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

EMODNET MedSea CheckPoint

Annex 2 to the Second DAR:
APPROPRIATENESS INDICATOR DEFINITIONS

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Workpackage	**11**	Annex 2 TO DAR
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1. Introduction

This Annex presents the Quality Elements (QE) composing the appropriateness indicators and the indicator of "Fitness for Use" for the input data sets.

After a list of Targeted products is presented, the appropriateness methodology is introduced followed by the description of the chosen ISO Quality Elements.

2. Mediterranean Checkpoint Targeted Products

The Mediterranean Sea Checkpoint has developed 45 Targeted Products out of the 7 Challenges. The Targeted Products and their components are listed in Table A2.1, A2.2 and A2.3. All products are available from the EMODnet MedSea Checkpoitn web page at:

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

Table A2.1 Targeted product nomenclature, content and format for Challenges 1,2,3

N. of TPs	Targeted Product name	Content of components	Format
Challenge 1: Wind farm siting			
3	**MEDSEA_CH1_Product_1**	Wind and wave data set from MARINA project	shapefile
	MEDSEA_CH1_Product_2	Suitability index of a wind farm in the NWMed concerning the environmental resources	shapefile
	MEDSEA_CH1_Product_3 Suitability index of a wind farm in the NWMed concerning the environmental resources, the natural barriers, human activities, MPA and fisheries	**MEDSEA_CH1_Product_3_1** Wind Impact	shapefile
		MEDSEA_CH1_Product_3_2 Impact of the natural resources on the total suitability index for offshore wind farm siting	
Challenge 2: Marine protected areas			
6	**MEDSEA_CH2_Product_1**	Med protection initiatives (management and conservation areas)	Excel files
	MEDSEA_CH2_Product_2	Med conservation areas and depth zones	shapefile
	MEDSEA_CH2_Product_3	Proposed regional conservation areas in the Mediterranean	shapefile
	MEDSEA_CH2_Product_4	Qualitative analysis of connectivity between MPAs	shapefile
	MEDSEA_CH2_Product_5	Representativity of habitats/species/other features	shapefile
	MEDSEA_CH2_Product_6	The monitoring capacity of biodiversity in MPAs	shapefile
Challenge 3: Oil platform leaks			
2	**MEDSEA_CH3_Product_1** Oil Platform Leak Bulletin released after	**MEDSEA_CH03_Product_1_1** Oil leak forecast	pdf

	a DG MARE request received by email on the 28th of July 2014	**MEDSEA_CH03_Product_1_2** Impact on the coastal environment	
	MEDSEA_CH3_Product_2 Oil Platform Leak Bulletin released after the DG MARE alert received by email on the 10th of May 2016	**MEDSEA_CH03_Product_2_1** Oil leak forecast	pdf
		MEDSEA_CH03_Product_2_2 Impact on the coastal environment	

Table A2.2 Targeted product nomenclature, content and format for Challenge 4

N. of TP	Targeted Product name	Content of components	Format
Challenge 4: Climate and coastal protection			
13	**MEDSEA_CH4_Product_1** Spatial layers of Sea surface temperature trend from observations (HadISST dataset) over periods of 10 (2003-2012), 50 (1963-2012) and 100 (1913-2012) years. Basin maps and NUTS3 region are considered.	**MEDSEA_CH4_Product_1_1** 10 years (2003-2012) basin map	shapefile
		MEDSEA_CH4_Product_1_2 50 years (1963-2012) basin map	
		MEDSEA_CH4_Product_1_3 100 years (1913-2012) basin map	
		MEDSEA_CH4_Product_1_4 10 years (2003-2012) NUTS map	
		MEDSEA_CH4_Product_1_5 50 years (1963-2012) NUTS map	
		MEDSEA_CH4_Product_1_6 100 years (1913-2012) NUTS map	
	MEDSEA_CH4_Product_2 Spatial layer of Sea temperature trend at mid-depth and at sea-bottom from reanalysis (CMEMS Mediterranean Physics Reanalysis) over period of 10 (2003-2012) years	**MEDSEA_CH4_Product_2_1** 10yrs basin trend at mid-water	shapefile
		MEDSEA_CH4_Product_2_2 10yrs basin trend at the sea bottom	
		MEDSEA_CH4_Product_2_3 10yrs NUTS3 trend at the sea bottom	
	MEDSEA_CH4_Product_3 Spatial layer of Sea internal energy trend from reanalysis (CMEMS Mediterranean Physics Reanalysis) over period of 20 (1993-2012) years	**MEDSEA_CH4_Product_3_1** 20yrs basin trend at the surface	shapefile
		MEDSEA_CH4_Product_3_2 20yrs NUTS3 trend at the surface	
	MEDSEA_CH4_Product_4 Spatial layers of sea level trend from CMCC reconstruction over periods of 50 years (1963-2012) and 100 years (1913-2012)	**MEDSEA_CH4_Product_4_1** 50yrs basin trend	shapefile
		MEDSEA_CH4_Product_4_2 100yrs basin trend	
		MEDSEA_CH4_Product_4_3 50yrs NUTS3 trend	
		MEDSEA_CH4_Product_4_4 100yrs NUTS3 trend	
	MEDSEA_CH4_Product_5 Spatial layer of sea-level trend from AVISO reconstruction over period of 10 years (2003-2012)	**MEDSEA_CH4_Product_5_1** 10yrs basin trend	shapefile
		MEDSEA_CH4_Product_5_2 10yrs NUTS3 trend	
	MEDSEA_CH4_Product_6 Spatial layers of sea–level trend from PSMSL tide-gauges over periods of 50 years (1963-2012) and 100 years (1913-2012)	**MEDSEA_CH4_Product_6_1** 50yrs location trend	shapefile
		MEDSEA_CH4_Product_6_2 100yrs location trend	
		MEDSEA_CH4_Product_6_3 50yrs NUTS3 trend	
		MEDSEA_CH4_Product_6_4 100yrs NUTS3 trend	

MEDSEA_CH4_Product_7 Sediment Mass Balance at the Coast from Experts Survey and Scientific Literature Review	**MEDSEA_CH4_Product_7_1** Sediment Mass Balance at the Coast from Experts Survey and Scientific Literature Review	pdf
	MEDSEA_CH4_Product_7_2 Sediment Mass Balance at the Coast from Experts Survey and Scientific Literature Review (10 years)	
	MEDSEA_CH4_Product_7_3 Sediment Mass Balance at the Coast from Experts Survey and Scientific Literature Review (50 years)	
MEDSEA_CH4_Product_8 Time series of annual average sea surface temperature from observations (HadISST dataset) over periods of 10 years (2003-2012), 50 years (1963-2012) and 100 years (1913-2012)	**MEDSEA_CH4_Product_8_1** 10yrs basin average at the surface	jpg
	MEDSEA_CH4_Product_8_2 50yrs basin average at the surface	jpg
	MEDSEA_CH4_Product_8_3 100yrs basin average at the surface	jpg
	MEDSEA_CH4_Product_8_4 10yrs NUTS3 average at the surface	excel file
	ME**DSEA_CH4_Product_8_5** 50yrs NUTS3 average at the surface	excel file
	MEDSEA_CH4_Product_8_6 100yrs NUTS3 average at the surface	excel file
MEDSEA_CH4_Product_9 Time series of annual average sea temperature at mid-depth and sea-bottom from reanalysis (CMEMS Mediterranean Physics Reanalysis dataset) over period of 10 years (2003-2012)	**MEDSEA_CH4_Product_9_1** 10yrs basin average at mid-water	jpg
	MEDSEA_CH4_Product_9_2 10yrs basin average at the sea-bottom	jpg
	MEDSEA_CH4_Product_9_3 10yrs NUTS3 average at the sea-bottom	excel file
MEDSEA_CH4_Product_10 Time series of annual average sea internal energy from reanalysis (CMEMS Mediterranean Physics Reanalysis dataset) over period of 20 years (1993-2012)	**MEDSEA_CH4_Product_10_1** 20yrs basin annual average of internal energy	jpg
	MEDSEA_CH4_Product_10_2 20yrs NUTS3 annual average of internal energy	excel file
MEDSEA_CH4_Product_11 Time series of annual average sea level from CMCC reconstruction over periods of 50 years (1963-2012) and 100 years (1913-2012)	**MEDSEA_CH4_Product_11_1** 50yrs basin average (1963-2012)	jpg
	MEDSEA_CH4_Product_11_2 100yrs basin average (1913-2012)	jpg
	MEDSEA_CH4_Product_11_3 50yrs NUTS3 average (1963-2012)	excel file
	MEDSEA_CH4_Product_11_4 100yrs NUTS3 average (1913-2012)	excel file
MEDSEA_CH4_Product_12 Time series of annual average sea level from PSMSL time-gauges over periods of 50 years (1963-2012) and 100 years (1913-2012)	**MEDSEA_CH4_Product_12_1** 50yrs NUTS3 average (1963-2012)	jpg
	MEDSEA_CH4_Product_12_2 100yrs NUTS3 average (1913-2012)	jpg
MEDSEA_CH4_Product_13 Time series of annual average sea-level from AVISO satellite altimetry over period of 10 years (2003-2012)	**MEDSEA_CH4_Product_13_1** 10yrs basin average (2003-2012)	jpg
	MEDSEA_CH4_Product_13_2 10yrs basin average (2003-2012)	excel file

Table A2.3 Targeted product nomenclature, content and format for Challenge 5,6,7

N. of TP	Targeted Product name	Content of components	Format
Challenge 5: Fisheries management			
8	**MEDSEA_CH5_Product_1** Collated data set of fish landings by species and year, for mass and number	**MEDSEA_CH5_Product_1_1**	excel file
	MEDSEA_CH5_Product_2 Collated data set of fish discards by species and year, for mass and number	**MEDSEA_CH5_Product_2_1**	excel file
	MEDSEA_CH5_Product_3 Collated data set of fish bycatch by species and year, for mass and number	**MEDSEA_CH5_Product_3_1**	excel file
	MEDSEA_CH5_Product_4 Impact of fisheries on the bottom from VMS data combined with habitat vulnerability	**MEDSEA_CH5_Product_4_1**	shapefile
	MEDSEA_CH5_Product_5 Change level of disturbance from VMS data combined with habitat vulnerability	**MEDSEA_CH5_Product_5_1**	shapefile
	MEDSEA_CH5_Product_6 Impact of fisheries on the bottom from AIS data combined with habitat vulnerability	**MEDSEA_CH5_Product_6_1**	shapefile
	MEDSEA_CH5_Product_7 Change level of disturbance from AIS data combined with habitat vulnerability	**MEDSEA_CH5_Product_7_1**	shapefile
	MEDSEA_CH5_Product_8 Impact of fisheries on the bottom from Data Logger combined with habitat vulnerability	**MEDSEA_CH5_Product_8_1**	shapefile
Challenge 6: Marine environment			
4	**MEDSEA_CH6_Product_1** Maps of Chlorophyll concentration seasonal climatologies (i.e., Winter, Spring, Summer, and Fall) over the Mediterranean Sea relative to the period 1998-2009.	**MEDSEA_CH6_Product_1_1**	jpg
	MEDSEA_CH6_Product_2 Map of Chlorophyll concentration trend over the Mediterranean Sea, relative to the period 1998-2009, expressed as percent of variation respect to the climatological field	**MEDSEA_CH6_Product_2_1**	jpg
	MEDSEA_CH6_Product_3 Maps of average TRIX indices calculated from Mediterranean Sea surface data for the periods 2008-2012, 1998-2002, and 1993-1997	**MEDSEA_CH6_Product_3_1**	pdf
	MEDSEA_CH6_Product_4 Maps showing differences between most	**MEDSEA_CH6_Product_4_1**	pdf

	recent TRIX estimates (2008-2012) and TRIX from the earlier periods 1998-2002 and 1993-1997		
Challenge 7: River Inputs			
9	**MEDSEA_CH7_Product_1** Annual time series of Water Discharge (Qw) [m3/s]	**MEDSEA_CH7_Product_1_1** RivDIS, SESAME, CISL	excel file
		MEDSEA_CH7_Product_1_2 E-HYPE daily	
	MEDSEA_CH7_Product_2 Monthly time series of Water Discharge (Qw) [m3/s]	**MEDSEA_CH7_Product_2_1** RivDIS, SESAME, CISL	excel file
		MEDSEA_CH7_Product_2_2 E-HYPE daily	
	MEDSEA_CH7_Product_3 Annual time series of TSM from satellite data	**MEDSEA_CH7_Product_3_1**	excel file
	MEDSEA_CH7_Product_4 Monthly time series of TSM from satellite data	**MEDSEA_CH7_Product_4_1**	excel file
	MEDSEA_CH7_Product_5 Annual time series of Total Nitrogen [mg/l]	**MEDSEA_CH7_Product_5_1**	excel file
		MEDSEA_CH7_Product_5_2	
	MEDSEA_CH7_Product_6 Monthly time series of Total Nitrogen from model data [mg/l]	**MEDSEA_CH7_Product_6_1**	excel file
	MEDSEA_CH7_Product_7 Annual time series of Total Phosphorous/Phosphates [mg/l]	**MEDSEA_CH7_Product_7_1** SESAME	excel file
		MEDSEA_CH7_Product_7_2 particulate	
	MEDSEA_CH7_Product_8 Monthly time series of Total Phosphorous from model data [mg/l]	**MEDSEA_CH7_Product_8_1**	excel file
	MEDSEA_CH7_Product_9 Annual time series of Eels production[tons]	**MEDSEA_CH7_Product_9_1**	excel file
45	**Total number of products**		

2. The appropriateness assessment methodology

The basic methodology for appropriateness assessment is based upon specific **metadata information and measures** associated to quality elements. Metadata information is related to:

1) the Data Product Specification (DPS);

2) the Targeted Data Product (TDP) description;

3) the Upstream Data (UD) used in the TDP.

The assessment methodology consists of two fundamental steps: the first is the choice of the **quality measures** that characterize DPS, TDP and UD and the second the definition of the **appropriateness indicators** based upon the quality measures.

2.1 Data Product Specification and Targeted Product Description nomenclature

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" (ISO 19131:2007). In our work, the "dataset" will be called "product" in order not to confuse this with the input datasets required to produce the Challenge Targeted products.

The DPS is a precise technical description of the product in terms of the requirements that it will or may fulfil. The TDP is along the same lines of the DPS but containing a precise technical description of the actual product developed. While the DPS only defines how the product should be, the TDP specifies how it was actually developed. In the Mediterranean CheckPoint the DPS and TPD metadata information will be created for each Challenge using the ISO 19131:2007 specifications, the ISO1957: 2013 Data Quality and the ISO 19115 : 2014.

2.2 Upstream Data specification nomenclature

The Mediterranean Checkpoint will use the DPS and TDP metadata information to assess the adequacy of the input data sets or Upstream Data (UD) that compose the "monitoring" of the Mediterranean Sea at the basin scale.

UD will then be classified on the basis of the same quality elements of the TDP and DPS, continuing the work started in the metadata base of input data sets required by the Challenges. The selection of input data sets was derived from expert specifications of data need for Challenges products required by the tender. The content of the Checkpoint metadatabase is strongly linked to the specific Challenges chosen by the DGMARE call for tender and the expert opinion.

2.3 Appropriateness quality elements

The Data Product Specifications (DPS), Targeted Product Description (TPD) and Upstream Data (UD) quality elements information contain “measures” of ISO quality elements that will allow the construction of the final list of **appropriateness indicators**. The quality elements **chosen for the Mediterranean Checkpoint** are:

- ✓ For spatial information
  - **Completeness** of the horizontal or vertical coverage **extent** (for a given resolution) (2 elements)
  - **Accuracy** of the horizontal or vertical **resolution** (or sampling interval) (2 elements)
- ✓ For time information
  - **Completeness** of the temporal coverage extent (for a given resolution)
  - **Accuracy** of the temporal **resolution** (or sampling interval)
  - **Temporal quality** of data with respect to time of update
- ✓ For thematic information
  - **Consistency** : list of the characteristics composing the product
  - **Accuracy:** of the characteristic thematic accuracy with respect to “standards”

Conceptual consistency is a quality element valid only for the DPS and TDP. In total we have 8 quality elements common to DPS, TDP and UD.

For each quality element, physical “measure units” have been defined and they are presented in the Table A2.4.

Table A2.4 Quality Elements for DPS, TPD and UD: definition of measures

	ISO Quality element			DPS, TPD, UD Quality Measure definitions			
QE #	**ISO Quality element**	**ISO sub-element**	**ISO definitions**	**Identification of appropriatness measures**	**MedCKP name of quality measure**	**MedCKP definition of quality measure**	**Units of quality measure**
1	Completeness	Omission	Data absent from a data set	XXX.AP.1.1	Horizontal Spatial Coverage	Horizontal coverage extent of product (eg: surface of the Mediterranean Sea covered by the product or by the input data set)	km**2
2	Completeness	Omission	Data absent from a data set	XXX.AP.1.2	Vertical Spatial Coverage	Vertical coverage extent of product or the input data set	metres
3	Completeness	Omission	Data absent from a data set	XXX.AP.1.3	Temporal Coverage	Temporal coverage extent of product or the input data set	days
4	Logical consistency	Conceptual consistency	Adherence to rules of the conceptual schema	XXX.AP.2.1	Number of Characteristics (only for DPS and TDP)	Number of characteristics in product (not applicable to input data set)	integer
5	Thematic accuracy	Classification correcteness	Comparison of classes	XXX. AP.3.1	Horizontal resolution	Averaged horizontal mesh	metres

			assigned to features or their attributes to universe of discourse (ground truth or reference data)			size or equivalent value for the given scale of product or input data set(eg 50m for 1/50 000)	
6	Thematic accuracy	Classification correcteness	Comparison of classes assigned to features or their attributes to universe of discourse (ground truth or reference data)	XXX.AP.3.2	Vertical resolution	Average vertical sampling and description of specific vertical sampling schema of the product or the input data set (100 words max)	metres " _" text
7	Thematic accuracy	Classification correcteness	Comparison of classes assigned to features or their attributes to universe of discourse (ground truth or reference data)	XXX.AP.3.3	Temporal resolution	Temporal sampling interval of product or input data set	days (real number, i.e. 1 hour is equal to 0.04167)
8	Thematic accuracy	quantitative attribute accuracy	Closeness of the value of a quantitative attribute to value accepted as or known to be true	XXX.AP.3.4	Thematic accuracy	Percentage error of the TPD or UD beyond the accuracy of the DPS and description of error concept for the product or the input data set (100 words max) provided by expert	percentage " _" text
9	Temporal quality	temporal validity	validity of data with respect to time	XXX. AP.4.1	Temporal validity	Max elapsed time between last input data records update and product creation date	days

The identification of the appropriateness is composed by characters (XXX) indicating the DPS (Data Product Specification) or TPD (targeted Product Description) or UD (Upstream Data - the Input data set), then by AP (appropriateness), followed by a first number indicating the quality element and by a second number indicating the sub-element:

- Example 1: DPS.AP.1.1 indicating the horizontal spatial coverage of the 'ideal' product'.
- Example 2: TPD.AP.1.1 indicating the horizontal spatial coverage of the product as realized by the Challenge.
- Example 3: UD.AP.1.1 indicating the horizontal coverage of the input data set to the specific product.

3. Appropriateness indicators definition

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

“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.

Considering this concept of “errors”, for every TDP and UD quality elements (QE), we can write:

$$\mathrm{QE_{TDP}} = \mathrm{QE_{DPS}} \pm \varepsilon_{\mathrm{TDP}} \qquad (1)$$

$$\mathrm{QE_{UD}} = \mathrm{QE_{DPS}} \pm \delta_{\mathrm{UD}} \qquad (2)$$

where ε, δ are the errors with respect to the specifications given in the DPS QE. These errors can be positive or negative depending if the product or the upstream data quality element are sufficient with respect to the DPS requirements while errors are negative if the QE is deficient with respect to specifications.

An appropriateness indicator for a specific QE can then be defined on the basis of these errors:

$$\varepsilon_{\mathrm{TDP}} = \mathrm{sign}\,(\mathrm{QE_{TDP}} - \mathrm{QE_{DPS}}) \qquad (3)$$

$$\delta_{\mathrm{UD}} = \mathrm{sign}\,(\mathrm{QE_{UD}} - \mathrm{QE_{DPS}}) \qquad (4)$$

where the “sign” function here is defined in order to have the negative values for the different QE errors represent lower than expected values and the opposite for positive values. Errors will be expressed as percentage errors, i.e.:

$$\varepsilon_{TDP}^{\%} = 100\left(\frac{\varepsilon_{\mathrm{TDP}}}{\mathrm{QE_{DPS}}}\right) \qquad (5)$$

$$\delta_{UD}^{\%} = 100\left(\frac{\delta_{\mathrm{UD}}}{\mathrm{QE_{DPS}}}\right) \qquad (6)$$

An appropriateness indicator will be defined then for each QE based upon the value of the percentage errors defined in (5) and (6).

3.1 Error Conventions

The choice of “sign” in equations (3) and (4) is crucial in order to have the required meaning of the errors. We then decide to:

- For “completeness” and “ consistency”(QE numbers 1,2,3 and 4 in Table A2.4), errors will be calculated as TDP or UD minus DPS. This means that:
    - for “coverage” QE, the positive value indicates that the TPD or UD is better than DPS requirements
    - for “consistency” QE the positive value indicates that the number of characteristics in the TDP are larger than DPS requirements (not applicable for UD)
- For “accuracy” and “temporal quality” QE (QE numbers 5,6, 7 and 9 in Table A2.4), errors will be calculated as DPS minus TDP or UD. A positive value indicates then that the TPD or UD QE is better than DPS requirement.

- For “consistency” QE (number 8 in Table A2.4) there is no difference carried out, the error is taken to be equal to the value given in the TDP or UD quality elements. The error is provided by the experts, and is an overall description of the error concept for the product or input data set.

The ε, δ error definitions are defined in details in Table A2.5 and A2.6

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 $\pm 100\%$.

In order to associate a range of indicator values to a synthetic indicator score it is necessary to establish “thresholds” for the values. 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 colour 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**

Table A2.5 TDP quality element indicator (error) definitions

QE number	Indicator short name	Indicator long name	Definition of quality errors (indicators)	Error definition	Units
1	TDP.APE.1.1	Horizontal spatial coverage error	Percentage to which the extent of the horizontal spatial coverage of TPD is compliant with the DPS extent in km**2	('TPD.AP.1.1' - 'DPS.AP.1.1')*100/' DPS.AP.1.1'	Percentage
2	TDP.APE.1.2	Vertical spatial coverage error	Percentage to which the extent of the vertical spatial coverage of TPD is compliant with the DPS extent in metres.	('TPD.AP.1.2' - 'DPS.AP.1.2')*100/' DPS.AP.1.2'	Percentage
3	TDP.APE.1.3	Temporal coverage error	Percentage to which the extent of the temporal coverage of TPD is compliant with the DPS extent in days.	('TPD.AP.1.3' - 'DPS.AP.1.3')*100/' DPS.AP.1.3'	Percentage
4	TDP.APE.2.1	Thematic content error	Percentage of Completeness/Incompleteness of the number of characteristics with respect to the list in DPS	('TPD.AP.2.1' - 'DPS.AP.2.1')*100/' DPS.AP.2.1'	Percentage
5	TDP.APE.3.1	Horizontal resolution error	Percentage to which the product averaged horizontal mesh size or horizontal scale is compliant with the DPS averaged mesh size or horizontal scale	('DPS.AP.3.1' - 'TDP.AP.3.1')*100/' DPS.AP.3.1'	Percentage
6	TDP.APE.3.2	Vertical resolution error	Percentage to which the product averaged vertical mesh size or vertical scale is compliant with the DPS averaged mesh size or vertical scale	('DPS.AP.3.2' - 'TDP.AP.3.2')*100/' DPS.AP.3.2'	Percentage
7	TDP.APE.3.3	Temporal sampling interval error	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)	('DPS.AP.3.3' - 'TDP.AP.3.3')*100/' DPS.AP.3.3'	Percentage
8	TDP.APE.3.4	Thematic accuracy error	Compliance with the value domain of the accuracy defined in DPS	TDP.AP.3.4'	Percentage
9	TDP.APE.4.1	Temporal validity error	Percentage to which the elapsed time of the product is compliant with the max elapsed time specified in DPS.	(DPS.AP.4.1-TDP.AP.4.1) * 100/DPS.AP.4.1	Percentage

Table A2.6 UD quality element indicators (errors) definitions

QE number	Indicator short name	Indicator long name	Definition of quality errors (indicators)	Error definition	Units
1	UD.APE.1.1	Horizontal spatial coverage error	Percentage to which the extent of the horizontal spatial coverage of UD is compliant with the DPS extent in km**2	('UD.AP.1.1' - 'DPS.AP.1.1')*100/' DPS.AP.1.1'	Percentage
2	UD.APE.1.2	Vertical spatial coverage error	Percentage to which the extent of the vertical spatial coverage of UD is compliant with the DPS extent in metres.	('UD.AP.1.2' - 'DPS.AP.1.2')*100/' DPS.AP.1.2'	Percentage
3	UD.APE.1.3	Temporal coverage error	Percentage to which the extent of the temporal coverage of TPD is compliant with the DPS extent in days.	('UD.AP.1.3' - 'DPS.AP.1.3')*100/' DPS.AP.1.3'	Percentage
5	UD.APE.3.1	Horizontal resolution error	Percentage to which the product averaged horizontal mesh size or horizontal scale is compliant with the DPS averaged mesh size or horizontal scale	('DPS.AP.3.1' - 'UD.AP.3.1')*100/' DPS.AP.3.1'	Percentage
6	UD.APE.3.2	Vertical resolution error	Percentage to which the product averaged vertical mesh size or vertical scale is compliant with the DPS averaged mesh size or vertical scale	('DPS.AP.3.2' - 'UD.AP.3.2')*100/' DPS.AP.3.2'	Percentage
7	UD.APE.3.3	Temporal sampling interval error	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)	('DPS.AP.3.3' - 'UD.AP.3.3')*100/' DPS.AP.3.3'	Percentage
8	UD.APE.3.4	Thematic accuracy error	Compliance with the value domain of the accuracy defined in DPS	UD.AP.3.4'	Percentage
9	UD.APE.4.1	Temporal validity error	Percentage to which the elapsed time of the product is compliant with the max elapsed time specified in DPS.	('DPS.AP.4.1' - 'UD.AP.4.1')*100/' DPS.AP.4.1'	Percentage

4. Fitness for use indicators

The appropriateness indicators for UD defined up to now do not consider the error that propagates from the input data set on the quality of the Targeted product. In other words the UD errors could be larger than the one calculated as a difference with DPS because they greatly impact the quality of the Targeted Product. Viceversa the UD errors could be large but their impact on the quality of the TDP small.
In mathematical terms, UD and TDP quality elements are two realizations of our expectations, given by DPS and the have two different errors ε, δ . Thus in principle it is possible, in a least square term, to combine these two estimates of the error to give a combined estimate.

We would like then to define a "combined error" for each UD that is defined now as the "fitness for use" error $\Delta_{FU}^{\%}$. The meaning is that for each upstream data set is given by input data set error "modulated" by the product error. Moreover Please note that "fitness" has to have the opposite meaning of "error" so that a change in sign is required.

We can have the following cases :

errors	$\varepsilon_{TDP}^{\%}$ negative (underfitness)	$\varepsilon_{TDP}^{\%}$ null or positive (overfitness)
$\delta_{UD}^{\%}$ null or positive (overfitness)	$\Delta_{FU}^{\%} = 100 + \delta_{UD}^{\%}$ Over-Fitness for use Explanation: this is the case where the input data set is over fitted but the product is under fit. This may mean that some other input data set degrades the quality of the product, not the specific input data set under investigation.	$\Delta_{FU}^{\%} = 100 + \frac{\lvert\varepsilon_{TDP}^{\%}\rvert\lvert\delta_{UD}^{\%}\rvert}{\sqrt{\varepsilon_{TDP}^{\%2} + \delta_{UD}^{\%2}}}$ Over-Fitness for use Explanation: this is the case where both the input data set and the product are over fitting the specifications. If $\varepsilon_{TDP}^{\%}$ is zero then $\Delta_{FU}^{\%} = 100$ meaning that it does not matter how positive is $\delta_{UD}^{\%}$ for that product.
$\delta_{UD}^{\%}$ negative (underfitness)	$\Delta_{FU}^{\%} = 100 - \frac{\lvert\varepsilon_{TDP}^{\%}\rvert\lvert\delta_{UD}^{\%}\rvert}{\sqrt{\varepsilon_{TDP}^{\%2} + \delta_{UD}^{\%2}}}$ Under-Fitness for use Explanation: this is the case where both the input data set and the product is undefit. We "modulate" the input data set error with the product error. If both UD and TDP errors are negative FU is assumed zero.	$\Delta_{FU}^{\%} = 100 - \frac{\lvert\varepsilon_{TDP}^{\%}\rvert\lvert\delta_{UD}^{\%}\rvert}{\sqrt{\varepsilon_{TDP}^{\%2} + \delta_{UD}^{\%2}}}$ Under-Fitness for use Explanation: this is the case where the input data set is underfit but the final product overfit. We "modulate" the input data set error with the product error. If $\varepsilon_{TDP}^{\%}$ is zero then $\Delta_{FU}^{\%} = 100$ and again it does not matter how negative is $\delta_{UD}^{\%}$ for that product.

Applying these formulas to the data, results are not completely convincing, probably due to the scarce statistics of the UD and TDP errors (we have only 90 data sets subdivided between 45 TDP).

The application of FU indicator will be further developed when statistically significant number of errors will be available. The combination formula in fact should be used not with the errors but with the error standard deviations.