessment of the data adequacy following INSPIRE rules.

ISO, INSPIRE and indicators

For communication standards we used the SeaDataNet Common Vocabulary that identifies monitoring characteristics or monitoring information by a code and a definition at different levels of aggregation. The list of the characteristics definitions is given in Annex 1.

SeaDataNet vocabulary

The overall working scheme of the Mediterranean Checkpoint is shown in Figure 1.1.

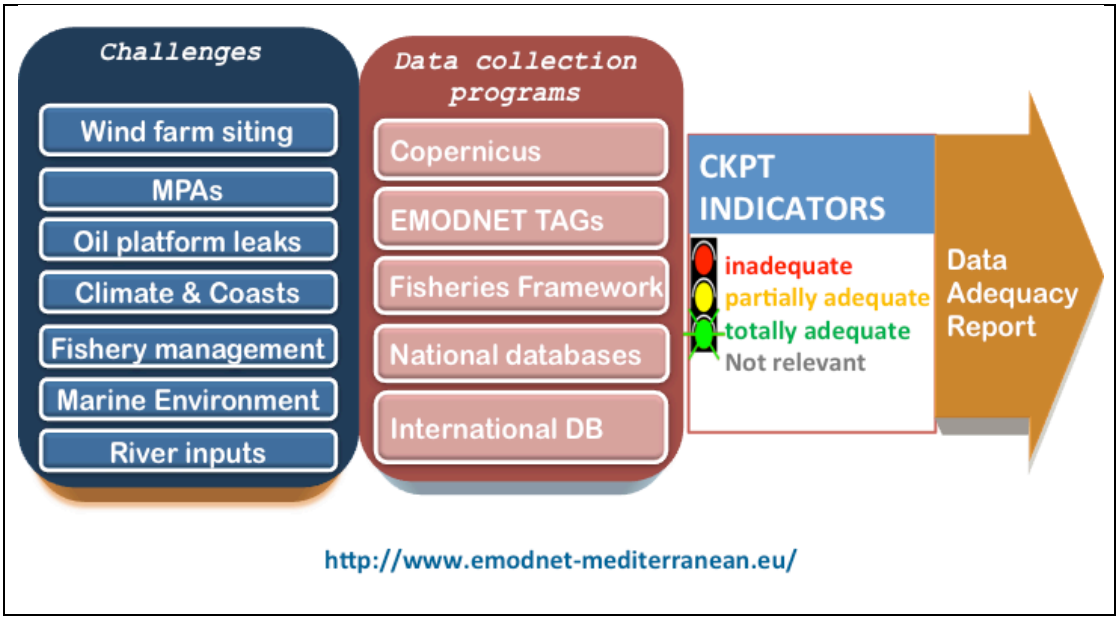


Figure 1.1 The Mediterranean Checkpoint Framework from tender challenges products, to input data sets, services and assessment

1.3 Structure of the document

Report structure

The report is subdivided into nine sections:

1) a general introduction;
2) a section describing the ISO and INSPIRE methodological framework used in the Checkpoint;
3) a section describing the assessment indicators;
4) a section describing the analysis of the input data sets presently stored in the Checkpoint metadatabase;
5) a section with the analysis the input data sets in terms of availability indicators;
6) a section showing the analysis the input data sets in terms of appropriateness indicators;
7) a section with the analysis of the Targeted product quality by expert evaluation;
8) the eight extracts the gaps from the combined analysis of the two indicators;
9) the ninth concludes with recommendations.

Five Annexes compose this second DAR. They contain the statistical analysis of the input data sets in the metadatabase and the vocabulary definitions (Annex 1), the indicator definition (Annex 2), the statistical analysis of indicators (Annex 3 and 4) and the expert opinions on the Challenge products and gaps (Annex 5).

2. The methodological framework

The Mediterranean Sea Checkpoint has developed an objective assessment methodology for the basin scale monitoring system. The latter is composed of "input data sets" that are used by the Challenges to derive products. The general framework has been provided by the "Methodology to assess and communicate the economic benefits of consensus-based standards"[4] developed by ISO.

2.1 Key definitions

Vocabulary definitions

The definition of key vocabulary terminology has an important role in the Mediterranean Sea Checkpoint assessment framework. These semantic aspects are mainly based on ISO standard definitions.

- **Characteristic:** A distinguishing feature which refers to:
  - a variable derived from the observation or the measurement;
  - a numerical model output of a phenomenon
  - an object property in the environment
  - a geographical representation of an object on a map (i.e. a layer such as a protected area, a coastline or wrecks) by a set of vectors (polygon, curve, point)
  - 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:** The environments where characteristics are measured or computed:
  - Air,
  - Fresh water, Marine water,
  - Biota/Biology,
  - Riverbed/Seabed,
  - Human activities.
- **Data:** reinterpretable representation of information in a formalised manner suitable for communication, interpretation or processing (ISO 19115)
- **Dataset:** 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 (e.g. the set of seismic data files recorded along the same line).
- **Input Dataset:** The collection of existing data to be input to the Challenges
- **Assessment criteria:** The criteria are focused on two questions : "what" and 'how' is made available to the challenges. Appropriateness (what) and availability (how) indicators have been defined using ISO 19113 and ISO 19157 standards.

Assessment criteria

[4] Assessing economic benefits of consensus-based standards – The ISO methodology. http://www.iso.org/iso/home/standards/benefitsofstandards/benefits-detail.htm?emid=6

- **Data adequacy:** can be defined as the fitness for use of the data for a particular user or for a variety of users. Since different applications require different properties associated with the data itself, 'adequacy' should be defined objectively using standardized nomenclature and methods. In an EC Report[5] adequacy was defined as an assessment of the reported information to meet the objectives of the Marine Strategy Framework Directive (MSFD) and its technical requirements listed in MSFD Articles 8, 9 and 10[6]. The CheckPoint adequacy is close to this definition but focused on several Challenges. In other words adequacy is here intended as 'sufficient to satisfy a requirement or meet a need'[7]. From this definition, 'adequacy' relates to meeting both requirements as well as needs and is normally applied within the framework of an ISO 9001 based Quality Management System.

Data adequacy definition

2.2 The ISO rules adopted for the assessment

Table 2.1 overviews the ISO standards used for definitions, services and assessment criteria of the Mediterranean Checkpoint.

Assessment standards

Table 2.1 ISO standards for Checkpoint methodology

Standards used for key definitions	Standards used for the Med Checkpoint Services	Standards used for assessment criteria
ISO9000: The ISO 9000 family addresses various aspects of quality management. The standards provide guidance and tools for companies and organizations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved. ISO9001: sets out the requirements of a quality management system. ISO19113: establishes	ISO19115: defines the schema required for describing geographic information and services by means of metadata. It provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services. ISO 19156:2011 defines a conceptual schema for observations, and for features involved in sampling when making observations. These provide models for the	ISO8601: is the international standard covering the exchange of 'date' and 'time' so as to avoid misinterpretation of numeric representation of them. ISO9004: focuses on how to make a quality management system more efficient and effective. ISO19108: defines concepts for describing temporal characteristics of geographic information. It depends upon existing information technology standards for the interchange of temporal information. ISO19157: establishes the principles for describing the

ISO rules for metadata

[5] 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

[6] Adequacy does not necessarily mean, for instance, that if the defined data is adequate, this automatically means that the quality of the marine waters Is acceptable

[7] Random House Unabridged Dictionary, Random House Inc, 2006

the principles for describing the quality of geographic data and specifies components for reporting quality information. It also provides an approach to organizing information about data quality. This standard has been revised by ISO19157. ISO19131: help in the creation of data product specifications, so that they are easily understood and fit for their intended purpose.	exchange of information describing observation acts and their results, both within and between different scientific and technical communities. ISO19119: identifies and defines the architecture patterns for service interfaces used for geographic information, defines its relationship to the Open Systems Environment model, presents a geographic services taxonomy and a list of example geographic services placed in the services taxonomy.	quality of geographic data (components for describing data quality; components and content structure of a register for data quality measures; general procedures for evaluating the quality of geographic data; principles for reporting data quality). It also defines a set of data quality measures for use in evaluating and reporting data quality. ISO25010: is a quality in use model composed of characteristics and sub-characteristics that relate to the outcome of interaction when a product is used in a particular context of use. The model is applicable to both computer systems and software products.

The ISO based methodology provides a set of standards that measure in an objective way the 'data adequacy'. The assessment is based on appropriate quality information, which include:

1. per-product quality (ISO quality elements);
2. input data set quality information (quantified values through indicators);
3. reputation of data (expert knowledge on the input data set);
4. community assessments of data relevance and usability within the application domain (expert opinion).

The ideal product specification

These elements require the definition of 'ideal product specifications' (called Data Product Specifications) that must be compared with the products obtained from existing input data (the Targeted Products). ISO19157:2013(E) quality elements are used to provide a statistical indication of the Targeted Products quality with respect to the Product Specifications and also provide a quantitative estimation of the extent to which data sets or data set series can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. In other words, ISO 19157 standards contain elements for assessing 'how' and 'how much' data meets requirements in order to enhance user satisfaction.

Quality management approach

The Mediterranean Check Point ISO9004 base concepts (Figure 2.1) allow a quality management approach with self-assessment as a tool to review the checkpoint results. This 'self-assessment' has been based on the internal review of deliverables and on the comparison between 'objective assessments' based on indicators and expert opinion. In the Figure 2.1 the

ISO schema is showing the processes important for the Checkpoints:

- continually monitor and regularly analyse the organization's environment, including its customers' needs and expectations, the competitive situation, new technologies, political changes, economic forecasts, or sociological factors
- identify and determine the needs and expectations of other interested parties
- assess its current process capabilities and resources,
- identify future resource and technology needs,
- identify the outputs necessary to meet the needs and expectations of the interested parties.

These processes should be established in a timely manner, with any necessary plans and resources being provided to support them.

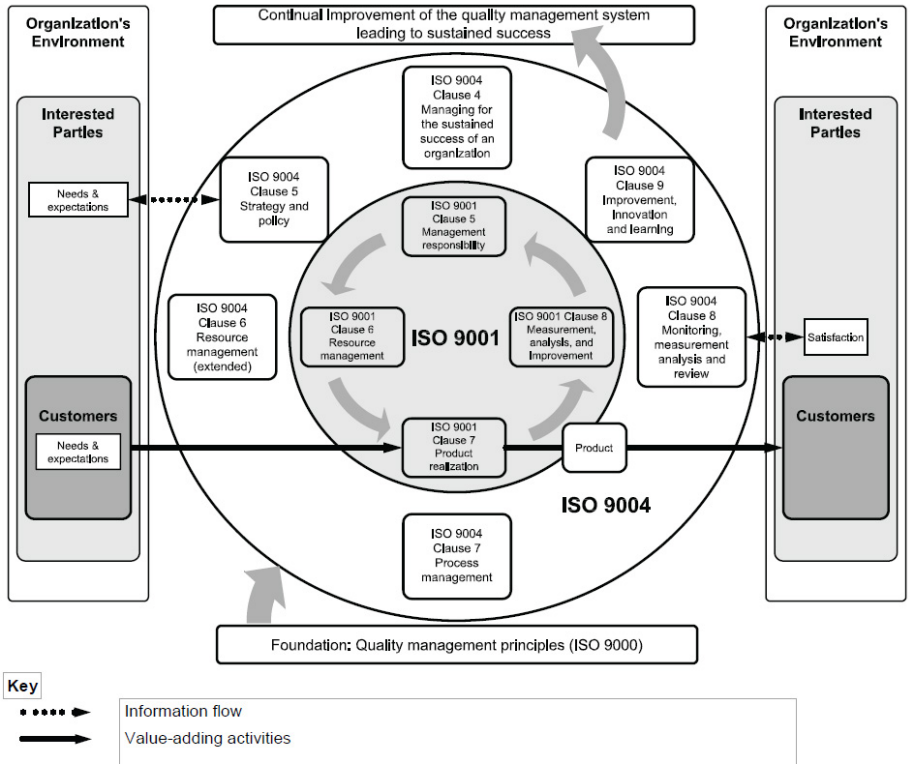


Figure 2.1 ISO9004 extended model of a process-based quality management

2.3 CheckPoint assessment methodology

The ISO based quality elements and assessment methodology allows to assess the quality of challenges' products and existing service delivery to stakeholders by:

The Checkpoint methodology

- Benchmarking their level of quality
- Identify their strengths and weaknesses
- Identify opportunities for either improvements or innovation, or both.

The Med Checkpoint assessment methodology has been based on four elements:

1. the Data Product Specification,
2. the collection of information on Input Data needed for these products,
3. the realization of Targeted Data Products (TDP - requested by the call) using the Input Data
4. the development of indicators to assess Input Data and the adequacy of products obtained from them with respect to DPS.

2.3.1 Data Product Specifications

A Data Product Specification (DPS) is a detailed description of a dataset or dataset series together with additional information that will enable it to be created, supplied to- and used by- another party (ISO19131:2007). It is a precise technical description of the data product in terms of the requirements that it will or may fulfil. The data product specification only defines how the dataset should be and provide the basis for the assessment of the Upstream Data sets supplied to- and used by- the challenges for the Targeted Data Products (TDP).

The Data Product Specification

2.3.2 Targeted data Products

The values of data increases when they are transformed in sophisticated Data Products (e.g. by means of analysis, models, etc.). Targeted Data Products can assist stakeholders with their specific decisions.

The Targeted Data Product

2.3.3 Upstream data sets

The initial effort of the Mediterranean Checkpoint was the collection of information related to input data sets potentially required by the Challenges. The selection of input data sets was derived from expert specifications of data needs for Challenge products required by the tender and listed in §1. The content of the Checkpoint metadatabase is then strongly linked to the specific Challenges chosen by the DGMARE call for tender and the expert opinion. Additional consultations in the challenge communities of practices have helped to finalise the list of data providers and data sets.

The Upstream Data sets

Challenges have collected information on providers selecting the ‘best copies’ of data sets, i.e. the ones with the highest level of quality and trying to avoid duplications. However, the same ‘best data sets’ could have been uploaded in the Med Checkpoint metadatabase by different challenges. To reduce these problems, the metadatabase has been checked by each challenge leader and successively by ‘auditors’ not working in the Challenges.

2.4 INSPIRE rules adopted for service

INSPIRE rules for Checkpoints

It has been noted that nearly all the characteristics that are populating the Mediterranean Checkpoint metadatabase are composed by spatial data. In general, the INSPIRE Directive is asking for spatial data service types, and the INSPIRE Metadata Regulation 1205/2008/EC mandates the use of (among others) a Discovery Service, View Service, Download Service, Transformation Service, Invoke Spatial Service.

The technical specification[8] provided by INSPIRE working groups are herewith listed.

- Service to access to information: The INSPIRE Rule for accessing information are part of the ISO19115 On-line resource and INSPIRE Implementing Rules for Metadata B 1.4 – Resource Locator. The Resource Locator is the 'navigation section' of a metadata record which point users to the location (URL) where the data can be downloaded, or to where additional information about the resource may be provided. Setting up the correct resource locators is important for the connection between the data and the services that provide access to them or for providing additional information concerning the resource. If a linkage for data is available, the Resource Locator shall be a valid URL providing one of the following:
    - a link to a web with further instructions
    - a link to a service capabilities document
    - a link to a client application that directly accesses the service
- Service to link datasets: In addition to the Resource Locator, it should be considered also the link of services to the relevant datasets, and this is the metadata element called Coupled Resources and referenced in B 1.6 of the Implementing Rules.
- Classification of characteristics: A correct categorisation of characteristics is very important to help users to search and find the resources they are looking for (Topic category, B2.1). For the purpose of the project, the SeaDataNet classification lists have been adopted for the following reasons:

    SeaDataNet classification classes: P02, P03 and P22

    - 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 hierarchy offers three different levels of granularity: the variables (SDN parameter list P01), the categories or characteristics (SDN P02 list) and the group of categories or group of characteristics (SDN P03 list) allowing to navigate from the more general level of information to the most detailed one. In addition the INSPIRE themes are included in the P22 list.
- INSPIRE Network Service: The INSPIRE Implementing Rules requires also

[8] INSPIRE metadata implementing rules: technical guidelines based on EN ISO 19115 and EN ISO 19119.

to specify if the discovery, view, download, transformation, invoke and other services are 'INSPIRE Network Services' (Spatial service type B 2.2).

- Conditions for access and use of spatial data sets and services, and where applicable, corresponding fees as required by Article 5(2)(b) and Article 11(2)(f) of INSPIRE Directive 2007/2/EC. These are part of B 8.1 Implementing Rules: Restrictions on the access and use of a resource or metadata. It is recommended to have in the metadata descriptions of terms and conditions, including where applicable, the corresponding fees or a link (URL) where these terms and conditions are described.
- The INSPIRE Implementing Rules defines the metadata concepts for limitations on public access in part B 8.2 that applies to access constraints to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource. In relation to constraints classes, there may be three scenarios according to the INSPIRE rules:
  - There may be no limitation on public access;
  - There may be only a classification property when expressing a security constraint;
  - There may be one or more instances of the access constraints property, possibly associated with one or more instances of other restrictions property (i.e, Legal Constraints).

The INSPIRE needs and requirements have been translated partly in terms of indicators and they have been used to construct the Checkpoint service.

3. Assessment Indicators

Assessment Territories

The assessment criteria have subdivided into two ‘Territories’ that need to be evaluated in terms of Challenge requirements. The term "territory" refers to a domain of assessment and we have chosen two categories:

Territory 1: Availability **How** the input data sets are made available to Challenges
Territory 2: Appropriateness **What** is the quality of the monitoring data for the Challenge products

Table 3.1 The two territories of the assessment

3.1 Territory 1: Availability

‘Availability' measures the extent to which datasets are ready for use and are obtainable. The eight availability indicators are:

Eight availability indicators

Definitions	Name of Availability indicators
Visibility Indicators	
Easily found	**AV-VI-1**
EU Inspire Catalogue service	**AV-VI-2**
Accessibility Indicators	
Policy visibility	**AV-AC-1**
Delivery	**AV-AC-2**
Data Policy	**AV-AC-3**
Pricing	**AV-AC-4**
Readiness	**AV-AC-5**
Performance Indicator	
Responsiveness	**AV-PE-1**

Table 3.1.1 Availability indicators nomenclature

The availability indicators (AV) provide an understanding of the readiness and service performance of the infrastructure providing access to data. The availability indicators are subdivided into three categories:

- Visibility (VI), i.e. the possibility of identifying and quickly accessing the appropriate site for the required data sets;
- Accessibility (AC) i.e. the possibility, for non expert users, to understand the retrieval model status;
- Performance (PE) i.e. the ability of a system to keep operating over time and to meet real time operational conditions. This is related to service performance.

3.1.1 Visibility indicators

"Visibility" is the ability to identify and quickly access the appropriate site delivering the desired data sets. In other words it is the ability for all users, including non-experts, to perform data sourcing through an EU Inspire catalogue. Two indicators have been defined for the visibility element, i.e.:

Visibility indicator

AV-VI-1 Easily found	Can the data sets or series of data sets be found easily?
AV-VI-2 EU Inspire catalogue service	Is the dataset referenced by a EU catalogue service or other bodies (private or public, national or international non EU services[9])

Table 3.1.2 Visibility indicator meaning

By referring to the INSPIRE Directive, this AV-VI-1 indicator provides information on visibility of data in catalogues. The AV-VI-2 indicator informs users whether the characteristic can be searched for by a catalogue service, such as EMODnet Thematic Portals, Copernicus core services, EEA services, DG MARE services, INSPIRE Geoportal, etc. Both indicators are identified as part of the INSPIRE Metadata Implementing Rules B 1.4 and the technical guidelines are based on EN ISO 19115 and EN ISO 19119.

3.1.2 Accessibility indicators

Accessibility indicators

'Accessibility' is the ability of all users, including non-experts, to understand the retrieval model status and its appropriateness. ISO 19115 provides a general mechanism for documenting different categories of constraints applicable to the resource (or its metadata). The constraints could be legal and/or security constraints.

The INSPIRE Implementing Rules defines the metadata concepts for limitations on public access in part B 8.2 that apply to access constraints in order to ensure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource. In relation to constraint classes, there may be three scenarios according to the INSPIRE rules:

- There might be no limitation on public access;
- There might be only a classification property when expressing a security constraint;
- There might be one or more instances of the access constraints property, possibly associated with one or more instances of other restrictions property (e.g., Legal Constraints).

There are five indicators devised for accessibility:

AV-AC-1 Policy visibility	Visibility on data policy adopted by data providers.
AV-AC-2	Data delivery mechanisms, i.e. the

[9] The non EU services are advanced services, but not following the guidelines defined in INSPIRE and its technical annexes.

Delivery	services available to the user to access data
AV-AC-3 Data Policy	Data policy
AV-AC-4 Pricing	Cost basis / price policy
AV-AC-5 Readiness	Format for use

Table 3.1.3 Accessibility indicator meaning

In the framework of the "blue growth" and for the specific indicator on Data policy, the exact meaning of 'open' has not been established. Among the many definitions of 'open', one or more of these can be adopted:

- Accessible to all; unrestricted to participants
- Free from limitations, boundaries, or restrictions
- Usable by registered users

The indicator will classify all of these under the same score value.

3.1.3 Performance indicators

The performance indicators indicate the ability of a system to keep operating over time and to meet real time operational conditions. It is related to service performance. Only one indicator is defined for performance:

Performance indicator

AV-PE-1 Responsiveness	How responsive is the delivery service for the available data?

Table 3.1.4 Performance indicator meaning

3.1.4 Availability indicators evaluation scale

Indicators provide both an overview of the situation at a high level of aggregation as well as detailed information about trends and links. The difficult task is to find an appropriate balance between simplification and completeness and offer, at the same time, an assessment of the input data sets without directly accessing all the metadata. The Checkpoint has defined 4-6 possible values for the different availability indicators and has defined a "color scale" evaluation that is described in Annex 3, Table A3.0. In synthesis the meaning of the color scale is:

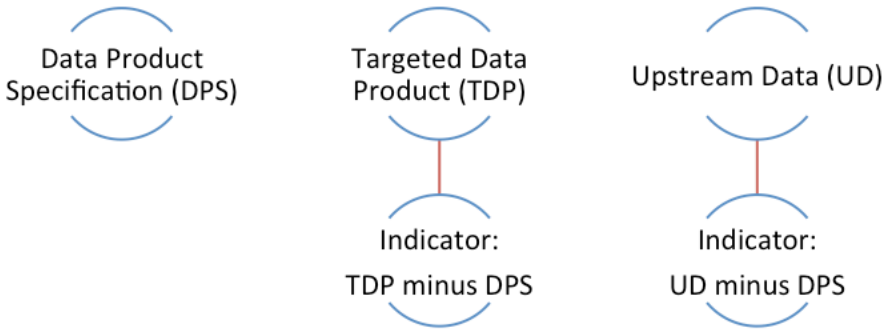
Availability indicators scale

Red: urgent actions are required to provide datasets and services fitting for use – totally inadequate
Yellow: limited actions are required to provide datasets and services fitting for use – partly adequate
Green: actions and services are fit for use and should be maintained – fully adequate

3.2 Territory 2: Appropriateness

Appropriateness indicators are constructed by comparing the DPS (Data

Product Specification) Quality Elements against the TDP (Targeted Data Product) and UD (Upstream Data) quality elements. The concept is illustrated in Fig. 3.2.1



Appropriateness indicators out of quality elements

Figure 3.2.1 High level scheme for the appropriateness indicators: Quality Elements are decided for DPS and reproduced for TDP and UD so that a "difference" (TDP minus DPS or UD minus DPS) can be calculated and this gives indicator values.

In a generic assessment process the first step is the assessment of the appropriateness of TDP vs the product specification. In Checkpoint we add the assessment also of the UD with respect to product specification since we are interested to extract information about quality the quality of the monitoring system that provides input data to the products. The details of the calculations are given in Annex 2.

3.2.1 Quality elements for appropriateness

'Appropriateness' is providing indications on the inherent properties of the products and the input data sets used in the products. The quality elements are specified in ISO19157 standards. The relevant Appropriateness quantitative elements chosen for the Checkpoint are listed in Table 3.2.1.

Definitions	Name of Appropriateness Quality Elements
Completeness	
Horizontal Spatial Coverage	**AP-1-1**
Vertical Spatial Coverage	**AP-1-2**
Temporal Coverage	**AP-1-3**
Consistency	
Number of Characteristics	**AP-2-1**
Accuracy	
Horizontal Resolution	**AP-3-1**
Vertical Resolution	**AP-3-2**
Temporal Resolution	**AP-3-3**
Thematic Accuracy	**AP-3-4**
Temporal Quality	
Temporal Validity	**AV-4-1**

Quality Elements for appropriateness indicators

Table 3.2.1 Appropriateness quality elements nomenclature

In the Mediterranean Checkpoint, appropriateness is measuring how input data sets are fit for the challenges. The appropriateness quality elements, definitions, measures, units and calculation of the fitness for use are given in Annex 2 and are herewith shortly presented.

3.2.1.1 Completeness quality elements

'Completeness' is the amount or extent to which something is covered or data are absent from a data set. In the case of the check points the completeness applies to both spatial and temporal coverage. Three indicators have been defined as 'coverage'.

#-AP-1.1 Horizontal Spatial Coverage	Horizontal coverage extent of product (eg : surface of the Mediterranean Sea)
#-AP-1.2 Vertical Spatial Coverage	**Vertical coverage extent of product**
#-AP-1.3 Temporal Coverage	**Temporal coverage extent of product**

Completeness quality elements

Table 3.2.2 Completeness quality elements meaning. The # is replaced in the metadatabase with DPS, TDP and UD as appropriate.

3.2.1.2 Consistency quality elements

'Consistency' is the adherence to rules of the conceptual schema and measures the uniformity among the parts of the Data Product Specification and Targeted Data Product. This quality element is only applicable to DPS and TDP.

#-AP-2.1 Number of Characteristics	Number of Characteristics in product

Table 3.2.3 Consistency quality element meaning. The # is replaced in the metadatabase with DPS and TDP as appropriate.

3.2.1.3 Accuracy quality elements

'Accuracy' is the comparison of classes assigned to features or their attributes to universe of discourse or the extent to which a given measurement agrees with the standard value for that measurement. Three indicators on 'spatial and temporal resolution' and one indicator on 'thematic accuracy' have been used.

Consistency quality elements

#-AP-3.1 Horizontal Resolution	Horizontal mesh size or equivalent value for the given scale of product (eg 50m for 1/50 000)
#-AP-3.2 Vertical Resolution	**Average vertical sampling and description of specific vertical sampling schema**

#-AP-3.3 Temporal Resolution	**Temporal sampling interval of product**
#-AP-3.4 Thematic Accuracy	**Percentage error of the product and description of error concept for the product**

Accuracy quality elements

Table 3.2.4 Accuracy quality elements meaning. The # is replaced in the metadatabase with DPS, TDP and UD as appropriate.

3.2.1.4 Temporal Quality element

'Temporal quality' is the validity of data with respect to time. This provide an indication on how old is the last update of the input data set and an indirect information on how much can be assumed valid the product.

#-AP-4.1 Temporal Validity	Max elapsed time between last input data records update and product creation date

Table 3.2.5 Temporal quality element meaning. The # is replaced in the metadatabase with DPS, TDP and UD as appropriate.

3.2.2 Appropriateness indicator definitions

The basic idea of appropriateness indicators is that they are related to "errors" in the Quality Elements just defined. Appropriateness corresponds then to "low" errors in the specific quality element.

Temporal Quality elements

"Errors" for quality elements are defined as the differences between what has been realized and what was "expected" or "required". DPS includes the requirements or expectations while TDP and UD are the actual products and input data sets used respectively.

The nine appropriateness indicators for Targeted Data Products are described in Table 3.2.6.

QE number	Indicator name	Definition of indicator	Units
1	TDP.APE.1.1	Percentage to which the extent of the horizontal spatial coverage of TPD is compliant with the DPS extent in km**2	Percentage
2	TDP.APE.1.2	Percentage to which the extent of the vertical spatial coverage of TPD is compliant with the DPS extent in metres.	Percentage
3	TDP.APE.1.3	Percentage to which the extent of the temporal coverage of TPD is compliant with the DPS extent in days.	Percentage

Appropriatenss errors for indicators

Targeted products indicators

4	TDP.APE.2.1	Percentage of Completeness/Incompleteness of the number of characteristics with respect to the list in DPS	Percentage
5	TDP.APE.3.1	Percentage to which the product averaged horizontal mesh size or horizontal scale is compliant with the DPS averaged mesh size or horizontal scale	Percentage
6	TDP.APE.3.2	Percentage to which the product averaged vertical mesh size or vertical scale is compliant with the DPS averaged mesh size or vertical scale	Percentage
7	TDP.APE.3.3	Percentage to which the product temporal sampling interval is compliant with the one defined in DPS (percentage to be extracted from text of AP.3.3 measure)	Percentage
8	TDP.APE.3.4	Compliance with the value domain of the accuracy defined in DPS	Percentage
9	TDP.APE.4.1	Percentage to which the elapsed time of the product is compliant with the max elapsed time specified in DPS.	Percentage

Table 3.2.6 Appropriateness indicators meaning for Targeted Data Products. The indicators that are based on calculation of "errors" for the different quality elements and they are explained in details in Annex 2.

Moreover the same type of indicators have been evaluated for the input data sets to the TDP and they are called UD indicators. The eight appropriateness indicators for Upstream Data are described in Table 3.2.7.

QE number	Indicator name	Definition of indicator	Units
1	UD.APE.1.1	Percentage to which the extent of the horizontal spatial coverage of UD is compliant with the DPS extent in km**2	Percentage
2	UD.APE.1.2	Percentage to which the extent of the vertical spatial coverage of UD is compliant with the DPS extent in metres.	Percentage
3	UD.APE.1.3	Percentage to which the extent of the temporal coverage of TPD is compliant with the DPS extent in days.	Percentage

Upstream Data indicators

5	UD.APE.3.1	Percentage to which the product averaged horizontal mesh size or horizontal scale is compliant with the DPS averaged mesh size or horizontal scale	Percentage
6	UD.APE.3.2	Percentage to which the product averaged vertical mesh size or vertical scale is compliant with the DPS averaged mesh size or vertical scale	Percentage
7	UD.APE.3.3	Percentage to which the product temporal sampling interval is compliant with the one defined in DPS (percentage to be extracted from text of AP.3.3 measure)	Percentage
8	UD.APE.3.4	Compliance with the value domain of the accuracy defined in DPS	Percentage
9	UD.APE.4.1	Percentage to which the elapsed time of the product is compliant with the max elapsed time specified in DPS.	Percentage

Table 3.2.7 Appropriateness indicators meaning for Upstream Data. The indicators that are based on calculation of "errors" for the different quality elements and they are explained in details in Annex 2.

3.2.3 Appropriateness indicators evaluation scale

In the case of appropriateness, it is less immediate than for availability to provide a simple characterization of the indicators at a high level of aggregation. At present we have made some simplifying assumptions, allowing a non-expert to easily assess the appropriateness indicators without looking at the metadata and reports.

Appropriateness indicator values for both TDP and UD can have negative or positive values. The former score is an "under-fitting score, representing lower than expected quality elements for the Targeted product or the Upstream data while the latter is an "over-fitting" score. Both the under-fitting and over-fitting scores have been saturated at $\pm 100\%$.

Appropriateness indicator scale

In order to associate a range of indicator values to an indicator score, it is necessary to establish "thresholds". It was decided that products with 'errors' within -10% and +10% with respect to DPS are 'appropriate' or at least partly adequate. Values smaller than -10% are under-fitting and not adequate while values large than +10% are over-fitting or totally adequate, no need for further development.

For a certain indicator value range, a color is associated with the following

meaning:

- **Red:** the TDP or UD have errors between -100% and -10% and urgent actions are required to provide datasets fit for use by the Challenges – not adequate
- **Yellow:** the TDP or UD have errors between -10% and +10% and can be considered quite appropriate and monitoring data are fit for use and should be maintained but also improved – partly adequate
- **Green:** the TDP or UD have errors between +10% and +100% and there is an 'over – offer', no need for further development – totally adequate

4. Analysis of the input data sets metadatabase

MedSea metadatabase contents

In the Mediterranean CheckPoint metadatabase there are 266 data sets descriptions that are distributed among the seven challenges, described by 47 P02 characteristic categories, 16 INSPIRE themes (over 34), 6 environmental matrices and 23 P03 group of characteristics. All the statistical information is provided in Annex 1. In the Table 4.1 a synthesis is displayed.

These data sets are potentially usable by the Challenge partners to generate their products. As we will see later, only 90 of these will be actually used by the Challenges.

Table 4.1 The number of input datasets by Challenge and the environmental matrices, P02, P03 and P22 characteristics by Challenge. (P02, P03, P22 numbers do not match with the overall "Numbers of different P02, P03 and P22 identified" because the same characteristic is requested by more than one Challenge).

	Challenge							
	Ch1 Windfarm siting	Ch2 Marine protected areas	Ch3 Oil platform leaks	Ch4 Climate and coastal protection	Ch5 Fisheries mgmt	Ch6 Marine env.	Ch7 River inputs	ALL
Number of input data sets identified	38	75	66	9	18	20	40	266
Environmental matrices identified	5	5	5	2	3	1	2	6
Numbers of different P03 identified	12	18	9	3	4	4	5	23
Numbers of different P02 identified	27	19	11	3	5	6	7	47
Numbers of different INSPIRE spatial themes identified (P22)	9	11	7	2	4	1	2	16

Statistical analysis of contents in terms of common vocabulary codes

The histogram of Fig. 4.2 illustrates the results of Table 4.1 making evident the larger number of P02, P03 and P22 categories potentially required by the first three Challenges with respect to the others.

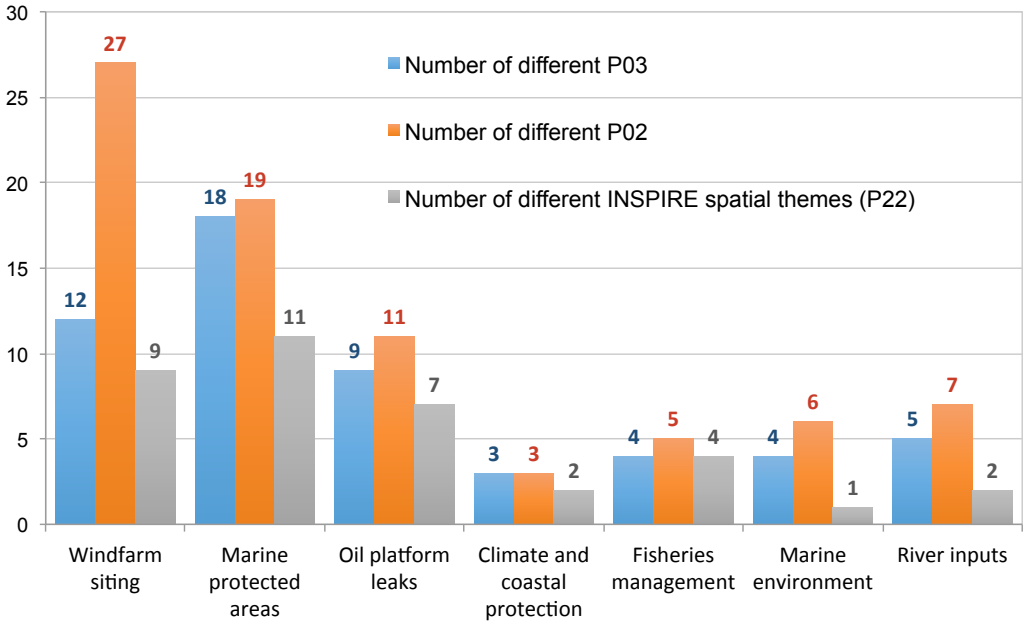
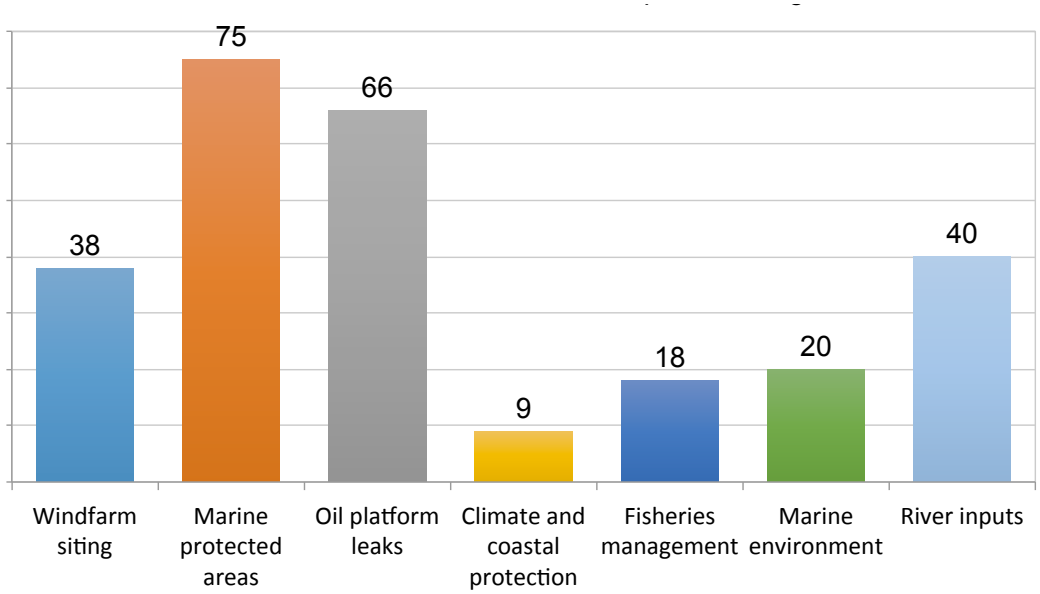


Figure 4.2: Number of characteristic categories identified by P02, P03 and P22 as a function of Challenges

The different number of input data sets potentially usable by the Challenges to generate their products is described in Figure 4.3 where it is evident that Wind Farm Siting, MPAs, Oil Platform Leaks and River inputs request more data sets than the others.



Number of potential input data sets for the Challenge products

Figure 4.3 Number of input data sets for each Challenge

5. Analysis of the monitoring system by availability indicators

The availability indicators, described in Section 3, have been used here to carry out the first part of the monitoring system assessment . The indicators for the 266 input data sets, inserted in the metadatabase and potentially required by the Challenges, have been analysed by means of a distribution histograms of the scores.

Monitoring system adequacy with availability indicators

5.1 Analysis of indicators across Challenges

In order to provide a visual indication of the input data availability, a colored table for each indicator has been produced as a function of Challenges. This assessment is done on the entire metadatabase constructed for all Challenges, and not only on the one referring only to the input data sets used for the products. The data sources selected for each Challenge and for each P02 characteristics could be more than one, and can have different availability indicators.

5.1.1. AV-VI-1: Easily Found

Table 5.1: Scores for the AV-VI-1 'Easily found' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-VI-1 Easily found	Low visibility	Choice 1: Red *"Cited in peer reviewed paper or grey literature but no info on how to access"*	2	0	3	0	9	0	0	14
		Choice 2 : Red *"Information retrieved upon specific request to the data source "*	30	0	6	0	7	0	3	46
	Medium visibility	Choice 3: Yellow *"Use of social network, community of practices sharing information, portals of organization where no search is organized by an engine"*	0	0	0	0	0	0	0	0
	High visibility	Choice 4: Green *"Use of open search engines, searching by name either the data provider or the characteristics"*	1	25	52	5	2	19	15	119
		Choice 5: Green *"Search via reference catalogue (e.g. Copernicus, GEOSS Geoportal…)"*	5	50	5	4	0	1	22	87
		Total	38	75	66	9	18	20	40	266

Easily found

For all Challenges more than the 77% of the input data sets can be ‘easily found’, however Ch. 1 and Ch. 5 have most of the input data sets non ‘easily found’.

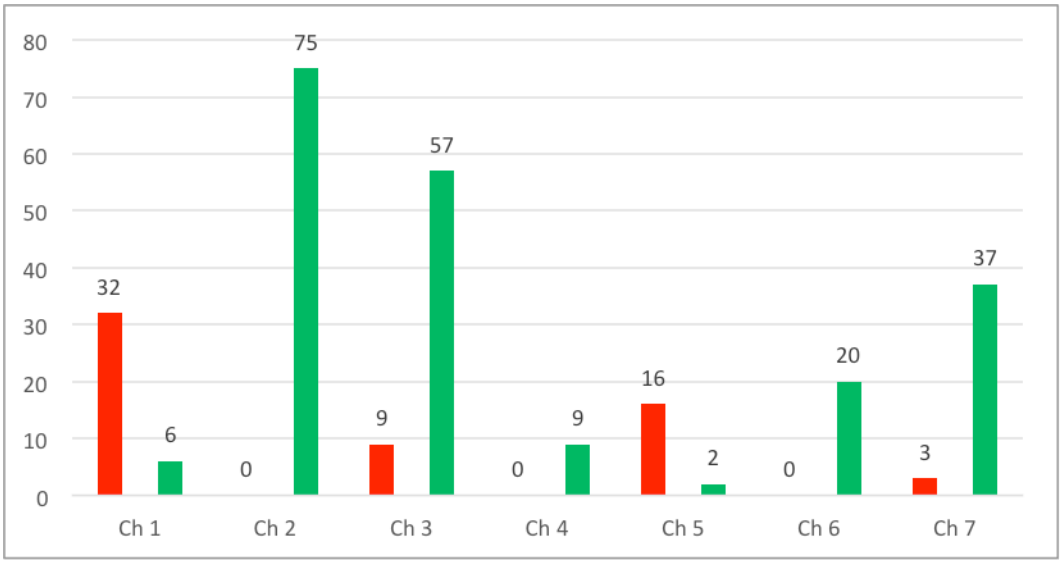


Figure 5.1: AV-VI-1 ‘Easily found’ indicator across all Challenges

5.1.2 AV-VI-2: EU INSPIRE catalogue service

Table 5.2: Scores for the AV-VI-2 ‘EU INNSPIRE catalogue service’ indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-VI-2 EU Inspire catalogue service	Inadequate	Choice 1: Red *"Data sets are not referenced in a catalogue or are referenced in a non public catalogue"*	**19**	**4**	**27**	**6**	**15**	**0**	**0**	**69**
	Partially adequate	Choice 2: Yellow *"The datasets are referenced in a public national catalogue, in an international catalogue service "*	**19**	**9**	**33**	**1**	**0**	**16**	**13**	**20**
	Totally adequate	Choice 3: Green *"The datasets provide a full EU Inspire catalogue service "*	**0**	**61**	**6**	**2**	**3**	**3**	**27**	**177**
	unknown							**1**		
			38	**75**	**66**	**9**	**18**	**20**	**40**	**266**

EU INSPIRE catalogue

For all Challenges there are more than 38% of INSPIRE compliant catalogue services, but there is also a significant amount (about 27%) of data not referenced or in no-public catalogues. Also in this indicator the worst cases

are in Ch. 1 and Ch. 5.

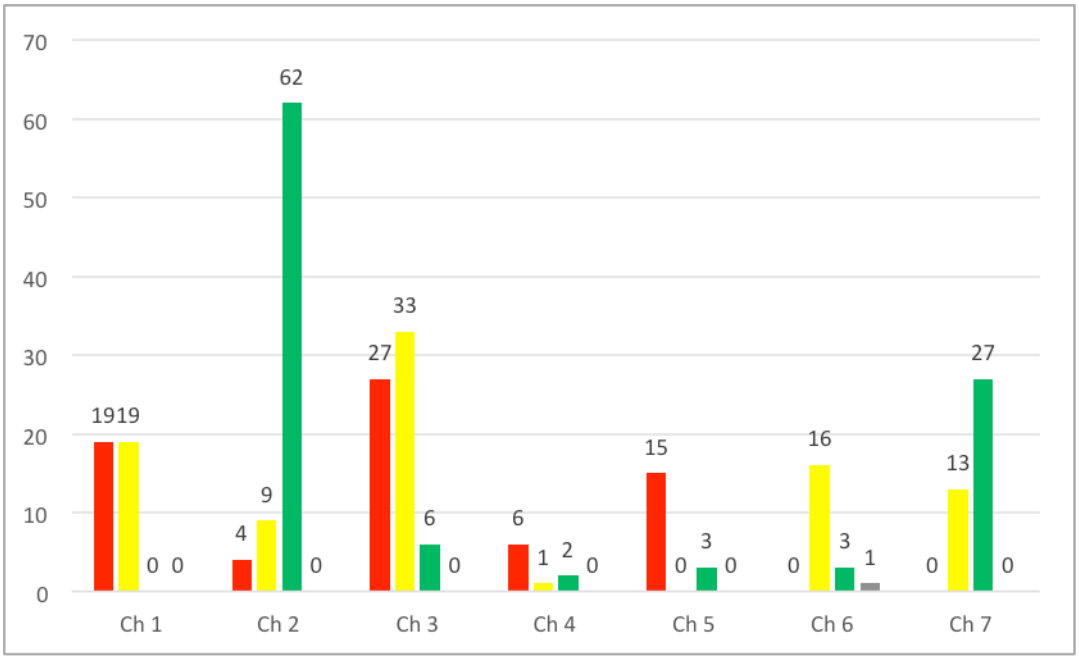


Figure 5.2: AV-VI-2 'EU INSPIRE catalogue service' indicator across all Challenges

5.1.3 Policy visibility

Table 5.3: Scores for the AV-AC-1 'Policy visibility' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-AC-1 Policy visibility	Low transparency	Choice 1: Red *"There is no information at all on data policy adopted by data providers"*	11	3	47	0	4	1	0	66
	Medium transparency	Choice 2: Yellow *"There is information, but details are available only on request"*	19	10	4	0	7	1	2	43
	High transparency	Choice 3: Green *"There is detailed information provided to understand data policy"*	8	62	15	9	7	18	38	157
			38	75	66	9	18	20	40	266

Policy visibility

For all Challenges there are more than 50% of input data sets with visible policy, red are about 19% and yellow about 30%. For this indicator the worst situation is in Challenge 3.

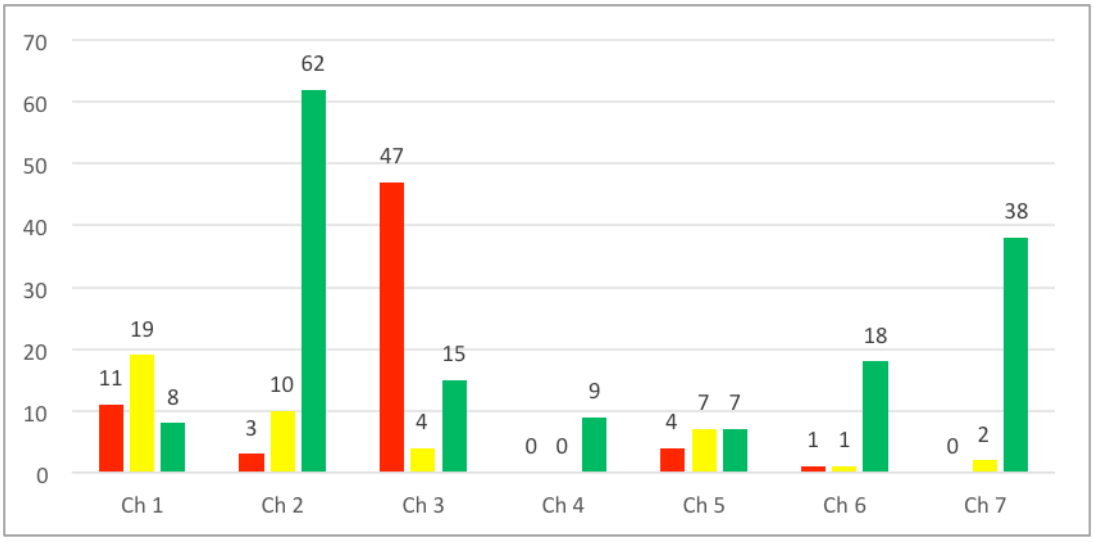


Figure 5.3: AV-AC-1 'Policy visibility' indicator across all Challenges

5.1.4 Delivery mechanism

Table 5.4: Scores for the AV-AC-2 'Delivery mechanism' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-AC-2 Delivery mechanism	No information	Choice 1: Red *"No information was found on data delivery mechanisms"*	**0**	**0**	**16**	**0**	**1**	**0**	**0**	**17**
	Manual	Choice 2: Red *"Order form/invoice is requested"*	**20**	**24**	**6**	**0**	**15**	**0**	**0**	**65**
	Partial Inspire function	Choice 3: Yellow *"Online downloading services "*	**1**	**1**	**4**	**1**	**1**	**1**	**40**	**49**
	Full Inspire function	Choice 4: Green *"Online discovery and downloading services"*	**2**	**35**	**3**	**7**				**47**
		Choice 5: Green *"Online discovery + downloading + viewing services*	**15**	**14**	**37**	**1**	**2**	**19**		**88**
			38	**75**	**66**	**9**	**18**	**20**	**40**	**266**

Delivery mechanism

For the delivery mechanism the green values are about 50%, a very significant amount of input data sets have a red indicator (more than 30%) and also the yellow is quite high (about 18%).

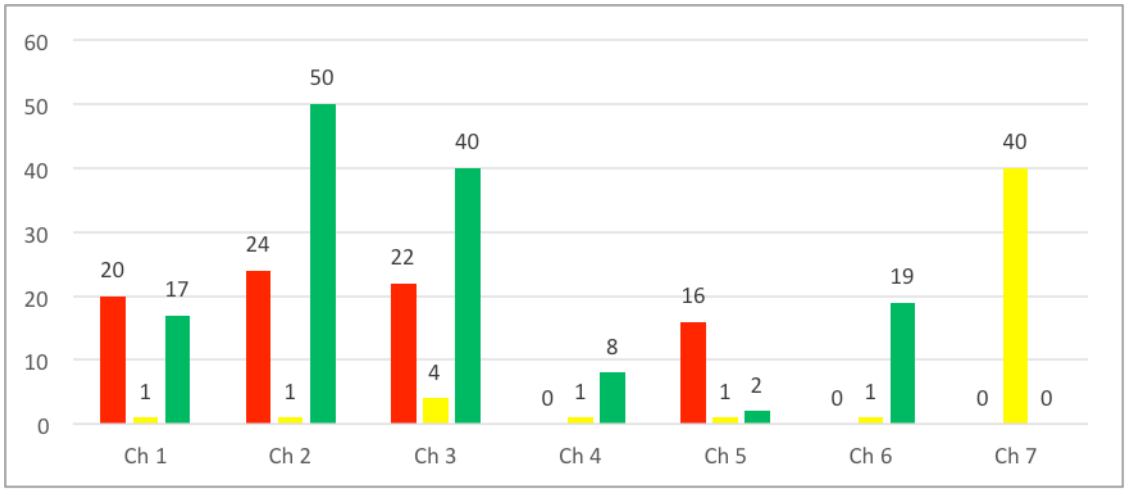


Figure 5.4: AV-AC-2 'Delivery mechanism' indicator across all Challenges

5.1.5 Data Policy

Table 5.5: Scores for the AV-AC-3 'Data policy' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-AC-3 Data policy	No documents	Choice 1:Red *" Not or not well documented"*	0	0	19	0	0	0	0	19
	Restricted	Choice 2: Red *"Restricted"*	4	22	0	2	2	0	0	30
	Partially restricted	Choice 3: Yellow "Accessible under moratorium"	19	4	27	0	12	2	0	64
	Unrestricted	Choice 4: Green *"Unrestricted"*	15	49	20	7	4	18	40	153
			38	75	66	9	18	20	40	266

Data policy

Data policy is still a problem. Only the 57% of input data sets are unrestricted, a 24% will be made open after the use by data collectors and 18% is not documented.

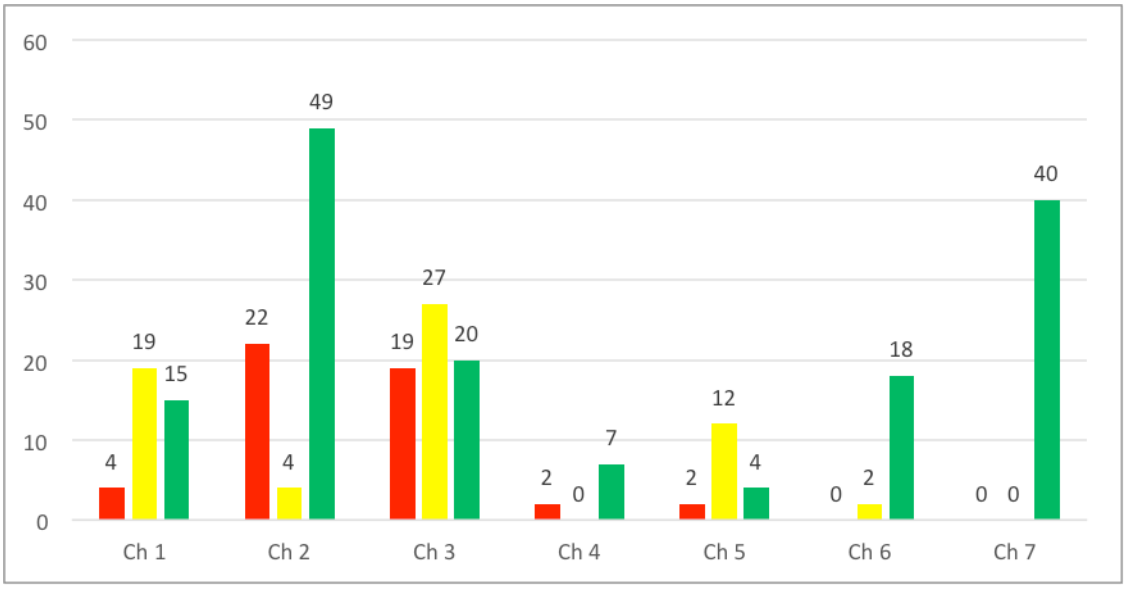


Figure 5.5: AV-AC-3 'Data policy' indicator across all Challenges

5.1.6 Pricing

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-AC-4 Pricing	Not documented	Choice 1: Red *"Not or not well documented"*	3	2	22	0	1	0	0	28
		Choice 2: Red *"Commercial cost charge"*	3	0	0	0	0	0	0	3
	Cost Charge	Choice 3: Yellow *"Distribution charge"*	18				1			19
		"Collection charge" *"Free of charge for academic institutions and uses"*			1		1			3
	Free	Choice 4: Green *"Open and Free, No charge"*	14	73	43	9	15	20	40	212
			38	75	66	9	18	20	40	266

Pricing

Table 5.6: Scores for the AV-AC-4 'Pricing' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Pricing indicator is quite good for all Challenges, since about 81% of input data sets is free. Reds in Ch. 1 and Ch. 3 must be noted as well as the yellow in Ch. 1 again.

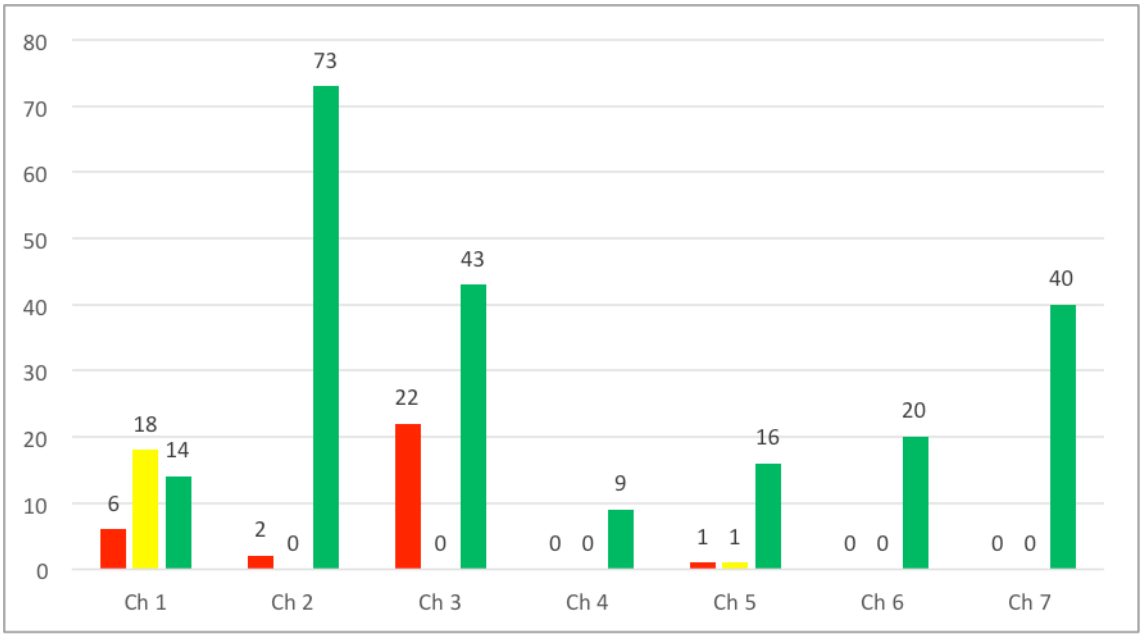


Figure 5.6: AV-AC-6 'Pricing' indicator across all Challenges

5.1.7 Readiness

Table 5.7: Scores for the AV-AC-5 'Readiness' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-AC-5 Readiness	No document	Choice 1: Red *"Not or not well documented"*	4	4	11	0	7	0	0	26
	Not ready to be consumed	Choice 2: Red *"Proprietary and not well documented "*	0	0	0	0	1	0	0	1
		Choice 3: Red *"Not proprietary but content not clearly specified "*	5	1	1	0	0	0	1	8
	Can be processed to be consumed	Choice 4: Yellow *"Proprietary but content clearly specified "*	1	2	0	0	2	0	1	6
	Ready to be consumed	Choice 5: Green *"Not proprietary and content clearly specified (eg auto-descriptive eg ODV, NetCDF CF) or at least with appropriate document describing the content."*	28	68	54	9	8	20	38	225
			38	75	66	9	18	20	40	266

Readiness indicator

Also Readiness indicator is quite good for all Ch.s, since about 84% of input data sets is ready to be consumed. Reds in Ch. 1 and Ch. 3 must be noted again, as well as in Ch. 2 and 5.

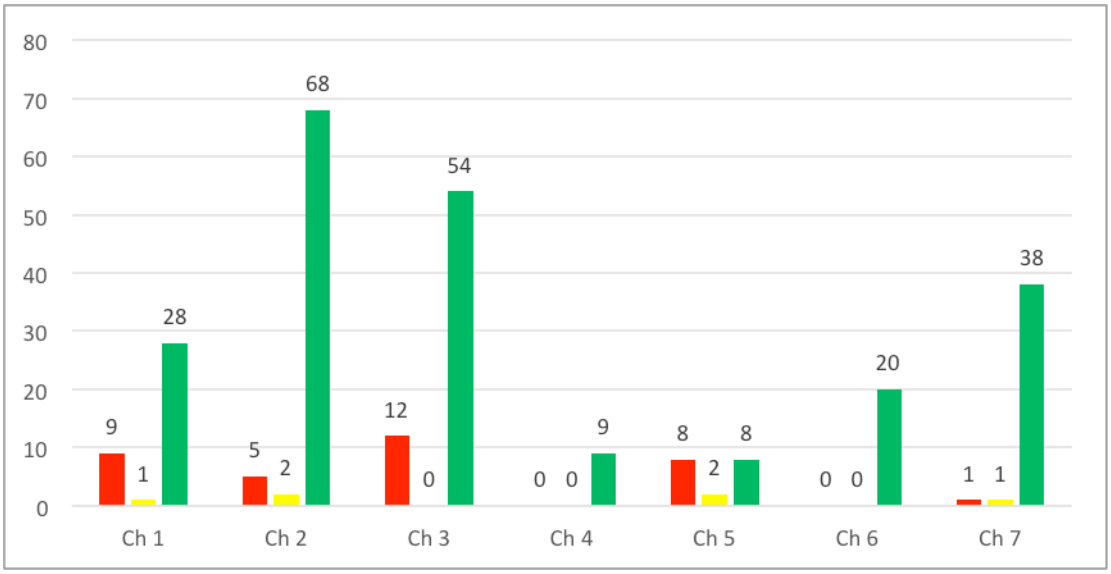


Figure 5.7: AV-CE-5 'Readiness' indicator across all Challenges

5.1.8 Responsiveness

Table 5.8: Scores for the AV-PE-1 'Responsiveness' indicator as a function of Challenges for all input data sets. The last column indicates the score across all challenges

Indicator name	Meaningful (Symbol)	Achievable & Realistic (Choice)	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	
AV-PE-1 Responsiveness	Low response	Choice 1: Red "No information is found on response time"	1	31	17	0	1	0	0	50
	Medium response	Choice 2: Red *"More than 1 week for release"*	0	0	0	0	5	0	0	5
		Choice 3: Yellow *"Less or equal to 1 week for release"*	21	0	1	0	0	0	36	57
	High response	Choice 4: Green Online downloading (i.e. a few hours or less) for release	14	44	48	9	2	19	4	141
		unknown	2	0	0	0	10	1	0	
			38	75	66	9	18	20	40	266

Responsiveness

Responsiveness is presenting significant problems. For all Challenges about the 53% of the input data sets are in high responsive systems, but red and yellow indicators (respectively 20.6% and 21%) together are of the same order of the green ones.

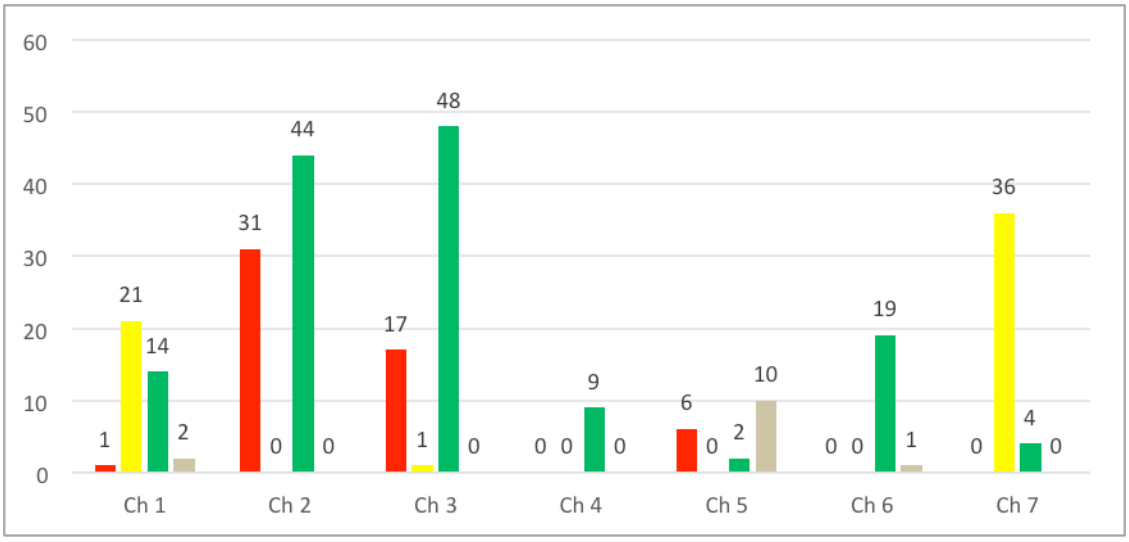


Figure 5.8: AV-PE-1 'Responsiveness' indicator across all Challenges

5.2 Analysis of adequacy of monitoring characteristics by availability

In order to assess the basin scale monitoring system on the basis of "availability" adequacy we need to organise the information across challenges, ordering the various indicators in terms of P02 characteristic categories.

Data adequacy on the basis of availability indicators

Table A3.1 and A3.2 lists all the indicator information as a function of P02 characteristic and for all the 266 data sets, across all the challenges that use the same P02. In order to get the score, hereafter called the "overall score" for each indicator, for each P02 the largest score colour has been considered. If two colour scores had the same number of occurrences, the "best score" was reported as "overall score" for the specific P02 and availability indicator.

We have extracted the monitoring Characteristics that have at least two overall red color scores among the availability indicators. The results are presented in Table 5.2.1. The conclusion is that 19 basin scale characteristic categories are not adequately monitored in the Mediterranean Sea for what concern the availability assessment criteria.

These 19 characteristic categories have been ordered in terms of inadequacy in Table 5.2.2.

P02 characteristics category	# of data sets	Easily found	INSPIRE catalog service	Visibility of Data policy	Data delivery	Data policy	Pricing	Readiness	Responsiveness
1. Sedimentary structure	1								
2. Spectral wave data parameters	1								
3. Wave direction	8								
4. Wave height and period statistics	19								
5. Pollution events	1								
6. Bird reproduction	1								
7. Fauna abundance per unit area of the bed	4								
8. Fish abundance in water bodies	3								
9. Fish behaviour	1								
10. Fish reproduction	1								
11. Habitat extent	17								
12. Fish and shellfish catch statistics	6								
13. Fishing by-catch	1								
14. Horizontal platform movement	8								
15. Marine archaeology	1								
16. Marine environment leisure usage	2								
17. Air pressure	1								
18. Air temperature	1								
19. Atmospheric humidity	1								

Table 5.2.1 Characteristic categories that scored at least 2 red indicators in Table A3.1 for overall availability indicators

P02 characteristics	# of Red scores	# of Yellow scores	# of Green scores	number of data sets
Pollution events	**7**	**1**	**0**	**1**
Spectral wave data parameters	**4**	**2**	**2**	**1**
Fish and shellfish catch statistics	**3**	**3**	**2**	**10**
Horizontal platform movement	**3**	**3**	**2**	**8**

Wave direction	**3**	**1**	**4**	**8**
Fishing by-catch	**3**	**3**	**2**	**1**
Sedimentary structure	**3**	**2**	**3**	**1**
Marine archaeology	**3**	**3**	**2**	**1**
Bird reproduction	**3**	**1**	**4**	**1**
Wave height and period statistics	**2**	**2**	**4**	**18**
Habitat extent	**2**	**1**	**5**	**17**
Fauna abundance per unit area of the bed	**2**	**1**	**5**	**4**
Fish abundance in water bodies	**2**	**1**	**5**	**3**
Marine environment leisure usage	**2**	**4**	**2**	**2**
Air pressure	**2**	**5**	**1**	**1**
Air temperature	**2**	**5**	**1**	**1**
Atmospheric humidity	**2**	**5**	**1**	**1**
Fish behaviour	**2**	**1**	**5**	**1**
Fish reproduction	**2**	**1**	**5**	**1**

Table 5.2.2 P02 characteristic categories that are inadequate for availability indicators in order of inadequacy

Sub-diving the 19 P02 characteristic categories into “themes” we can say that:

Adequacy for availability

1) for geology: sedimentary structure data is totally inadequate in terms of Data Policy, Pricing and Readiness and quite inadequate for INSPIRE Catalogue and responsiveness;
2) for physics: wave data (wave direction, wave height and period statistics) is totally inadequate for the visibility, the EU Catalogue and the Data Policy visibility;
3) for chemistry: pollutants in the water column (oil) are totally inadequate for almost all the availability indicators (7 over 8);
4) for biology: sea birds and fish characteristics (abundance, reproduction, behaviour) are totally inadequate for visibility, INSPIRE Catalogue and Data Policy Visibility;
5) for habitat: habitat extent is totally inadequate for Data Policy, Data delivery and and responsiveness
6) for human activities: fish catch and by-catch, horizontal platform movement (maritime traffic), marine archaeology, marine environment leisure usage are totally inadequate for visibility, INSPIRE catalogue, and readiness.
7) for others: atmospheric conditions in general are totally and partly inadequate.

The 19 inadequate characteristics

These results are also summarized in Table 5.2.3 where the availability indicator scores are now summed considering all the input data sets without

distinguishing the P02 characteristics.
This analysis shows that above 60% of the input data sets contributing to the monitoring of the Mediterranean Sea are totally and partly inadequate of the data set in terms of the INSPIRE Catalogue. Moreover above 40% of the input data sets contributing to the monitoring of the Mediterranean Sea are partly and totally inadequate for Policy Visibility, Delivery mechanism, Data Policy and Responsiveness.

60% of input data do not have an adequate INSPIRE Portal service

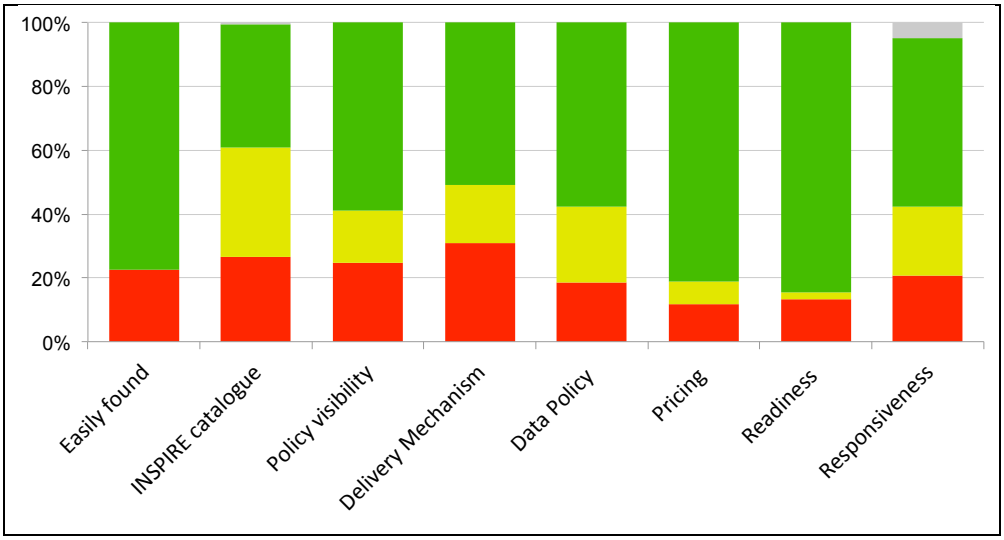


Table 5.2.3 Availability indicators scores in percentage over the total number of input data sets (266) present in the metadatabase.

5.3 Analysis of availability indicators for Copernicus and EMODnet services

A special analysis has been carried out specifically for the Copernicus and EMODnet Portals data sets. This is reported in Table 5.3.1.

EMODnet and Copernicus services assessment

Results indicate that CMEMS has a weak Data policy visibility especially for sea level products.

EMODnet Portals instead have:

1) not completely structured in a user-friendly EU-INSPIRE web portals
2) the Habitat Portal data fails on most of the availability scores

Table 5.3.1 Copernicus and EMODnet Portals availability indicator scores

Data set provider: Copernicus Marine environment monitoring service

P02 characteristics	Easily found	INSPIRE catalogue	Visibility of Data policy	Data delivery	Data policy	Pricing	Readiness	Responsiveness
Chlorophyll pigment concentrations in water bodies	4	4	4	4	1 3	4	4	4
Dissolved oxygen parameters in the water column	2	2	2	2	2	2	2	2
Horizontal velocity of the water column (currents)	4	4	4	4	4	4	4	4
Nutrient fluxes between the bed and the water column	2	2	2	2	2	2	2	2
Salinity of the water column	2	2	2	2	2	2	2	2
Temperature of the water column	2	2	2	2	2	2	2	2
Sea level	2	2	2	2	2	2	2	2

Data set provider: EMODnet

P02 characteristics	Easily found	INSPIRE catalogue	Visibility of Data policy	Data delivery	Data policy	Pricing	Readiness	Responsiveness
Bathymetry and Elevation	3	1 2	3	3	1 2	3	3	3
Depositional environment	3	3	3	3	3	3	3	1
Dissolved oxygen parameters in the water column	1	1	1	1	1	1	1	1
Habitat characterisation	2	1 1	1	1 1	1	1	2	1 1
Light extinction and diffusion coefficients	2	2	2	2	2	2	2	2
Nitrate concentration parameters in the water column	1	1	1	1	1	1	1	1
Phosphate concentration parameters in the water column	1	1	1	1	1	1	1	1

6. Analysis of monitoring system by appropriateness indicators

Monitoring system adequacy with appropriateness indicators

The appropriateness indicators, described in Section 3 and Annex 2, have been used to define the adequacy of the monitoring system for the different quality elements that compose the appropriateness territory. Here we discuss the results of the statistical analysis of the indicators for all the input data sets used in the Challenge products.

6.1 Analysis of appropriateness indicators across products

Using the Appropriateness indicators defined in Annex 2 for the Upstream data we can extract the characteristics that have negative appropriateness indicator values, i.e. they do not comply with the specifications given for the targeted product.

The appropriateness scores for the Upstream Data

As written in section 3, the scores are as follows:

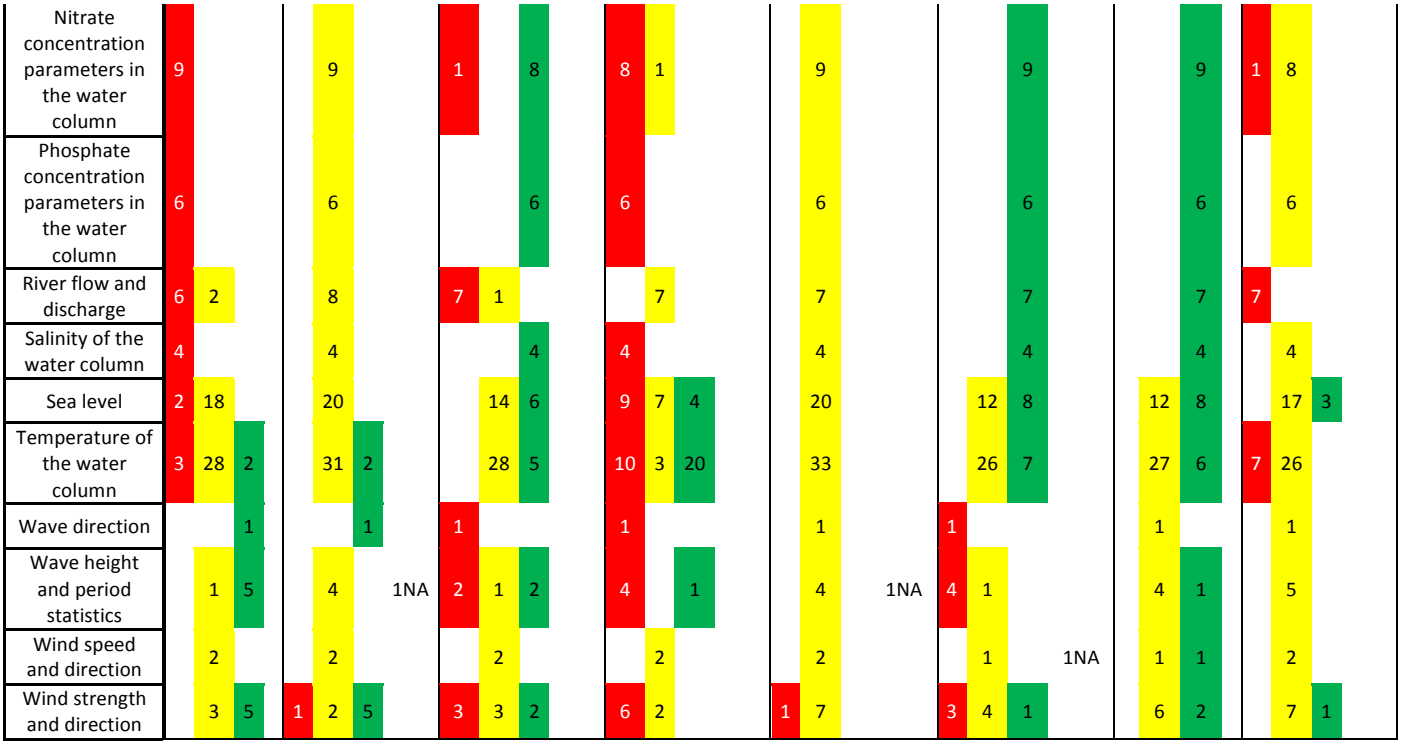
- **Red:** the Upstream Data (UD) have errors between -100% and -10% and urgent actions are required to provide datasets fit for use by the Challenges – **not adequate**
- **Yellow:** the UD have errors between -10% and +10% and can be considered quite appropriate and monitoring data are fit for use and should be maintained but also improved – **partly adequate**
- **Green:** the UD have errors between +10% and +100% and there is an 'over – offer', no need for further development –**totally adequate**

Only 90 data sets for appropriateness indicators

Only 90 of the potential 266 data sets, which cover only 29 of the P02 characteristic categories, are used in the Challenge products. Statistics is becoming a problem and results could be noisier than the assessment via availability indicators. Table 6.1 shows the scores across all Challenge products and their upstream data.

Table 6.1 Upstream data sets appropriateness indicators as a function of P02 across all Challenges. Numbers on the color scores indicate the number of Upstream Data that have that score thus giving an indication of the prevailing value.

List of P02 Characteristics related to input data sets	Horizontal Coverage UD.APE.1.1	Vertical Coverage UD.APE.1.2	Temporal Coverage UD.APE.1.3	Horizontal Resolution UD.APE.3.1	Vertical Resolution UD.APE.3.2	Temporal Resolution UD.APE.3.3	Thematic Accuracy UD.APE.3.4	Temporal Validity UD.APE.4.1
Administrative units	1 11 1	9 2 1 1NA	6 5 1NA	6 1 4 2NA	2 1 10NA	2 11NA	3 10	7 4 1 1NA
Air pressure	1	1	1	1	1	1	1	1
Bathymetry and elevation	3 3	2 4NA	2 4NA	2 4	1 5NA	6NA	3 3	1 4 1NA
Birds count	1	1NA	1	1	1NA	1NA	1	1
Chlorophyll pigment concentrations in water bodies	4	4	1 3	4	4	4	4	4
Coastal geomorphology	3	3	3	3	3	3	3	3
Concentration of suspended particulate material in the water column	2	2	2	2	2	2	2	2
Dissolved oxygen parameters in the water column	8	8	8	8	8	8	8	8
Dissolved total and organic nitrogen concentrations in the water column	2	2	1 1	2	2	2	2	2
Dissolved total or organic phosphorus concentration in the water column	1 2	3	1 1 1	3	3	3	3	3
Fish abundance in water bodies	1	1	1	1	1	1	1	1
Fish and shellfish catch statistics	4 2	6	3 3	6	6	6	6	4 2
Fishing by-catch	1	1	1	1	1	1	1	1
Habitat characterisation	2 2	1 2 1NA	1 1 2NA	4	4NA	4NA	2 2	4
Habitat extent	1 5	3 2 1	4 2	4 2	1 2 2 1NA	1 4 1NA	6	2 3 1
Horizontal platform movement	9 4	1 9 3	11 2	4 7 2	3 10	6 10	11 5	9 3 4
Horizontal velocity of the water column (currents	1 2	1 2	2 1	3	3	2 1	3	1 2
Light extinction and diffusion coefficients	1	1	1	1	1NA	1NA	1	1
Lithology	1 9	3 1 6	8 2	9 1	6 1 3	10	10	4 6
Man-made structures	1	1NA	1NA	1	1	1NA	1	1



We first note that some characteristic categories use only less than 5 upstream data sets for the analysis and this makes the results uncertain from a statistical point of view. The most frequent quality elements that score "not adequate" are:

1) horizontal coverage;
2) temporal coverage;
3) horizontal resolution;
4) temporal validity.

Prevailing monitoring system inadequacy

We apply now the same filter as for the availability indicators, i.e. we select only the characteristic categories that have at least 2 "overall" red scores among the appropriateness indicators. The "overall score" is defined as the score with largest number of occurrences for the specific P02 and indicator. The results of this analysis are shown in Table 6.2 and Table 6.3.

Over a total of 29 P02 characteristics used in the Challenge products, using the "overall score" filter and the minimum number of two red scores, 15 characteristics are not adequate with respect to appropriateness indicators at the scale of the Mediterranean Sea (Table 6.2 and 6.3).

Table 6.2 Upstream data sets appropriateness indicators as a function of P02 across all Challenges only for P02 that have more than 2 "overall" red scores in Table 6.1.

List of P02 Characteristics related to input data sets	Horizontal Coverage UD.APE.1.1	Vertical Coverage UD.APE.1.2	Temporal Coverage UD.APE.1.3	Horizontal Resolution UD.APE.3.1	Vertical Resolution UD.APE.3.2	Temporal Resolution UD.APE.3.3	Thematic Accuracy UD.APE.3.4	Temporal Validity UD.APE.4.1
1.Administrative units	1 11 1	9 2 1 1NA	6 5 1NA	6 1 4 2NA	2 1 10NA	2 11NA	3 10	7 4 1 1NA
2. Coastal geomorphology	3	3	3	3	3	3	3	3
3. Dissolved oxygen parameters in the water column	8	8	8	8	8	8	8	8
4. Fish abundance in water bodies	1	1	1	1	1	1	1	1
5. Fish and shellfish catch statistics	4 2	6	3 3	6	6	6	6	4 2
6. Fishing by-catch	1	1	1	1	1	1	1	1
7.Habitat extent	1 5	3 2 1	4 2	4 2	1 2 2 1NA	1 4 1NA	6	2 3 1
8. Horizontal platform movement	9 4	1 9 3	11 2	4 7 2	3 10	6 10	11 5	9 3 4
9. Lithology	1 9	3 1 6	8 2	9 1	6 1 3	10	10	4 6
10. Nitrate concentration parameters in the water column	9	9	1 8	8 1	9	9	9	1 8
11.Phosphate concentration parameters in the water column	6	6	6	6	6	6	6	6
12. River flow and discharge	6 2	8	7 1	7	7	7	7	7
13. Salinity of the water column	4	4	4	4	4	4	4	4
14. Wave direction	1	1	1	1	1	1	1	1
15. Wave height and period statistics	1 5	4 1NA	2 1 2	4 1	4 1NA	4 1	4 1	5

Table 6.3 List of 15 P02 characteristics that have at least two "overall scores" red, ordered in terms of inadequacy for the appropriateness indicators.

P02 Characteristics	# of Red scores	# of Yellow scores	# of Green scores	number of data sets
1. Administrative units	4	2	2	12
2. Horizontal platform movement	3	4	1	13
3. Lithology	3	1	4	10
4. River flow and discharge	3	3	2	8
5. Fish and shellfish catch statistics	3	2	2	6
6. Habitat extent	3	2	3	6
7. Coastal geomorphology	3	5	0	3
8. Fish abundance in water bodies	3	3	2	1
9. Wave direction	3	3	2	1
10. Nitrate concentration parameters in the water column	2	3	3	9

11. Dissolved oxygen parameters in the water column	**2**	**3**	**3**	**8**
12. Phosphate concentration parameters in the water column	**2**	**3**	**3**	**6**
13. Wave height and period statistics	**2**	**4**	**2**	**4**
14. Salinity of the water column	**2**	**3**	**3**	**4**
15. Fishing by-catch	**2**	**4**	**2**	**1**

6.2 Sensitivity analysis for the score ranges

As explained in Annex 3, the appropriateness indicator values represent range of "error" values for UD and TDP. Error values can have negative or positive sign. The negative values indicate an "under-fitting score, representing lower than expected quality elements for the Upstream Data while the positive value is an "over-fitting" score. In addition, errors where given as percentage over the DPS values, our reference measure of quality.

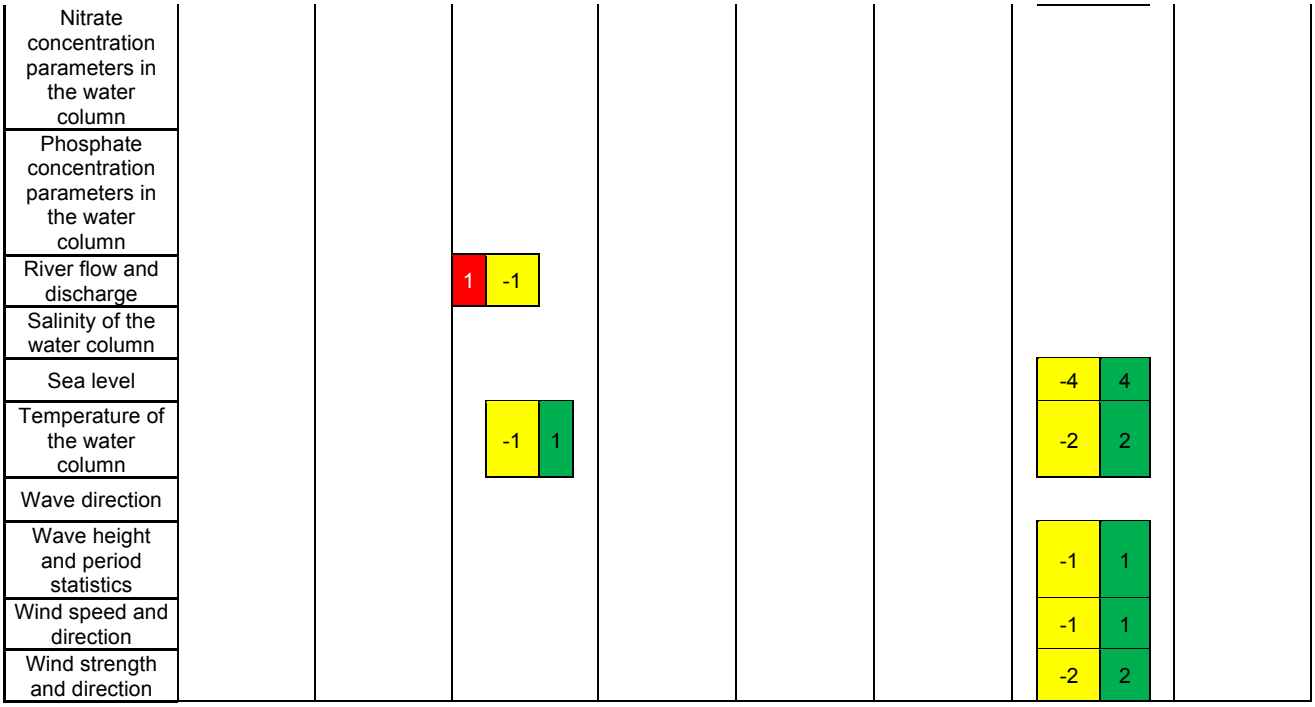
In the analysis of section 6.1 both the under-fitting and over-fitting scores have been saturated at ±100%. In order to associate indicator values to a range of error values, it was necessary to establish "thresholds" for the error values. Products with 'errors' within - ε % and + ε % with respect to DPS are 'appropriate' or at least partly adequate. Values smaller than - ε % are under-fitting and not adequate while values large than + ε % are over-fitting or totally adequate, and there is no need for further development in the data systems.
For a certain indicator value range, the colour is associated with the following meaning:

- **Red:** the UD have errors between -100% and - ε % and urgent actions are required to provide datasets fit for use by the Challenges – not adequate
- **Yellow:** the UD have errors between - ε % and + ε % and can be considered quite appropriate and monitoring data are fit for use and should be maintained but also improved – partly adequate
- **Green:** the UD have errors between + ε % and +100% and there is an 'over – offer', no need for further development –totally adequate

Section 6.1 documents the scores for ε = 10. We recomputed the indicator scores taking ε = 20 and the detailed results are shown in Annex 4.
The Table 6.4 shows the differences between the results of the appropriateness indicators as a function of P02 across all challenges for ε = 10 and ε = 20. To make visible the result, only the differences different from nil values are shown and the associated colours.

Table 6.4 Upstream data sets appropriateness indicators sensitivity experiment. The values in the Table indicate changes between the scores of Table 6.2 (obtained with errors in the range of $\pm 10\%$) and scores reported in Table A4.4 (obtained with errors in the range $\pm 20\%$).

List of P02 Characteristics related to input data sets	Horizontal Coverage UD.AP.1.1	Vertical Coverage UD.APE.1.2	Temporal Coverage UD.APE.1.3	Horizontal Resolution UD.APE.3.1	Vertical Resolution UD.APE.3.2	Temporal Resolution UD.APE.3.3	Thematic Accuracy UD.APE.3.4	Temporal Validity UD.APE.4.1
Administrative units			2 -2				-7 7	
Air pressure							-1 1	
Bathymetry and elevation							-2 2	
Birds count								
Chlorophyll pigment concentrations in water bodies								
Coastal geomorphology								
Concentration of suspended particulate material in the water column								
Dissolved oxygen parameters in the water column								
Dissolved total and organic nitrogen concentrations in the water column								
Dissolved total or organic phosphorus concentration in the water column								
Fish abundance in water bodies								
Fish and shellfish catch statistics							-6 6	
Fishing by-catch							-1 1	
Habitat characterisation							-2 2	
Habitat extent							-5 5	
Horizontal platform movement			2 -2				-10 10	
Horizontal velocity of the water column (currents								
Light extinction and diffusion coefficients							-1 1	
Lithology							-10 10	
Man-made structures							-1 1	



The sensitivity analysis to the score thresholds

It is evident that changes affect the score for the temporal coverage and the thematic accuracy indicators. We are interested to see if changing the threshold error value for the score some new inadequacy monitoring characteristics will appear. For thematic accuracy the scores go from yellow to green for many P02 characteristic categories, so this will not affect the final gap analysis.

For temporal coverage the score with 20% error limits adds three red scores for the P02 “Administrative Unit”, “Horizontal Platform movement” and ”River Flow and discharge”. However, as t can be seen from Table 6.3 this does not change the list of most inadequate characteristics. Thus we will continue to use the results obtained with errors in the range of $\pm 10\%$ since this is not affecting the general conclusions for gap analysis carried out in section 8.

6.3 Analysis of appropriateness indicators for Copernicus and EMODnet services

In this section we analyse the EMODnet and Copernicus service input data used in the Challenge products. Most common negative values are for the horizontal/vertical coverage and resolution indicators meaning that products are still too coarse to be satisfactory for the Challenge products and that coverage is still low, especially for the EMODnet datasets.

Table 6.5 P02 characteristics used by the Challenge products from EMODnet portals and most common indicator with negative scores

P02 Characteristic	Emodnet Portal	Used in:	Negative value Indicators
Administrative units	Habitats	MEDSEA_CH3_PRODUCT_2_3	
Bathymetry and Elevation	Bathymetry	MEDSEA_CH2_PRODUCT_6, MEDSEA_CH3_PRODUCT_2_2	Temporal coverage,
Dissolved oxygen parameters in the water column	EMODnet Chemistry	MEDSEA_CH6_Product_4	Horizontal Coverage Horizontal Resolution
Habitat characterisation	Seabed habitats	MEDSEA_CH3_PRODUCT_2_4	
Light extinction and diffusion coefficients	Seabed habitats	MEDSEA_CH2_PRODUCT_5	Temporal coverage,
Lithology	Seabed habitats	MEDSEA_CH5_Product_7, MEDSEA_CH5_Product_8, MEDSEA_CH5_Product_9, MEDSEA_CH5_Product_10	Vertical Coverage Temporal Coverage Horizontal Resolution Vertical Resolution
Nitrate concentration parameters in the water column	EMODnet Chemistry	MEDSEA_CH6_Product_5	Horizontal Coverage Horizontal Resolution
Phosphate concentration parameters in the water column	EMODnet Chemistry	MEDSEA_CH6_Product_6	Horizontal Coverage Horizontal Resolution

Table 6.6 P02 characteristics used by the Challenge products from Copernicus service and most common indicator with negative scores

P02 Characteristic	Used in:	Negative value Indicators
Chlorophyll pigment concentrations in water bodies	MEDSEA_CH6_Product_2, MEDSEA_CH6_Product_3, MEDSEA_CH6_Product_4,	
Horizontal velocity of the water column (currents)	MEDSEA_CH2_PRODUCT_4, MEDSEA_CH3_PRODUCT_2_7	Vertical Coverage, Horizontal Resolution, Temporal Validity
Sea level	MEDSEA_CH4_PRODUCT_4_1, MEDSEA_CH4_PRODUCT_4_2, MEDSEA_CH4_PRODUCT_4_3, MEDSEA_CH4_PRODUCT_4_4, MEDSEA_CH4_PRODUCT_5_1, MEDSEA_CH4_PRODUCT_11_1, MEDSEA_CH4_PRODUCT_11_2, MEDSEA_CH4_PRODUCT_11_3, MEDSEA_CH4_PRODUCT_11_4, MEDSEA_CH4_PRODUCT_12_1,	Horizontal Resolution
Temperature of the water column	MEDSEA_CH3_PRODUCT_2_6, MEDSEA_CH4_PRODUCT_2_1, MEDSEA_CH4_PRODUCT_2_2, MEDSEA_CH4_PRODUCT_2_3, MEDSEA_CH4_PRODUCT_3_1, MEDSEA_CH4_PRODUCT_9_1, MEDSEA_CH4_PRODUCT_9_2, MEDSEA_CH4_PRODUCT_9_3, MEDSEA_CH4_PRODUCT_10_1, MEDSEA_CH4_PRODUCT_10_2	Horizontal Resolution

7. Analysis of Challenge targeted products quality

In this section we will analyse and discuss the appropriateness indicators for 79 Challenge Targeted Product components (out of 45 products).

7.1 Evaluation of Targeted Products from appropriateness indicators

As for the availability indicators we will display here the scores for each indicators across all Challenges products.

Targeted product evaluation by indicators

The picture emerging from the TDP appropriateness indicators, shown in Fig. 7.1 is that:

1) most of the products have consistent quality with respect to the DPS requirements;
2) the largest TDP errors are linked to **inadequate horizontal coverage and resolution and to temporal validity**.

7.2 Evaluation of Targeted Products from expert opinion

Targeted product evaluation by expert opinion

The objective of this internal project survey is to provide an expert evaluation of the "fitness for purpose" of the Targeted Products. The coordinator asked the challenges teams to answer to the following points:

1. Assign an overall product quality score with respect to scope (fitness for purpose) and explain why according to the scale in Table 7.2.1.
2. Explain what is (are) the most important characteristic(s) for the Targeted Product quality (if all characteristics are important please say so);
3. Explain what is (are) the quality element(s) (see Annex 1) of the most important characteristic(s) that affects the Targeted Product quality;
4. Explain the limitations on the quality of Targeted products due to the input data set used;
5. Explain which characteristics "fails the most" to meet the scope of the Targeted Product;
6. Provide an expert judgement to describe for each Targeted Product the most important gaps in the input data sets.

SCORE	MEANING
1	EXCELLENT → it meets completely the scope of the Targeted Product
2	VERY GOOD → it meets more than 70% of the scope of the Targeted Product
3	GOOD → it meets less than 70% of the scope of the Targeted Product
4	SUFFICIENT → it does not really meet the scope but it is a starting point
5	INADEQUATE → it does not really fulfil the scope, not usable

Table 7.2.1 Targeted Products quality scores and their meaning.

The detailed answers to these questions are documented in Annex 5. Table 7.2.2 summarizes the quality scores given by the project experts. The Targeted products with lowest "fitness for purpose" are:

1. Challenge 5 (fishery management) products encountered the largest problems since of the data are not available at appropriate time.
2. Challenge 7 (river inputs) produced a low accuracy product since the quality of the input data is low.
3. Challenge 4 reported a lack of information on the sediment mass balance and gaps on the sea level data which do not allow to compute long time series directly from measurements so that only reconstructed time series are possible.
4. Challenge 2 faced the issue of assessing MPA connectivity at the whole basin scale where some crucial data sets are missing, i.e. larval behavior and spawning time. Furthermore the Challenge products are not based on a sound methodology yet. The assessment of MPA network representativeness is still an open research issue.

Challenge products problems

TP	CH1	CH2	CH3	CH4	CH5	CH6	CH7
1	1	2	3	2	3	2	2
2	1	1	2	3	4	2	2
3	1	3		1	5	4	2
4		4		3	4	4	2
5		3		1	4		5 2
6		4		4	3		2
7				5	4		5 2
8				2	4		2
9				3			4
10				1			
11				3			
12				4			
13				1			

Table 7.2.2 Summary of the quality scores associated to each Targeted Products according to the expert's evaluations.

Thus, in conclusion the monitoring system of the Mediterranean does not make possible to have "fit for purpose" products for at least six of seven Challenge products.

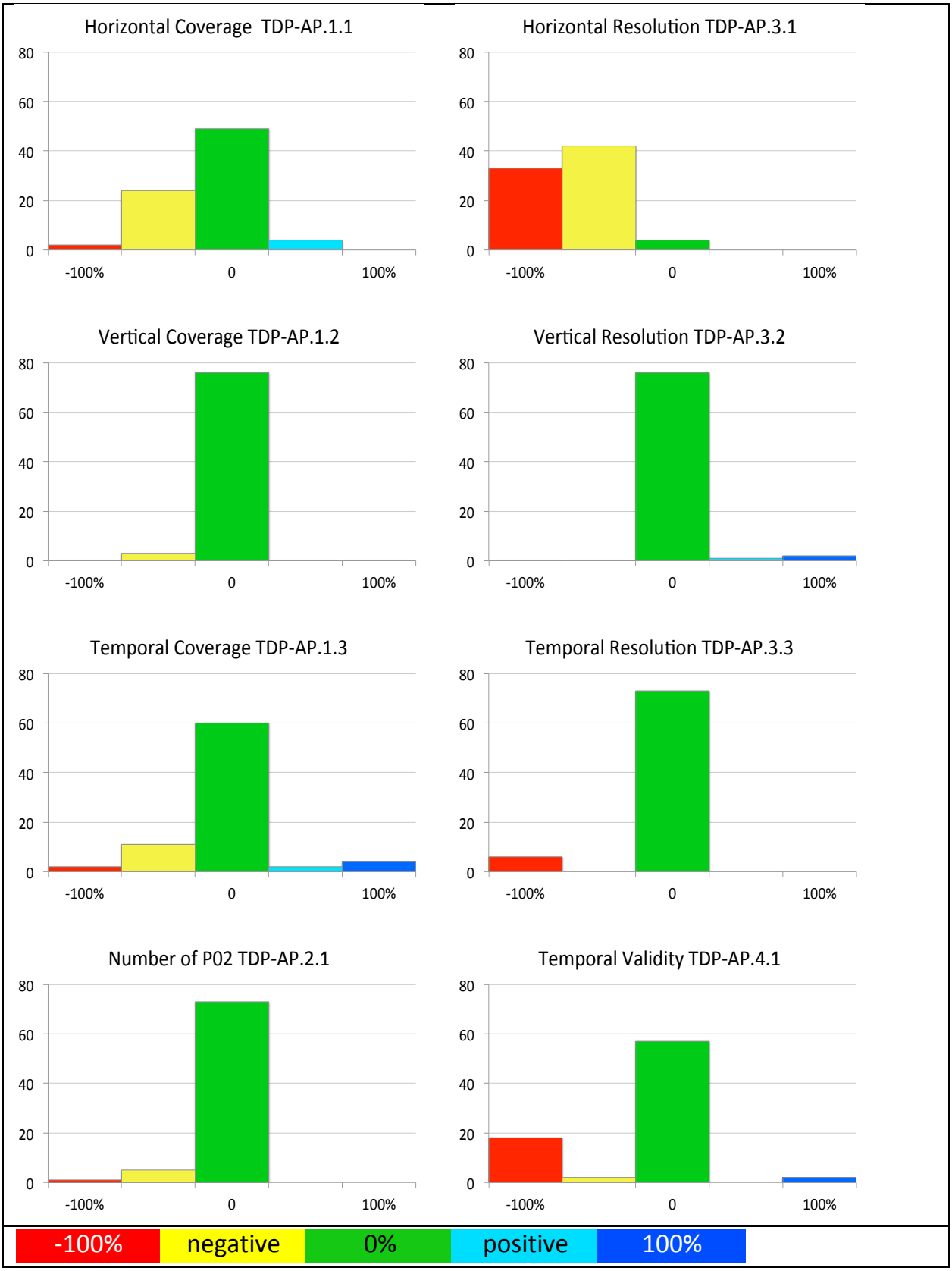


Figure 7.1: TDP appropriateness indicator score distributions (79 products).

8. Key gaps based on all indicators and expert opinions

Methodology to define monitoring gaps

Gaps of the monitoring system for the Mediterranean Sea are emerging from all the previous analyses and here we will try to make a synthesis of the findings from a combination of the availability and appropriateness indicators. Such a combination has been called in Annex 2 the “fitness for use” indicator and we devised also an algorithm to compute the scores.

Unfortunately the fitness for use indicator described in Annex 2 does not give rise to reasonable values probably because of the limited numbers of input data sets available that do not allow to compute properly the error standard deviations. As shown in Table 6.1, for the Targeted Products we have used 29 different characteristics for 90 input data sets, i.e. about 3 data sets per characteristics. Thus it is impossible to have a combined fitness for use indicator calculated with sufficient statistics.

The final DAR result: data inadequacy at the basin scale level

In order to distil the gaps from a combination of the two indicator territories, we made an inter-comparison between the inadequate P02 characteristic categories for the availability (see Table 5.2.2) and appropriateness indicators (see Table 6.3).

Table 8.1 The most inadequate P02 characteristics for the availability and appropriateness indicators. Colors indicate characteristics that are present in both the indicator territories

Not adequate for availability indicators	Not adequate for appropriateness indicators
Pollution events	Administrative units
Spectral wave data parameters	Horizontal platform movement
Fish and shellfish catch statistics	Lithology
Horizontal platform movement	River flow and discharge
Wave direction	Fish and shellfish catch statistics
Fishing by-catch	Habitat extent
Sedimentary structure	Coastal geomorphology
Marine archaeology	Fish abundance in water bodies
Bird reproduction	Wave direction
Wave height and period statistics	Nitrate concentration parameters in the water column
Habitat extent	Dissolved oxygen parameters in the water column
Fauna abundance per unit area of the bed	Phosphate concentration parameters in the water column
Fish abundance in water bodies	Wave height and period statistics
Marine environment leisure usage	Salinity of the water column
Air pressure	Fishing by-catch
Air temperature	
Atmospheric humidity	
Fish behaviour	
Fish reproduction	

The comparison between the inadequate characteristics for availability and appropriateness indicators is shown in Table 8.1 which is the final result of our DAR. We argue that gaps in the Mediterranean Sea monitoring system are identified by the **common inadequate characteristics between the negative scored characteristics in the two territories.**

The result is that 7 monitoring characteristics have inadequate scores for both availability and appropriateness. We group the 7 characteristics in 4 classes that are more relevant to show the gaps.

1. **the fishery data, composed of fish and shellfish catch, fish by-catch and fish abundance in the water column.** Many of the indicators are inadequate for both availability and appropriateness. The key **inadequate** quality attributes for this monitoring characteristics are: **visibility, EU INSPIRE catalogue, data policy visibility, readiness, data delivery and data policy, horizontal and temporal coverage, temporal validity**.

A synthesis of the indicators for this monitoring characteristics is given in Table 8.2

P02 Characteristics related to input data sets	Horizontal Coverage	Vertical Coverage	Temporal Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	Thematic Accuracy	Temporal Validity
Fish abundance in water bodies	1	1	1	1	1	1	1	1
Fish and shellfish catch statistics	4 2	6	3 3	6	6	6	6	4 2
Fishing by-catch	1	1	1	1	1	1	1	1
	Easily found	**INSPIRE catalogue**	**Visibility of Data policy**	**Data delivery**	**Data policy**	**Pricing**	**Readiness**	**Responsiveness**
Fish abundance in water bodies	2 1	2 1	2 1	3	3	3	3	1 2
Fish and shellfish catch statistics	6	6	2 4	4 2	6	6	6	6
Fishing by-catch	1	1	1	1	1	1	1	1

Table 8.2 Availability and appropriateness indicators for the P02 fishery management characteristics. The numbers in the cells corresponds to the number of data sets and the number of challenges that have used them in the evaluation.

It is to be noted that for the entire Mediterranean Sea only 6 data sets were available for fish catch statistics while only 1 data set is present for fishing by-catch.

The Challenge products that showed the gap in the Upstream data were:

MEDSEA_CH05_Product_1	Collated data set of landings by species and year, for mass and number
MEDSEA_CH05_Product_2	Collated data set of discards by species and year, for mass and number
MEDSEA_CH05_Product_3	Collated data set of bycatch by species and year, for mass and number

MEDSEA_CH_7_Product_9	Annual time series of Eels Production per country [tons]

1. **the habitat extent** characterization (Posidonia oceanica, Coralligenous and Maerl habitats, seabed sensible habitats) input data sets are also totally inadequate in terms of **Data Policy and Responsiveness, Vertical and horizontal coverage, temporal and horizontal resolution**.

A synthesis of the indicators for this monitoring characteristics is given in Table 8.3

P02 Characteristics related to input data sets	Horizontal Coverage	Vertical Coverage	Temporal Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	Thematic Accuracy	Temporal Validity
Habitat extent	1 5	3 2 1	4 2	4 2	1 2 2	1 4	6	2 3 1
	Easily found	INSPIRE catalogue	Visibility of Data policy	Data delivery	Data policy	Pricing	Readiness	Responsiveness
Habitat extent	1 16	2 1 14	6 11	12 5	10 1 6	17	1 16	11

Table 8.3 Availability and appropriateness indicators for the P02 habitat extent characteristics. The numbers in the cells corresponds to the number of data sets and the number of challenges that have used them in the evaluation.

The Challenge products that used upstream data sets for this characteristic are:

MEDSEA_CH02_Product_5	Representativity of habitats/species/other features. Combination of bathymetry, MPA, seagrass distributions, Cetaceans, light, habitats substrate, Natura sites
MEDSEA_CH05_Product_4	Impact of fisheries on the bottom from VMS data combined with seabed substrate and habitat vulnerability
MEDSEA_CH05_Product_5	Change level of disturbance from VMS data combined with seabed substrate and habitat vulnerability
MEDSEA_CH05_Product_6	Impact of fisheries on the bottom from AIS data combined with habitat vulnerability
MEDSEA_CH05_Product_7	Change level of disturbance from AIS data combined with seabed substrate and habitat vulnerability
MEDSEA_CH05_Product_8	Impact of fisheries on the bottom from Data Logger combined with seabed substrate and habitat vulnerability

1. **the wave height, period and direction** input data sets are totally **inadequate** because of negative scores for **visibility, INSPIRE Catalogue, Data Policy, Pricing, responsiveness, temporal coverage, horizontal and temporal resolution**

A synthesis of the indicators for this monitoring characteristics is given in Table 8.4

P02 Characteristics related to input data sets	Horizontal Coverage			Vertical Coverage			Temporal Coverage			Horizontal Resolution			Vertical Resolution			Temporal Resolution			Thematic Accuracy			Temporal Validity		
Wave direction			1			1	1			1			1			1				1			1	
Wave height and period statistics		1	5		4		2	1	2	4		1		4		4	1			4	1		5	
	Easily found			INSPIRE catalogue			Visibility of Data policy			Data delivery			Data policy			Pricing			Readiness			Responsiveness		
Wave direction	2		6	5	3		5	3		5	3		2	2	4	2	2	4	1	6	1	4	1	3
Wave height and period statistics	7		11	15	3		9	3		9	7	2	4	6	8	4	6	8	7	7	4	6	8	4

Table 8.4 Availability and appropriateness indicators for the P02 wind waves characteristics. The numbers in the cells corresponds to the number of data sets and the number of challenges that have used them in the evaluation.

The Challenge products that used upstream data sets for these two characteristics are:

MEDSEA_CH03_Product_1_1	OPL Bulletin released after a DG MARE request received by email on the 28th of July 2014, containing the notification of two oil leaks
MEDSEA_CH03_Product_2_1	OPL Bulletin released after the DG MARE alert received by email on the 10th of May 2016 about the following situation

2. **the Platform movement, i.e. maritime traffic** input data sets are totally **inadequate** because of negative scores for **visibility, INSPIRE Catalogue, responsiveness, horizontal and temporal coverage, temporal validity**

A synthesis of the indicators for this monitoring characteristics is given in Table 8.5

P02 Characteristics related to input data sets	Horizontal Coverage			Vertical Coverage			Temporal Coverage			Horizontal Resolution			Vertical Resolution			Temporal Resolution			Thematic Accuracy			Temporal Validity		
Platform movement	9	4		1	9	3	11	2		4	7	2	3	10			6	10		11	5	9	3	4
	Easily found			INSPIRE catalogue			Visibility of Data policy			Data delivery			Data policy			Pricing			Readiness			Responsiveness		
Platform movement	8			8			2	6		1	7		2	6		1	1	6	1	2	5	7	1	

Table 8.5 Availability and appropriateness indicators for the P02 Platform movement character characteristics. The numbers in the cells corresponds to the number of data sets and the number of challenges that have used them in the evaluation.

The Challenge products that used upstream data sets for this characteristic are:

MEDSEA_CH05_Product_4	Impact of fisheries on the bottom from VMS data combined with seabed substrate and habitat vulnerability
MEDSEA_CH05_Product_5	Change level of disturbance from VMS data combined with seabed substrate and habitat vulnerability
MEDSEA_CH05_Product_6	Impact of fisheries on the bottom from AIS data combined with habitat

	vulnerability
MEDSEA_CH05_Product_7	Change level of disturbance from AIS data combined with seabed substrate and habitat vulnerability
MEDSEA_CH05_Product_8	Impact of fisheries on the bottom from Data Logger combined with seabed substrate and habitat vulnerability

8.1 Expert opinion on sediment mass balance inadequate monitoring

The only product in the Mediterranean Sea Checkpoint that was not realizable was the Challenge 4 product:

"Spatial data layers for the sediment mass balance at the coast for the past 10 years, the past 50 years and the past 100 years"

The project expert group of Challenge 4 discussed the inadequacy of the input data sets that might have been used to realize the products if existing. The discussion is done by answering 6 questions (see Section 7.2) and here we report such discussion for the specific sediment mass balance product.

1) Question: Assign an overall product quality score with respect to scope (fitness for purpose) and explain why according to the scale in Table 7.2.1.
   As a result of the Checkpoint investigations, there is a lack of valid data on sediment mass-balance or coastal erosion-accretion at a basin level. The EUROSION dataset (that ended in 2004) provides a qualitative estimation of sediment mass balance coded as stable, eroded, or accreted, without being specific on time extent, methods and approaches used. Other available data from EMODnet Portal, Geology Portal or from the European Atlas of the Seas provide data (i.e. sediment type, deep-sea water bathymetries) that do not fulfil the minimum requirements for a sediment mass balance assessment and therefore **the overall product quality score is inadequate**, despite the challenge have explored the existence of alternative data sources and datasets described in the report entitled "D5.3.5.1 Sediment Mass Balance Data Assessment in the Mediterranean".
2) Explain what is (are) the most important characteristic(s) for the Targeted Product quality (if all characteristics are important please say so);
   There are no usable characteristics for generating this product.
3) Explain what is (are) the quality element(s) of the most important characteristic(s) that affects the Targeted Product quality
   To justify why we did not constructed the requested product, two approaches were addressed: (1) a specific survey to the national agencies dealing with coastal protection and (2) a scientific literature survey. In both cases the resulting datasets incorporates doubts about the quality of the exploitable characteristics.
4) Explain the limitations on the quality of Targeted products due to the input data set used;
   The main limitations of the resulting products relate to the type and nature of available data. Firstly, the specific surveys identified (i.e.

surveys originated from national agencies or scientific literature) a plethora of data sources that would be appropriate for the Tender request. However, in most cases this data is not visible, neither easily available. Additional analyses and supplementary effort would be needed to locate and access them, and determine their usefulness and value to address the Tender purposes or the potential use for non-expert users. The data from specific surveys indicate that in relation to spatial layers of sediment mass balance, adequate resolution can be obtained for only 10% of Mediterranean NUTS3 regions. Only 4 regions have adequate temporal resolution. We have discarded local studies that can provide time series at a specific location, but not at the scale requested by the tender. Secondly, the scientific literature survey carried out shows that despite the existence of numerous studies in the Mediterranean, they are usually local and with an incoherent frequency. In addition, very different methods are used and as a consequence, it is very difficult to use and compare the resulting data. Additionally, there is some concern on the representativeness of the locations surveyed for being used as NUTS3 regional indicators.

5) Explain which characteristics “fails the most” to meet the scope of the Targeted Product;

   Regarding to the limitations of this products, both the scientific literature survey and the specific surveys showed a persistent difference on the amount of data and its quality between countries and between the northern and southern coasts of the Mediterranean.

The literature survey done for the sediment mass balance data is available at the project web site:

http://www.emodnet-mediterranean.eu/portfolio/climate-coastal-protection/

for the product called MEDSEA_CH4_Product_7 .

9. Conclusions

This document describes the findings of the EMODnet Checkpoint investigation for the assessment of the basin scale monitoring system data adequacy in the Mediterranean Sea.

Monitoring system assessment methodology in other projects

Assessment of monitoring systems has been undertaken in the past for the Global Ocean Observing System (GOOS; http://www.goosocean.org/) and the European Seas (EuroGOOS, http://eurogoos.eu/) and it has started for basin-scale systems (TPOS, http://tpos2020.org/first-report/, AtlantOS, https://www.atlantos-h2020.eu/). However all these approaches are connected to intermediate users, i.e., ocean analysis and forecasting centres that produce more elaborated but still basic information about the ocean state, from physics to biochemistry. However an approach that tries to assess the upstream observing system by the quality of the end-user products is missing, desirable and timely.

EMODnet methodology

On the impetus of the EMODnet activities in Europe, DGMARE started an ambitious program, the EMODnet Checkpoint network, that, on the basis of the existing monitoring capabilities evaluates the quality of targeted products to define the monitoring "data adequacy" at the level of the European sub-basins, from the Arctic to the Black Sea, through the Mediterranean Sea among others.

The principles, ISO and INSPIRE

The Mediterranean Sea EMODnet Checkpoint project started at the end of 2013, together with the North Sea basin, and it developed a strategy for such an assessment. The work was undertaken following two basic principles:

1) use ISO standards to define the quality elements of the assessment;
2) use INSPIRE principles to make available intermediate and final results of the assessment.

Both principles guided the development of a system infrastructure that uses a well-defined vocabulary and a consistent metadata framework that can be used by multiple stakeholders (see Fig. 10.1). The Checkpoint Service has the main aim to produce reports, the so-called "Data Adequacy Reports", and this report is one of them, in particular the final one for the Mediterranean Sea. Hopefully in the future the reporting will be done regularly, with a report coming out yearly or bi-yearly (see recommendations).

The three components of the Checkpoint service

The information system infrastructure build in the EMODnet Mediterranean Sea Checkpoint is based upon three major pillars:

1) a structured metadatabase containing information about: a) input data sets from the monitoring system; b) targeted products description and outputs, all

in a standardized way;

2) a set of monitoring assessment indicators developed with ISO standards;
3) a dashboard for computation of indicator or product statistics from the information collected in the metadatabase.

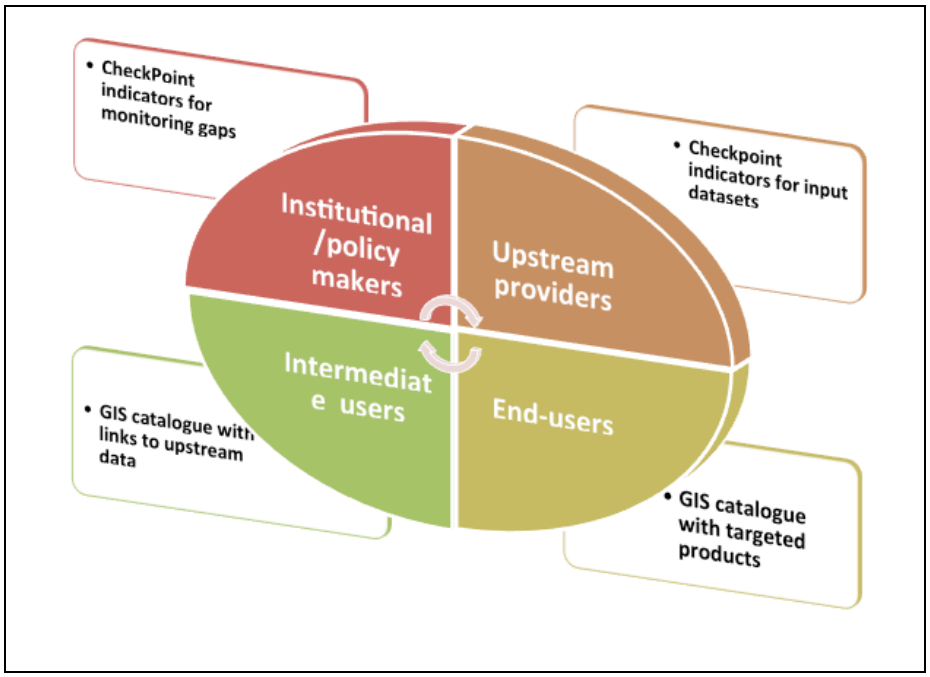


Fig. 10.1 The Checkpoint stakeholders and the relationship to Checkpoint services

The 266 potential input data sets

In the Mediterranean Sea information was collected for 266 input data sets, covering 47 different characteristics categories, 45 different Targeted products to satisfy 7 Challenges needs: CH1- Wind Farmi siting, CH2- Marine Protected Areas, CH3- Oil spill platform Leaks, CH4- Climate and coastal protection, CH5-Fishery management, CH6- Marine Environment, CH7-River inputs.

The final metadatabase is available here: http://www.emodnet-mediterranean.eu/browser/ where all the information about input data sets can be accessed.

The Targeted data products are instead available from each Challenge web page: http://www.emodnet-mediterranean.eu/challenges/

and a visualization service is available with the Sextant GIS Portal technology.

The dashboard is still under final revisions and will be ready soon here: http://www.emodnet-mediterranean.eu/checkpoint-dashboard-new/

To summarize, the results presented in this DAR are:

1) a detailed analysis of input data sets both as a function of Challenges and different characteristic categories (Annex 1 and Section 4 of this report).
2) a detailed analysis of indicators for input data sets from the two territories, the availability and the appropriateness (Annex 3 and 4 and Sections 5 and 6);
3) a detailed analysis of the quality of the Targeted products via indicators and expert opinion (Annex 5 and Section 7)
4) an analysis of basin monitoring gaps based upon indicators and expert opinions.

The overall results in this DAR

9.1 The monitoring system gaps

The monitoring system gaps

We first analyse the gaps separately for the availability and the appropriateness indicators, after we combine the two and we arrive to the common minimum denominator, i.e. the basic monitoring system gaps from the point of view of the Challenge products.

From the availability indicators of the 266 input data sets, we found that data adequacy is low for 19 categories of monitoring data at the basin scale. Sub-diving them into “themes” these not adequate characteristics are:

1) for geology: sedimentary structure data is totally inadequate in terms of Data Policy, Pricing and Readiness and partly inadequate for INSPIRE Catalogue and responsiveness;
2) for physics: wave data (spectra, wave height and direction) is totally inadequate for the visibility, the EU Catalogue and the Data Policy visibility;
3) for chemistry: pollutants in the water column (oil) are totally inadequate for almost all the availability indicators (7 over 8);
4) for biology: sea birds and fish characteristics (abundance, reproduction, behaviour) are totally inadequate for visibility, INSPIRE Catalogue and Data Policy Visibility;
5) for habitat: habitat extent is totally inadequate for Data Policy, Data delivery and and responsiveness;
6) for human activities: fish catch and by-catch, horizontal platform movement (maritime traffic), marine archaeology, marine environment leisure usage are totally inadequate for visibility, INSPIRE catalogue, and readiness.
7) for others: atmospheric conditions in general are totally and partly inadequate.

These results are also summarized in Table 5.2.2 where the availability indicator scores are now summed up considering all the input data sets

without distinguishing the P02 characteristics. The results show that above 60% of the input data sets contributing to the monitoring of the Mediterranean Sea for the seven Challenges are totally and partly **inadequate for the INSPIRE Catalogue indicator**. Moreover above 40% of the input data sets contributing to the monitoring of the Mediterranean Sea are partly and totally **inadequate for Policy Visibility, Delivery mechanism, Data Policy and Responsiveness**.

Using now the appropriateness indicators, over a total of 29 P02 characteristics used in the Challenge products, 15 (Table 6.2) are not adequate at the Mediterranean Sea basin scale. The most frequent quality elements that score "not adequate" are:

1) horizontal coverage;
2) temporal coverage;
3) horizontal resolution;
4) temporal validity.

From the combined availability and appropriateness point of view, the emerging gaps for the monitoring system at the basin scales, in view of the 7 prescribed Challenges, are:

1. **sediment mass balance monitoring data, the targeted product could not be done, data are only available in the literature and after the last EUROSION project, terminated in 2004, no INSPIRE catalogue and database was constructed from the data collected.**

2. **the fishery management data, such as fish catch and by-catch, are totally inadequate to cover the required targeted products needs from all the indicators point of view. The key inadequate quality attributes for this monitoring are: visibility, EU INSPIRE catalogue, data policy visibility, readiness, data delivery and data policy, horizontal and temporal coverage, temporal validity. Another major point is the scarcity of the data collected in 2 years search.**

3. **the habitat extent input data sets, such as Posidonia oceanica, Coralligenous and Maerl habitats, seabed sensible habitats, are totally inadequate in terms of Data Policy and Responsiveness, Vertical and horizontal coverage, temporal and horizontal resolution.**

4. **the wave height, period, direction and spectral parameters input data sets are totally inadequate because of negative scores for visibility, INSPIRE Catalogue, Data Policy, Pricing, responsiveness, temporal coverage, horizontal and temporal resolution.**

5. **The Maritime traffic (Platform movement) input data sets are totally**

inadequate because of negative scores for visibility, INSPIRE Catalogue, responsiveness, horizontal and temporal coverage, temporal validity

From the different expert opinions it emerges that many data sets that would be necessary and that are available are not yet ready to be "ingested" into the Challenge products because the data sets do not have an appropriate format. This does not emerge completely from the indicators because people have avoided from the beginning to list input data sets which they did not understand how to use.

9.2 Comparison of Mediterranean and North Sea Checkpoint conclusions

Comparison of MedSea and North Sea results

Following our Expert Panel advice we attempted a brief inter-comparison between the North Sea[10] and the Mediterranean Sea Checkpoint data adequacy analysis.
The North Sea Checkpoint reports that only 17% of the potential input data sets were used to meet the Challenges. In our case, the ratio is 90 over 266, i.e. 34% of potential upstream data sets were actually used for the Challenge products. The discrepancy between North Sea and Mediterranean input data sets is large but the common conclusion is that, as in the North Sea: "Such a falloff of appropriate data through the expert evaluation process indicates that, although there may not appear to be a data gap at first sight, the detailed analyses uncover gaps which do exist.". Furthermore we argue that the falloff of the input data sets could be due to insufficient QC/accuracy of the input data sets but it is impossible at this stage to say. The choice of a data set as input to a Challenge product is a matter also of reputation of data (expert knowledge on the input data set) and community assessments of data relevance and usability within the application domain (expert opinion). This point will require more attention in the future development of the Checkpoint framework for Europe.

The North Sea methodology is different

The North Sea Checkpoint did not use the same methodology as the Mediterranean Checkpoint and their evaluation of data gaps is done exclusively within each Challenge. Thus our results can be properly inter-compared only at the level of the analysis done in Section 7 of this report.

For the Mediterranean Sea, we have concluded in section 7 that the

[10] The North Sea Checkpoint Data Adequacy Report is available here: https://webgate.ec.europa.eu/maritimeforum/sites/maritimeforum/files/DLS0342-RT016-R01-00-unsecured.pdf

monitoring system does not make possible to have “fit for purpose” products for six out of the seven Challenges. The most problematic Challenges are “Fishery Management”, “Marine Protected Areas” and “Climate and coastal protection”.

North Sea Marine Environmenta Challenge was not met

For the North Sea, many of the Challenges were only partly met but in particular the “Marine Environment” Challenge was not met, at the contrary of the Mediterranean Sea where satellite chlorophyll data were used and the Challenge product was realized. This is due to the fact that, due to the high latitude location of the North Sea, satellite images cannot be used as efficiently as at lower latitudes to detect decadal trends due to cloud cover.

Both North Sea and MedSea Marine Environment Challenge were not met

Both Challenges did not find data to evaluate the “sediment mass balance” in Challenge “Climate and coastal protection”, so this is definitely a common characteristic monitoring gap. For many of the Challenges in the North Sea the gaps seem to concentrate on the biology and ecology in analogy with our findings where fishery data and habitats are two of the five main gaps.

The North Sea did not point out to “waves” and “horizontal platform movement” monitoring inadequacies and this might be due to the fact that: 1) the partners of the North Sea consortia have available waves and ship movement data because of their specific expertise and work in the field and 2) their products did not require specifically the same type of data sets. This problem could be solved in the future by increasing the number of Challenges and intercomparing the product quality.

Possible reasons for discrepancies

It is believed that even if discrepancies exist between the Checkpoint conclusions, the methodology to use Challenge products to find monitoring data inadequacy has proven to be effective in determining gaps in both the North Sea and Mediterranean Sea monitoring systems.

9.3 Recommendations and actions

We conclude our assessment with nine recommendations:

Recommendation 1: (critical action) include or develop new EMODnet like Portals for sediment mass balance and fishery data. Probably there is a need for a separate portal for a) fishery, b) hydrology and river loading. This recommendation is due to the fact that: 1) fishery data are totally inadequate for visibility, INSPIRE catalogue, and readiness; 2) hydrology and river loading are required to partially fill the gaps of sediment mass balance at the coasts.

The final nine recommendation from the MedSea Checkpoint

Recommendation 2: (critical action) improve the habitat and the wave data set availability from the existing EMODnet portals in close connection with Copernicus Marine Service and the satellite community.
This recommendation derives from the monitoring gap on waves and from the understanding that Copernicus has activated a new service in April 2017 to release wave data.

The final nine recommendation from the MedSea Checkpoint

Recommendation 3: (critical action) develop a metadata and data format system for maritime traffic data that will make possible to have ship traffic data available for the research community.
This recommendation derives from the monitoring gap extracted from Challenge 5, fishery impact assessment. A metadata system that will eliminate critical ship traffic information (i.e. ship name or other private/commercial information) but make available the data both in real time and delayed mode, will make possible to understand impact of fisheries and thus to solve a major data gap for the Mediterranean Sea.

Recommendation 4: (critical action) invest in the development of a new monitoring strategy for the sediment mass balance at the basin scales, keeping however local relevance. Key elements of such new sediment mass balance strategy could include the integration of satellite with situ measurements and the fusion of coastal morphodynamics modelling and predictions with observations.
This recommendation derives from the sediment mass balance monitoring gap emerged from the DAR.

The final nine recommendation from the MedSea Checkpoint

Recommendation 5: develop INSPIRE compliant transformation services connected to the EMODnet Portals, in particular investigate what stakeholders needs and have Challenges use the same data set in a multidisciplinary setting.
This recommendation derives from the fact that EMODnet Portals and Copernicus Services are only partially INSPIRE compliant and a consistent portion of the upstream data sets from the EMODnet Portals were scored inadequate for the specific INSPIRE catalogue indicator (Table 5.3.1). Furthermore the uptake from the Challenges was limited and transformation services would increase the usage of data.

The final nine recommendation from the MedSea Checkpoint

Recommendation 6: “operationalize” the data collection for sediment and fishery data sets, since most of the negative appropriateness scores arise from “temporal validity”. Data sets should be continuously updated and maintained and this can be done only with an operational service providing periodic upgrades.

Recommendation 7: Connect EMODnet Portals to EU projects to act as

a repository of all data collected and produced by H2020 and future research programs.
The DAR results show that the majority of the data producers for Challenge products are EU Framework projects (shown in the Literature Report[11]) and these data should be made available for re-use through the EMODnet Portals. In addition it is necessary to increase the data collection initiatives in European and Interreg projects.

The final nine recommendation from the MedSea Checkpoint

Recommendation 8: make partnerships with the atmospheric observing and forecasting community (World Meteorological Organization-WMO) that has developed a global infrastructure and protocols for data sharing, recently including hydrology. Coupling the sediment flux measurements to such existing infrastructure could accelerate the effective remediation of the sediment mass balance data gap.
This recommendation derives from the sediment mass balance gap, starting from a potential existing data sharing infrastructure.

Recommendation 9: Further develop the monitoring assessment framework developed in the Checkpoints as an authoritative network service to assess periodically the monitoring systems at the six European marine basin scales. Harmonization of methods between sea basin Checkpoints will be required. The continuation of the Checkpoint network will allow to increase the statistical database, achieve credibility in the indicator analysis, upgrade the system with new indicators chosen by end-users.

Possible actions in the short to medium time range (2017-2020):

The suggested critical actions

Action 1: develop a new data access system for fishery data that will be research based and that will harmonize the data collection protocols and the data analysis systems.

Action 2: start a new R&D initiative for the planning and implementation of a monitoring and data access system for hydrology and sediment load at the coasts, as well as sediment bottom structure and composition. Such system should be based upon a basic satellite observing system for the rivers and coastal areas coupled to an in situ advanced monitoring/calibration/validation observational network and a morphodynamics modelling system.

Action 3: enlarge the activities of the Habitat and Physics EMODnet Portals in terms of: 1) new data collection programs with open and free data policy; 2) assembly of wave data.

[11] The Mediterranean Sea Literature Report is available here: http://www.emodnet-mediterranean.eu/reports_news/

Action 4: join forces with JRC and other authoritative Institutions for maritime traffic data and develop tools and methods for incorporating these data in Challenges 1,2,3 and 5.

Action 5: Produce multiple format products and more value added products (“easier to ingest”) from EMODnet Portals as well as Copernicus service.

Action 6: form a Checkpoint steering committee that will distil the harmonized Checkpoint infrastructure that should emerge as a service that will go hand-in-hand with the EMODnet Portals and the CMEMS future developments.

Action 7: provide a user consultation Forum for the choice of Challenge products, the requirements for the products and the choice of assessment indicators.

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