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7th Meeting of the Ecosystem Approach Coordination Group

Athens, Greece, 9 September 2019

Agenda Item 7: Updated IMAP Guidance Factsheets for Common Indicators 13, 14, 15, 16, 17, 18, 20 and 21; New proposal for Candidate Indicators 25, 26 and 27

Indicator guidance factsheets for EO7 and EO8 Coast and Hydrography Common Indicators 15, 16 and 25

UNEP/MAP
Athens, 2019

Note by the Secretariat

The document reflects conclusions and recommendations of the CORMON meeting on Coast and Hydrography (Rome, Italy, 21-22 May 2019) for the Common Indicator (CI) 15 related to the Ecological Objective 7 (Hydrography), CIs 16 and 25 related to Ecological Objective 8 (Coastal Ecosystems and Landscape).

With regard to CI15 the CORMON agreed to replace the existing Guidance Factsheet with the one presented below with the following title: "Location and extent of the habitats potentially impacted by hydrographic alterations" so to reflect the precautionary principle and risk assessment approach. The indicator focuses on the assessment of physical loss including the footprint of the structures, permanent changes of seafloor and in addition permanent hydrographic changes of the surrounding area with a view to determining areas of potentially impacted habitats. Other parameters to be monitored (such as salinity and temperature) are structure-specific.

The request for development of this alternative version was expressed by several Contracting Parties at many occasions such as at the PAP/RAC Focal Points meetings, at Sub-regional meeting on Coast and Hydrography (December 2017), in comments on QSR assessment factsheets and in particular at the 6th EcAp Coordination Group meeting (September 2017). It is believed that current Common Indicator 15 is too complex and not mature enough to be implemented at the Mediterranean scale. It requires substantial financial, technical and human capacities that are not available in many Mediterranean countries. Some simplification of the Guidance Factsheet has been already done also by the EU (in the MSFD) what showed that the originally developed method for monitoring of hydrographic changes and related impacts on habitats was too ambitious.

With regard to CI 16 "Length of coastline subject to physical disturbance due to the influence of manmade structures" the CORMON agreed on minor changes to the Guidance Factsheet and in particular expressed the importance of the definition of GES. It emphasized that due to national circumstances such as socio-economic, historic, cultural and alike, a unique target and GES cannot be specified quantitatively (as a threshold value). It was therefore agreed that the definition of GES and related targets and measures should be left to the Contracting Parties taking legal obligations of the Barcelona Convention into account, in particular the ICZM Protocol.

The Meeting agreed on the removal of "*impervious surface in the coastal fringe (100m from the coastline)"* and "*the land claim, i.e. the surface area reclaimed from the 1980's onward (ha)"* from the list of criteria for calculation of this indicator. Minor adjustments to the Guidance Factsheet namely, replacement of the term 'manmade structures' with the term 'human made structures' to respect the gender-neutrality was endorsed by the Meeting.

Human induced coastal erosion was recognized as an important process affecting coastline, so the CORMON suggested developing a relevant indicator under this EO.

The CORMON meeting welcomed and endorsed the Guidance Factsheet for the CCI 25 "Land cover change" and proposed to put the on the IMAP List of Common Indicators. Convinced that this indicator is mature enough and that its monitoring is very important for the ecosystem approach implementation as well as for the reporting on the evolution and state of coastal zone as requested by the ICZM Protocol, this CCI 25 will also significantly contribute to the integration of the land and marine environment of coastal zones, i.e. to take LSI into account.

Similar to the CI 16, the Meeting agreed that the GES, targets and measures cannot be expressed quantitatively but, due to country specific circumstances (socio-economic, cultural, historical), should be defined by the countries themselves. In doing so the Contracting Parties should take their spatial development and planning policies into account, as well as the legal obligations of the Barcelona Convention, in particular the ICZM Protocol.

Finally following the approval by the SPA/BD Thematic Focal Points Meeting (Portorož, Slovenia, 18-21 June 2019) of the Reference List of Marine and Coastal Habitat Types in the Mediterranean, this list will be annexed to the Common Indicator Guidance Factsheet for CI 15, as an important integration element for EO1 And EO7, to ensure coherence and coordination in the work for populating and amending this indicator.

Table of Contents

1. Indicator guidance factsheet for the Common Indicator 15

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.	
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Negative impacts due to new structure are minimal with no influence on the larger scale coastal and marine system.	Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimised.	Planning of new structures takes into account all possible mitigation measures in order to minimize the impact on coastal and marine ecosystem and its services integrity and cultural/historic assets. Where possible, promote ecosystem health.

Rationale

Justification for indicator selection

After agreeing to progressively apply the ecosystem approach (EcAp) to the management of human activities in the Mediterranean at the 15th Meeting of the Contracting Parties to the Barcelona Convention (COP15, 2008), the Contracting Parties agreed, at COP17 in 2012, on an overall vision and goals for EcAp, and on 11 ecological objectives for the Mediterranean. Among these ecological objectives was the Ecological Objective 7 („Alteration of hydrographical conditions"), with its clearly outlined operational objectives and indicators. EO7 corresponds to Descriptor 7 (Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems) of the European Marine Strategy Framework Directive (MSFD).

Ecological Objective 7 („Alteration of hydrographical conditions") addresses permanent alterations in the hydrographical regime of currents, waves and sediments due to new large-scale developments that have the potential to alter hydrographical conditions. An agreed common indicator - 'Location and extent of habitats impacted directly by hydrographic alterations' considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads).

There is a clear link between EO7 and other ecological objectives, especially EO1 (Biodiversity). Such link needs to be determined on a case-by-case basis. Refer to Annex 1 for habitats to be considered in EO7. Ultimately, the assessment of impacts, including cumulative impacts, is a cross-cutting issue for EO1 and EO7.

Scientific References

EC JRC (2015). Review of Commission Decision 2010/477/EU concerning MSFD criteria for assessing good environmental status Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems

EMEC Ltd (2005). Environmental impact assessment (EIA) guidance for developers at the European Marine Energy Centre.

OSPAR Commission (2012). MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012.

OSPAR Commission (2013). Report of the EIHA Common Indicator Workshop.

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

Royal Haskoning DHV (2012). Environmental Impact Assessment (EIA) and Appropriate Assessment (AA) Evaluation of assessment tools and methods. Lot 2: Analysis of case studies of port development projects in European estuaries. Tidal Rover Development (TIDE) Interreg IVB

Some reference and guidance documents on EIA can be found at : http://ec.europa.eu/environment/eia/eia-support.htm and in the „Guidance Document on how to reflect changes in hydrographical conditions in relevant assessments" (UNEP/MAP/PAP, 2015).

Policy Context and targets

Policy context description

Following the COP17 agreement on an overall vision and goals for EcAp, on 11 ecological objectives, operational objectives and indicators for the Mediterranean, a six-year cyclic review process of EcAp implementation was established (EcAp MED I 2012-2015), with the next EcAp cycle set to cover 2016-2021.

At COP18, in 2013, the targets for achieving GES of the Mediterranean Sea and its coastal zone by 2020 were adopted. In addition, through Decision IG. 21/3 (the so called "COP18 EcAp Decision") the EcAp roadmap was agreed on. The Contracting Parties also agreed to design an Integrated Monitoring and Assessment Programme (IMAP) by COP19, which would, for the first time, ensure a common assessment basis for the Mediterranean marine and coastal environment. At COP19, in 2016, the IMAP was adopted. The IMAP provides guidance to the parties on how to practically implement quantitative monitoring and assessment of the ecological status of the Mediterranean Sea and coast in line with the EcAp.

As part of the EcAp roadmap, expert-level monitoring discussions took place in the various Correspondence Groups on Monitoring (CORMONs) meetings on Biodiversity and Fisheries; Pollution and Litter; and Coast and Hydrography sub-clusters. An Integrated Correspondence Group on Monitoring Meeting (Integrated CORMON) took place on 30 March-1 April 2015, to discuss the main elements of the Integrated Monitoring and Assessment Programme.

As for Protocols of the Barcelona Convention relevant for the EO7, the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean calls to Contracting Parties of the Barcelona Convection for continuous monitoring of ecological processes, population dynamics, landscapes, as well as the impacts of human activities (Article 7 b). In addition, it calls to Parties to evaluate and take into consideration the possible direct or indirect, immediate or long-term impacts, including the cumulative impact of the projects and activities, on protected areas, species and their habitats (Article 17).

Another Protocol of the Barcelona Convention, the Protocol on the Integrated Coastal Zone Management in the Mediterranean, in its Article 9, calls for Parties to minimize negative impacts on coastal ecosystems, landscapes and geomorphology, coming from infrastructure, energy facilities, ports and maritime works and structures; or where appropriate to compensate these impacts by non-financial measures. In addition, the Article 9 demands maritime activities to be conducted "in such a manner as to ensure the preservation of coastal ecosystems in conformity with the rules, standards and procedures of the relevant international conventions".

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

Out of other international legislation that can be relevant for the EO7 Ecological Objective, it is essential to mention Marine Strategy Framework Directive – MSFD 2008/56/EC since EcAp's EO7 corresponds to MSFD's Descriptor 7 to large extent. The hydrographical conditions outlined under the MSFD are, to a large extent, comparable to the hydromorphological conditions referred to under the Water Framework Directive (WFD) which calls for the protection of all water resources, including coastal waters. EO7 overlaps with other policy frameworks, such as the Environmental Impact Assessment (EIA) procedure on the assessment of the environmental impacts of certain public and private projects; the Strategic Environmental Assessment (SEA) procedure on the assessment of the effects of certain plans and programs on the environment; assessments undertaken under Marine Spatial Planning (MSP); and in the context of integrated coastal zone management (ICZM).

Targets

Planning of new structures takes into account all possible mitigation measures in order to minimize the impact on coastal and marine ecosystem and its services, integrity and cultural/historic assets. Where possible, promote ecosystem health.

Policy documents

Protocol on the ICZM in the Mediterranean - http://www.pap-thecoastcentre.org/pdfs/Protocol_publikacija_May09.pdf

Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean - http://www.rac-spa.org/sites/default/files/protocole_aspdb/protocol_eng.pdf

MSFD Directive - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

Other EU-related documents can be found at: http://ec.europa.eu/environment/eia/eia-support.htm

Indicator analysis methods

Indicator Definition

The EO7 Common Indicator reflects location and extent of the habitats potentially impacted by the alterations and/or the circulation changes induced by them. It concerns area/habitat and the proportion of the total area/habitat where alterations of hydrographical conditions are expected to occur (estimations by modelling or semi-quantitative estimation).

Methodology for indicator calculation

Methodology used for indicator measurement encompasses elaboration on:
(i) Mapping of area where human activities may cause permanent alterations of hydrographical conditions (using i.e. existing EIA, SEA and Maritime Spatial Planning -MSP); and
(ii) Mapping of habitats of interest in this area of hydrographical changes; and
(iii) Intersection of the spatial map of the areas of hydrographical changes with spatial maps of habitats to determine the areas of individual habitat types that are impacted by hydrographical changes.

New structures to be considered under EO7 assessment:

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

As far as the type and dimension of structures to be taken into account: use the case by case approach depending on the nature of the coast, the function of the structure and the depth reached by the structure where appropriate threshold values are taken into account (such as absolute surface in m², range of depths where structure will be built (to avoid habitat "segmentation")). As an additional criterion it was agreed that all permanent structures, for which an EIA and/or a planning/building permit is required, should be considered.

Hydrographical conditions to be considered:

- At least, waves and currents changes (can be used to assess changes in bottom shear stress, turbulence and alike).
- For sandy sites or sites with natural sediment dynamic, changes in sediment transport processes and turbidity and induced changes in morphology of the coast.
- If the new structure involves water discharge, water extraction or changes in fresh water movements: assessment of salinity and/or temperature changes.

Steps to assess hydrographical alterations:
In case of insufficient data and resources and if the implementation of hydrodynamic modelling is not feasible, a simplified approach for assessing hydrographical alterations is proposed.
Following new decision on the MSFD (Decision 2017/048/UE, May 2017), an alternative approach proposes to assess first the hydrographical alterations as a result of physical loss (permanent changes to the seabed in term of bathymetry, morphology or nature substrate) induced by the structure itself or human activities in its surroundings.
Such approach aims to focus on:

1. The hold of the structure (location and extend on the sea floor). In this area, the presence of the structure will definitively alter the existing habitats (physical loss).
2. Permanent changes to the seabed related to the structure and due to human activities. For instance, the creation of a port often requires the digging of basins and the dumping of materials at sea. These diggings and discharges, leading to permanent bathymetric and eventually substrate changes and modifying waves and currents propagation, will also definitively alter the existing habitats.
3. Effects of the structure on hydrographical conditions in its neighbourhood. The existence of the structure will modify the regime of currents and agitation and also the coastal transit with creation of erosion and deposition zones. For instance, in a harbour, the presence of dikes attenuates the currents and the swell inside the basins and leads to decantation of suspended material (vases, organic matter, debris plants.) inducing changes in benthic settlements.

First level of assessment: assessment of physical loss induced by the structure itself (on sea floor and in water column)
The objective here is to represent by a polygon (GIS data) the exact location and extend on sea floor of the expected construction, i.e. a footprint (and not only the extent of the submerged part of the structure). These data can be taken from the construction plan of the structure that should be present in the EIA or another planning document.
A proposal for attribute's GIS data can be found in Chapter „Expected assessment outputs" below.

Second level of assessment: assessment of permanent changes to the seabed due to human activities (related to the construction and the use of the structure)
The objective here is to represent by a polygon (GIS data) the exact location and extend of dredged and disposal areas leading to permanent changes in bathymetry. These changes can happen during the

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

construction of the structure (digging of basins) or for its normal use (channels dredging to maintain a certain depth).
Information relative to these activities can be found in the EIA or can be asked to the project manager responsible for its construction or to the structure owner.

Third level of assessment: assessment of hydrographical changes induced by the structure in the surrounding area

The first possibility to assess these alterations is to use the information provided by the EIA if available. Even if the EIA does not fully meet the needs of this indicator, it should at least provide some information on the main expected hydrographic changes since they may compromise the use or sustainability of the structure. For instance, in case of a port or a marina, the attenuation of agitation, being the objective, should be well studied. The same way, on a coast with strong sediment transit, the impact of the structure on erosion and sedimentation changes should be studied as they could compromise the use or the durability of the structure.

If the EIA does not provide a sufficient level of information, other available sources of information concerning similar or close sites have to be explored: historical evolution of sediment supply, analysis of the evolution of the coastline and the seabed, analysis of the impact of existing defence structures and ports on the morphodynamics of the coastline and alike.
These available data and studies are not directly applicable to assess hydrographical alterations induced by the new structure. Nevertheless, they can be used by experts to extrapolate evolution tendencies on the site of interest, thus providing a first level of characterization of expected hydrographic alterations and allowing to roughly specify their extent and location.
In the case where no information can help to characterize the extent of the expected hydrographic alterations, a buffer zone proportional to the largest dimension of the structure may be used to assess this extend (eg a buffer zone of 5 times the cross-shore length of the structure). If this approach is used to assess the extend, this must be clearly said in the attribute table relative to this GIS layer (see *Expected assessments outputs*).

For the first level of assessment, it is clear that under the hold of the structure the hydrographical conditions and the habitats will be definitively and permanently altered. On the other side, for the second and third levels of assessment, depending on the available data, the actual knowledge and the assumptions followed, there may be some degree of uncertainty in the assessment of location and extend of expected hydrographical alterations. To take into account these uncertainties and the limits of the assessments, it is proposed to notify them in the attribute table relative to these assessments (A proposal for attribute's GIS data can be found in „Expected assessment outputs“). These notifications will help to identify and subsequently improve the evaluations deemed to be the least reliable.
At the end, the results of the above assessments are integrated on one single GIS layer (i.e. hydrographical alterations GIS layer). The last step of the EO7 indicator calculation consists of overlaying hydrographical alterations GIS layer with habitats GIS maps/layer. Calculations are made with GIS tools in order to define habitats potentially impacted by hydrographic alterations.

If the assessment of hydrographic alterations presents a high level of uncertainty, a risk-based approach can be used to identify habitats that are most sensitive to expected alterations. To do this sensitivity matrix can be used (see for instance: La Rivière M. et al., 2018. *An assessment of French Mediterranean benthic habitats' sensitivity to physical pressures.* UMS PatriNat, AFB-CNRS-MNHN. Paris, 86 pp.).

Due to the ecological importance of *Posidonia* meadows in the Mediterranean Sea and their vulnerability to coastal development, a specific paragraph for this habitat is presented.

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

Particular considerations for *Posidonia* meadows:

In addition to direct impacts, induced by the structure itself, which will definitively destroy the meadow by recovery, some construction techniques and then indirect impacts, following its construction, on currents and sedimentary transport, may also alter this habitat, on areas much larger than the structure footprint.

Indeed, the *Posidonia* is very sensitive to water turbidity, even transient. Also, during the construction of the structure, a turbid cloud can be generated (discharge at sea of fine materials). This turbid cloud will decrease the transparency of the water, and therefore photosynthesis, in the short term; it can also be deposited on the seagrass meadow that can cause smothering by hyper sedimentation. The thinnest sediments can also be resuspended during storms, thus decreasing the transparency of the water in the long term. Major seagrass meadow destructions due to these phenomena have been observed, for example, in France following the construction of the ports of Pointe Rouge in Marseille and Mouillon in Toulon.
Moreover, the construction machines are often fixed on the bottom, for stability reasons, directly and / or by means of anchors, which has a very negative impact on the bottoms: digging holes (feet of the machines) or furrows (chains of anchors) in the *Posidonia oceanica* meadows.

Once the structure is built, its presence can modify the sedimentary transit and induce areas of erosion and accumulation around it. These modifications will alter the equilibrium between the sedimentation rate and the vertical growth of *Posidonia*. So, if the rate of sedimentation **exceeds 5-7cm / year**, the vegetative points die; conversely, if this rate is zero or negative (sediment departure), the rhizomes are loosened; they are then very sensitive to breakage (hydrodynamism, anchors, trawling, etc.)
It should also be noted that it is extremely rare for a seagrass meadow to survive in a harbor basin in the medium or long term.

In order to avoid all these phenomena, it is therefore advisable to:

- Use materials and construction techniques that minimize the suspension of fine particles that can induce turbidity in the surrounding waters. (for example: the dumping of fine materials (diameter less than 1 mm) at sea, or of blocks mixed with fine materials, is to be excluded completely; when rockfill is installed, it is advisable to rinse the blocks of rock; geotextile protective screens must be put in place around the site to minimize turbidity induced).
- Avoid the use of construction machines located at sea by favouring the use of machines lying on the ground. if it is essential to use them at sea, they must not be anchored or relied on *Posidonia* meadows.
- Avoid carrying out construction work in summer, when the plant rebuilds its reserves for the following year
- Build a new development at several tens of meters from the closest living *Posidonia* meadow
- Avoid including *Posidonia* meadow in a port basin
- Monitor the condition of the surrounding seagrass, both during and at the end of the work.

(These elements on *Posidonia* meadows have been taken from : Boudouresque et al., 2006, Préservation des herbiers à *Posidonia oceanica*. RAMOGE pub.: 1-202, N°ISBN 2-905540-30-3)

Indicator units

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

- km2 of impacted habitats
- proportion (%) of the total area/habitats impacted

List of Guidance documents and protocols available

UNEP/MAP/PAP (2015). Guidance document on how to reflect changes in hydrographical conditions in relevant assessment (prepared by Spiteri, C.). Priority Actions Programme. Split, 2015.

UNEP(DEPI)/MED IG.22. UNEP(DEPI)/MED IG.22/Inf.7 (2016). Draft Integrated Monitoring and Assessment Guidance

UNEP(DEPI)/MED WG.433/1 (2017) PAP/RAC Meeting of the Ecosystem Approach Correspondence Group on Monitoring (CORMON) on Coast and Hydrography – Working Document

Advice document on hydrographical conditions (Descriptor 7) in the context of MSFD, published by OSPAR Commission (2012);

Scientific and technical review of the MSFD Commission Decision 2010/477/EU in relation to Descriptor 7 carried out by the EC JRC; etc.

Data Confidence and uncertainties

Data used or produced for the monitoring should be in agreement with Shared Environmental Information System (SEIS) principles. More on SEIS principles can be found in Draft Integrated Monitoring and Assessment Guidance.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

At this stage, there is no clear available methodology and monitoring protocols (see **Known gaps and uncertainties in the Mediterranean).**
Some methodologies or protocols could be proposed, once done an inventory of existing and available data in Mediterranean Sea.

For more details, see "Guidance document on how to reflect changes in hydrographical conditions in relevant assessments".

Available data sources
Global marine data source at the scale of the Mediterranean Sea:

- EMODnet Central Portal (http://www.emodnet.eu/)
- Mediterranean Marine Data (http://www.mediterranean-marinedata.eu/)
- Copernicus, Marine environment monitoring service (http://marine.copernicus.eu/)

Available regional or local data sources (in each country) should be also identified.

Spatial scope guidance and selection of monitoring stations

The monitoring will focus on habitats of interest, around new permanent constructions (lasting more than 10 years) in coastal waters.

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

The study area should depend on the footprint of the new construction considered and on the local (or regional) geographical and marine conditions. It should be large enough:

- to show all the hydrographic alterations induced by the construction, even for long term;
- to follow all the habitats of interest that could be potentially impacted.

At first, the spatial scale (in cross-shore and long-shore directions) to be used should be about 10 to 50 times the characteristic length of the structure. Depending on the first results obtained for this area, the area should be enlarged or zoomed in around the structure.

It should be highlighted if monitoring was performed in sensitive areas, such as marine protected areas, spawning, breeding and feeding areas and migration routes of fish, seabirds and marine mammals, since they are priority.

Temporal Scope guidance

To correctly assess changes in time on habitats induced by constructions, different monitoring timescales are proposed:

- Before construction, initial state assessment (baseline conditions):
  Monitoring should provide the initial hydrodynamics conditions surrounding the future construction.
- During construction: monitoring should ensure that impacts due to works are limited in space and in time.
- After construction, short term changes (0 to 5 years after): at least yearly up to 5 years.
  During this period, strong changes should happen on hydrographical, morphological and habitats conditions. The monitoring frequency should be high* enough to assess these changes. It should be annual (at the same period of year) and provide, each year, the changes in hydrodynamic conditions (assessed by comparing present and initial conditions).
- After construction (5 to 10 years after): at least biennium to 10 years.
  Same as before with a lower* monitoring frequency as the changes should be lower.
- Long term changes (10 to15 years after construction)
  Same as before with a lower* monitoring frequency as the changes should be lower.

* The monitoring frequencies to be used in these different phases should depend on the intensity of changes in hydrographical and morphological conditions occurring on the site (case by case).

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Expected assessments outputs

All the outputs that came out of the monitoring (I.e. trend analysis, distribution maps, etc.) should be listed, along with source(s) where they can be found.

The outputs to be reported are (map and GIS data):

- The area and location where the future structure will be built;
- The area and location where alterations in hydrographical conditions are expected to occur and those areas where alterations are actually occurring;
- The area and location of the habitats of interest potentially impacted by these alterations;
- The area and location of these habitats of interest previously identified for the whole analysis unit (to assess the proportion of total habitats that are altered).

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

For the area and location where the future structure will be built, additionally to the surface representation of the structure, some information has to be provided as attributes of the GIS layer. The following attributes are proposed:

Country	*Locality / District*	*ID of the structure*	*Role of structure*	*Type of structure*	*Materials*	*Extend on the sea floor (in m², ha or km²)*
Specify the country	*Specify the location of the structure*	*The ID must be unique to identify the structure. It could be a number or a numbered code using letters from the previous column*	*Harbour, coastal defense, marine energy, ...*	*Quay, groynes, wind farm,...*	*Concrete, rockfill, ...*	*Area of the structure on sea floor. The used unity has to be provided in the name of the field*

If the structure is composite (in terms of type, materials, ...), several GIS surface objects could be defined.

For the area and location of expected hydrographical alterations, additionally to the surface representation of these alterations, some information has to be provided as attributes of the GIS layer. The following attributes are proposed:

Country	*Locality / District*	*ID of the structure*	*Nature of expected hydrographic alterations*	*Data used*	*Method of alterations assessment*	*Level of assessment confidence*	*Extend of hydrographical alteration (in m², ha or km²)*
Specify the country	*Specify the location of the structure*	*The ID must be unique to identify the structure. It could be a number or a numbered*	*Waves/currents attenuation; anthropic changes of bathymetry; changes in sediment transit inducing erosion/sedimentation;*	*Data provided by EIA ; dredging/ disposal scheme ; ...*	*Modeling; expert judgment ; Analogy with similar and close site;...*	*Low/Medium/ Good*	*Area of the structure on sea floor. The used unity has to be provided in the name of the field*

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations

		code using letters from the previous column					

If different extend of hydrographical alterations can be identified (in terms of nature, intensity, …) several GIS surface objects could be defined.

For each GIS data layer produced, a metadata file must be added. This file must provide information on: creation date of the GIS data, GIS data author, contact information, source agency, map projection and coordinate system, scale, error, explanation of symbology and attributes, data dictionary, data restrictions, and licensing (see for instance INSPIRE Directive).

Known gaps and uncertainties in the Mediterranean

There are general difficulties, not particular to the Mediterranean context, that can be identified for this EO7:

- Lack of coherence in definitions, standard approaches in the development and application of indicators and in the assessment of impacts, together with lack of methodological standards.
- Lack of knowledge and understanding on the link between physical pressures and biological impacts and on the cumulative impacts.

Another difficulty comes from the hydrographical alterations that EO7 indicator should assess. These alterations, around a particular coastal construction, often change in intensity, in area and indeed in time, depending on the off-shore hydrographical conditions (calm weather/extreme event; seasonality of waves height and directions; local wind conditions…) and on the morphologic history of the site (the present state is due to the succession of these different conditions).
So, a work to define which hydrographical conditions and temporal scale have to be used to assess hydrographical alterations by numerical modelling must be carried out.

Like everywhere, there is certainly a lack of physical characteristics data in the Mediterranean Sea (bathymetric data, seafloor topography, current velocity, wave exposure, turbidity, salinity, temperature, etc.), that will be the main problem to implement this indicator, in particular to define the base-line conditions. To identify these lacks, a global and clear inventory of existing and available data in Mediterranean Sea should be done.

Nevertheless, data can be collected from regional models (bathymetry, hydrodynamics, salinity, temperature). These data with coarse resolution will need to be refined close to the location of the new structure.

In case of no sufficient data, the use of assessment methods needing less data (empirical formulae, expert judgment, comparison with similar sites) should be considered, as well as acquisition/monitoring of missing data, promoting regional cooperation.

Contacts and version Date

Key contacts within UNEP for further information

Ecological Objective 7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.	
Indicator Title	Location and extent of the habitats potentially impacted by hydrographic alterations	
Version No	**Date**	**Author**
V.1	27/6/16	PAP/RAC
V2	11/07/16	Olivier Brivois
V3	13/07/16	Olivier Brivois
V4	16/03/17	Olivier Brivois
V5	19/06/18	Olivier Brivois
V6	26/07/18	Olivier Brivois

Annex 1. Reference list of habitats to be considered

2. Indicator guidance factsheet for EO8 Coastal Ecosystems and Landscapes Common Indicator 16 "Length of coastline subject to physical disturbance due to the influence of human-made structures"

Ecological Objective 8:	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved	
Indicator Title	Length of coastline subject to physical disturbance due to the influence of human-made structures	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Physical disturbance to coastal areas induced by human activities should be minimized.	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved.	Negative impacts of human activities on coastal areas are minimized through appropriate management measures.
GES, targets and measures cannot be expressed quantitatively (as a threshold value) but due to country specific circumstances (socio-economic, cultural, historical) should be defined by the countries themselves. In doing so the CPs should take their spatial development and planning policies into account, as well as the legal obligations of the Barcelona Convention, in particular the ICZM Protocol. The above GES definition and Proposed target(s) are just examples.		
Rationale		
Justification for indicator selection Mediterranean coastal areas are particularity threatened by coastal development that modifies the coastline through the construction of buildings and infrastructure needed to sustain residential, commercial, transport and tourist activities. The land, intertidal zone and near-shore estuarine and marine waters are increasingly altered by the loss and fragmentation of natural habitats and by the proliferation of a variety of built structures, such as ports, marinas, breakwaters, seawalls, jetties and pilings. These coastal human-made infrastructures cause irreversible damage to landscapes, losses in habitat and biodiversity, and strong influence on the configuration of the shoreline. Indeed, physical disturbance due to the development of artificial structures in the coastal fringe can disrupt the sediment transport, reduce the ability of the shoreline to respond to natural forcing factors, and fragment the coastal space. The modification of emerged beach and elimination of dune system contribute to coastal erosion phenomena by lessening the beach resilience to sea storms. Coastal defence infrastructures have been implemented to solve the problem together with beach nourishment but preserving the natural shoreline system with adequate sediment transport from river has proved to be the best solution. Monitoring the length of coastline subject to physical disturbance due to the influence of human-made structures and its trend is of paramount importance to preserve habitat, biodiversity and prevent coastal erosion phenomena, as well as for its importance in land-sea interactions. Until now there has not been systematic monitoring in Mediterranean regarding this, in particular not quantitatively based monitoring or any major attempt to homogenously characterize coastal ecosystems on a wider Mediterranean basis. The status assessment of EO8 aims to fill this gap.		
Scientific References Boak, E., H. & Turner I., L. (2005), Shoreline definition and detection: a review. Journal of Coastal Research 21(4), 688-703. Deichmann, U., Ehrlich, E., Small, E., and Zeug, G. (2011). Using high resolution satellite data for the identification of urban natural disaster risk (GFDRR (Global Facility for Disaster Reduction and Recovery)).		

Ecological Objective 8:	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	Length of coastline subject to physical disturbance due to the influence of human-made structures

European commission and Directorate General Environment (2004a). Living with coastal erosion in Europe: Sediment and Space for Sustainability. A guide to coastal erosion management practices in Europe (The Netherlands: Eurosion project).

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UNEP/MAP/PAP (2001). White paper: coastal zone management in the Mediterranean. (Split).

UNEP/MAP (2013). Approaches for definition of Good Environmental Status (GES) and setting targets for the Ecological Objective (EO) 7 "Hydrography" and EO8 "Coastal ecosystems and landscape" in the framework of the Ecosystem Approach.

Policy Context and targets

Policy context description

ICZM Protocol (Article 8, point 3):

The Parties shall also endeavour to ensure that their national legal instruments include criteria for sustainable use of the coastal zone. Such criteria, taking into account specific local conditions, shall include, inter alia, the following:

(a) identifying and delimiting, outside protected areas, open areas in which urban development and other activities are restricted or, where necessary, prohibited;
(b) limiting the linear extension of urban development and the creation of new transport infrastructure along the coast;
(c) ensuring that environmental concerns are integrated into the rules for the management and use of the public maritime domain;
(d) providing for freedom of access by the public to the sea and along the shore;
(e) restricting or, where necessary, prohibiting the movement and parking of land vehicles, as well as the movement and anchoring of marine vessels, in fragile natural areas on land or at sea, including beaches and dunes.

Targets

Ecological Objective 8:	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	Length of coastline subject to physical disturbance due to the influence of human-made structures

Negative impacts of human activities on coastal areas are minimized through appropriate management measures.

Additional country-specific criteria should be taken into account for definition of targets, measures and interpretation of results regarding this indicator due to strong socio-economic, historic and cultural dimensions in addition to characteristic geomorphological and geographical conditions in each respective country (reflected in policy documents, strategies and other country-specific documents). Interpretation of results should be left to the countries taking above criteria into account.

Policy documents
Protocol on the ICZM in the Mediterranean - http://www.pap-thecoastcentre.org/pdfs/Protocol_publikacija_May09.pdf

Indicator analysis methods

Indicator Definition

The monitoring aim of the EO8 common indicator is twofold: (i) to quantify the rate and the spatial distribution of the Mediterranean coastline artificialitsation and (ii) to provide a better understanding of the impact of those structures to the shoreline dynamics. It has an operational target on impact, thus it is associated to concrete implementation measures related to specific human activities (i.e. appropriate management measures) to minimize negative impacts and to inform about progress towards GES.

Methodology for indicator calculation

The monitoring of this Common Indicator entails an inventory of the length and location of human-made coastline (hard coastal defence structures, ports, marinas (see Figure 1). Soft techniques e.g. beach nourishment are not included.

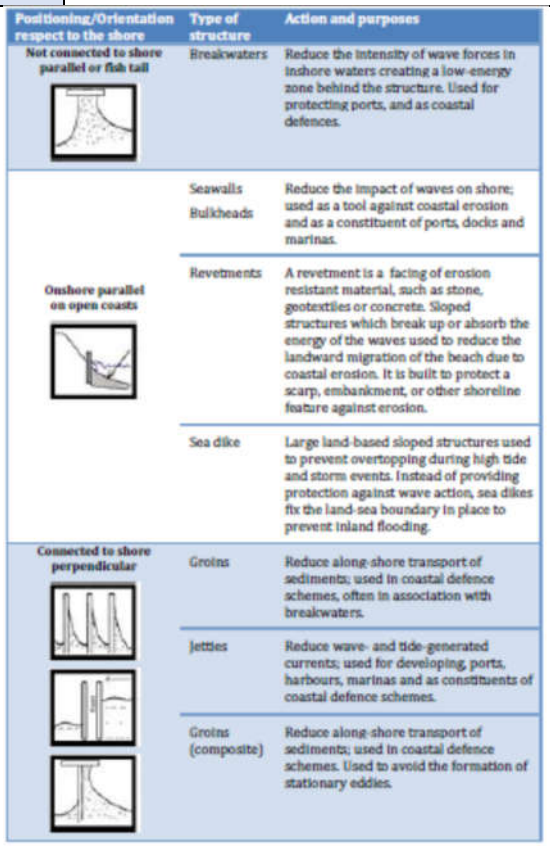
With regard to the coastline to be considered: the fixed reference official coastline as defined by responsible Contracting Party should be considered. The optimal resolution should be 5 m or 1: 2000 spatial scale.

Once a proper geographic scale has been established, monitoring should focus, in particular, on the location, the spatial extent and the types of coastal structures taking into account the minimum coastal length that can be classified as artificial or natural.

The identification procedure of human-made structures should be carried on based on typical situations added to the indicator guidance factsheet, including the minimum size (length, width of human-made structures) to be taken into account.

As monitoring should be done every 6 years, every CP should fix a reference year in the time interval 2000-2012 in order to eliminate the bias due to old or past human-made infrastructures.

Ecological Objective 8:	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	Length of coastline subject to physical disturbance due to the influence of human-made structures



Positioning/Orientation respect to the shore	Type of structure	Action and purposes
Not connected to shore parallel or fish tail	Breakwaters	Reduce the intensity of wave forces in inshore waters creating a low-energy zone behind the structure. Used for protecting ports, and as coastal defences.
Onshore parallel on open coasts	Seawalls Bulkheads	Reduce the impact of waves on shore; used as a tool against coastal erosion and as a constituent of ports, docks and marinas.
	Revetments	A revetment is a facing of erosion resistant material, such as stone, geotextiles or concrete. Sloped structures which break up or absorb the energy of the waves used to reduce the landward migration of the beach due to coastal erosion. It is built to protect a scarp, embankment, or other shoreline feature against erosion.
	Sea dike	Large land-based sloped structures used to prevent overtopping during high tide and storm events. Instead of providing protection against wave action, sea dikes fix the land-sea boundary in place to prevent inland flooding.
Connected to shore perpendicular	Groins	Reduce along-shore transport of sediments; used in coastal defence schemes, often in association with breakwaters.
	Jetties	Reduce wave- and tide-generated currents; used for developing, ports, harbours, marinas and as constituents of coastal defence schemes.
	Groins (composite)	Reduce along-shore transport of sediments; used in coastal defence schemes. Used to avoid the formation of stationary eddies.

Figure 1. Hard coastal defence structures, modified from the EUROSION Shoreline Management Guide, EU, 2004. Taken from IMAP guidelines, page 134, Table 1.

Indicator units

- Km of artificial coastline and % of total length of coastline.
- Percentage (%) of natural coastline on the total coastline length.

The length of artificial coastline should be calculated as the sum of segments on reference coastline identified as the intersection of polylines representing human-made structures with reference coastline ignoring polylines representing human-made structures with no intersection with reference coastline. The minimum distance between coastal defence structures should be set to 10 m in order to classify such segments as natural, i.e. if the distance between two adjacent coastal defence structures is less than 10 m, all the segment including both coastal defence structures is classified as artificial.

List of Guidance documents and protocols available

Monitoring and assessment methodological guidance on EO8: coastal ecosystems and landscapes (within IMAP guidelines)

Ecological Objective 8:	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	Length of coastline subject to physical disturbance due to the influence of human-made structures

EUROSION Shoreline Management Guide (European Commission and Directorate General Environment, 2004, Annex 2)

Data Confidence and uncertainties

Regarding data confidence, both geographic scale and resolution of images have to be properly selected depending on type and density of coastal human-made structures. A specific cost/benefit analysis has to be carried on to choose the right balance among resolution, an acceptable level of uncertainties and the necessity to assure comparability of results at Mediterranean level.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Space and airborne earth observation systems are the most suitable tool to conduct the monitoring strategy of the EO8 common indicator, i.e. very high resolution (VHR) satellite imagery, aerial photographs, laser scanners etc. Beyond earth observation data, identification techniques and procedures used through GIS tools also have to be described

Available data sources

CORINE land cover, national spatial plans, World Imagery Basemap feature (in ArcGIS 10.1), Landsat satellite imagery, Google earth, aerial photographs surveys.

Spatial scope guidance and selection of monitoring stations

The exact territorial extent of the monitoring should be presented.
The optimum spatial scale for a proper identification of human-made structures should be 5 m by satellite imagery or aerial photographs.

Temporal Scope guidance

Monitoring human-made structures data should be updated at least every 6 years, while shoreline survey of sandy coastline under anthropogenic pressure should be, if possible, repeated annually (at the same time of the year)

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

The total length of coastline estimated as being subjected to physical disturbance due to the influence of human-made structures should be summed. In addition, the share of this coastline in total country's coastline should be determined. If an official coastline is available, i.e. an institutional body provides a GIS polyline, then such coastline can be used to “project” the identified human-made structures in order to classify parts of the coastline as being subjected to physical disturbance due to the influence of human-made structures. Geographic scale of maps and cartography used to identify human-made structures could be different but not too much form the ones used for the official coastline. In case if such official coastline is not available or its geographic scale is too coarse with respect to one needed to properly identify human-made structures, then coastline will be defined by the same maps/cartography used for human-made structures identification.

Expected assessments outputs

Ecological Objective 8:	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	Length of coastline subject to physical disturbance due to the influence of human-made structures

The total length of coastline influenced by human-made structures and the share of this coastline in total country's coastal length should be provided on a map showing the coastline subject to physical disturbance due to human-made structures (artificial segments) in red line and the rest (natural segments) in green line.
The assessment output should be reported as a common shape file format with GRS as WGS84. Shape file with other GRS will also be accepted if provided with a complete .prj file that allows GRS transformations by standard GIS tools.

Known gaps and uncertainties in the Mediterranean

In order to implement EO8 indicator with an acceptable level of accuracy, recent data sources with proper spatial resolution and complete coastline coverage should be used jointly with adequate GIS tools and expert team.
Capacity building can be readily assessed for each CP as such resources are generally available for the Mediterranean Region also taking into account the increasing efforts on satellite imagery products (ESA Sentinels constellation). So, once a common framework of data sources, GIS procedures and way of representing the output of EO8 indicator are agreed, a common implementation work for all CPs could be in principle settle down.

Contacts and version Date

Key contacts within UNEP/MAP for further information

Version No	Date	Author
V.1	27/6/16	PAP/RAC & Giordano Giorgi
V.2	27/7/16	Giordano Giorgi
v.3	23 March 2018	PAP/RAC

3. Indicator guidance factsheet for EO8 Coastal Ecosystems and Landscapes Common Indicator 25 "Land cover change"

<table>
<tr><td>Ecological Objective</td><td colspan="2">The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved</td></tr>
<tr><td>Indicator Title</td><td colspan="2">Land cover change</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Proposed Target(s)</td></tr>
<tr><td>- Linear coastal development minimised, with perpendicular development being in balance with integrity and diversity of coastal ecosystems and landscapes.
- Mixed land-use structure achieved in predominantly man-made coastal landscapes</td><td>Integrity and diversity of coastal ecosystems, landscapes and their geomorphology are preserved.</td><td>Proposed targets should be considered as general recommendations to be adapted to regional/local specificities and knowledge.

- No further construction within the setback zone
- Change of coastal land use structure, dominance of urban land use reversed
- Keep, and increase where needed, landscape diversity</td></tr>
<tr><td colspan="3">GES, targets and measures cannot be expressed quantitatively (as a threshold value) but due to country specific circumstances (socio-economic, cultural, historical) should be defined by the countries themselves. In doing so the CPs should take their spatial development and planning policies into account, as well as the legal obligations of the Barcelona Convention, in particular the ICZM Protocol. The above GES definition and Proposed target(s) are just examples.</td></tr>
<tr><td colspan="3">Rationale</td></tr>
<tr><td colspan="3">Justification for indicator selection

The UNEP/MAP's Correspondence Group on Monitoring (CORMON) on Coast and Hydrography agreed, in May 2013, on a specific candidate common indicator for the Mediterranean region addressing land cover change.

Identifying and understanding the processes of land cover change (i.e. how land cover has been changed by humans and the processes that result in landscape transformation) is especially relevant for critical and vulnerable areas such as coastal zones, where several competitive uses are pressing. In this context urbanization, or land take, is the most dramatic change given the (almost) irreversibility of the process. The associated impacts could be listed as follows (Figure 1):
• Habitat loss with the associated impact on related ecosystem functions like C sequestration, regulation of water cycle, or biomass production.
• Fragmentation. The division of natural habitats in smaller parcels contributes to the isolation of number of species and also compromises its viability.
Therefore, the accumulated impacts of urbanization highly compromise ecosystem integrity. Since impacts are dependent on the scale and pace of changes it is important to consider these aspects when monitoring land cover changes.

Beyond the process of urbanization there are other changes that are less irreversible and also have important consequences:
• Conversion from forest to agricultural use. This results in habitat loss, habitat fragmentation and, consequently, loss of biodiversity. There is also a decrease on the degree of soil coverage by vegetation which in turn determines the risk of erosion. Also this type of change results in a net loss of soil carbon.
• Conversion from agriculture to semi-natural. The impact strongly depends on the conditions at the time of abandonment. If conditions are favorable, land abandonment can lead to a recovery of natural vegetation. However, in case of unfavorable conditions like low vegetation coverage and/or steep slope, agricultural abandonment could lead to further land degradation.</td></tr>
</table>

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

- *Conversion from agricultural land to forest (forestation). This change involves tree plantation and it has a positive impact on land stability by increasing the vegetation cover of the soil and the increase of C sequestration. In terms of biodiversity it strongly depends on the species used for plantation. Native species definitely increase diversity and connectivity.*

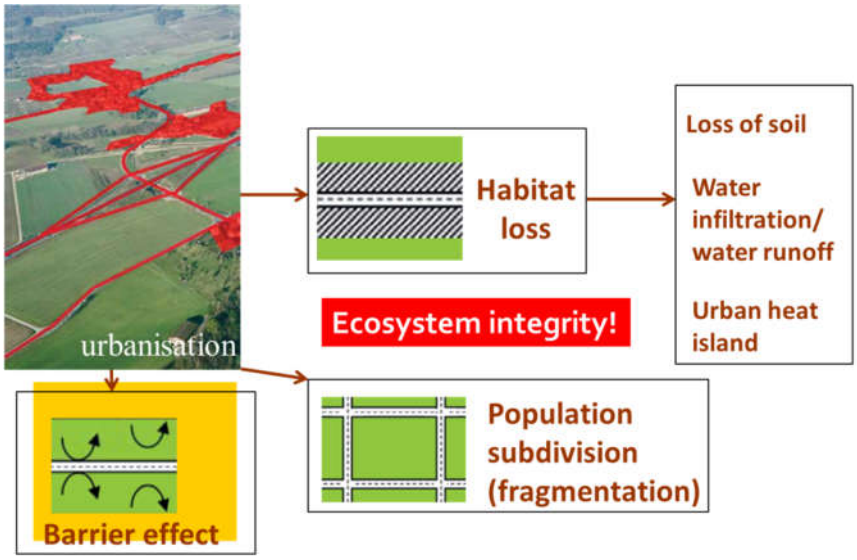


Figure 1. ***Overview of major impacts on land take***

Scientific References

References are grouped by the topic addressed. Within each section references are sorted by relevance (the first ones are more relevant to the current indicator)

Land us/land cover change and related impacts:

- Bajocco, S., De Angelis, A., Perini, L., Ferrara, A. i Salvati, L., 2012, 'The Impact of Land Use/Land Cover Changes on Land Degradation Dynamics: A Mediterranean Case Study', *Environmental Management*, 49(5), p.980-989.
- Dale,V. H. , Brown, S. , Haeuber, R. A. , Hobbs, N. T. , Huntly, N. , Naiman, R. J. , Riebsame, W. E. , Turner, M. G. and Valone, T. J., 2000. Ecological principles and guidelines for managing the use of land. *Ecological Applications* 10:639–670.
- Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., Snyder, P. K., Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T. i Daily, G. C., 2005. Global Consequences of Land Use. *Science*, 309(5734), p.570-574.
- Haines-Young, R., 2009, 'Land use and biodiversity relationships', *Land Use Policy*, 26, p.S178-S186.

Methodology to compute land use change indicator:

- Breton, F., Ivanov, E., Morisseau, F., Nowell, M. 2014. *D4.2 Report, accompanying database and supporting materials on LEAC Methodology and how to apply it in CASES*. PEGASO 06/Deliverable. URL: http://www.pegasoproject.eu/images/stories/WP4/D4.2%20LEAC_UAB_140401.pdf

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

- EEA, 2006. The changing faces of Europe's coastal areas, EEA report. European Environment Agency ; Office for Official Publications of the European Communities, Copenhagen, Denmark : Luxembourg.
- Feranec, J., Jaffrain, G., Soukup, T. and Hazeu, G., 2010, 'Determining changes and flows in European landscapes 1990–2000 using CORINE land cover data', *Applied Geography*, 30(1), p.19-35.
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- Weber, J.-L., 2007, 'Implementation of land and ecosystem accounts at the European Environment Agency', *Ecological Economics*, 61(4), p.695-707.
- EC - DG.ENV, 2013. Mapping and assessment of ecosystems and their services an analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: discussion paper - final, April 2013. Publications Office, Luxembourg. URL: http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

Policy Context and targets

Policy context description

After agreeing on including the candidate common indicator on Land use change in CORMON on Coast and Hydrography in 2013, it was decided that this candidate common indicator would need further testing, pilot implementation (including during the initial phase of IMAP), before the Contracting Parties could agree to its regional usage as a common indicator.
In order to follow-up on this CORMON Coast and Hydrography recommendation, an EcAp pilot project took place in the Adriatic to test the feasibility of this candidate common indicator on the sub-regional level, in the framework of an EU funded project on the "Implementation of the Ecosystem Approach in the Mediterranean by the Contracting Parties in the context of the Barcelona Convention for the Protection of the Marine Environment and the Coastal region of the Mediterranean and its Protocols (EcAp-MED project 2012-2015)". The main conclusions of the Pilot project suggest that by using the common remote data and a common method for processing and presenting the results are feasible and a very positive step forward as far as monitoring the processes, the state and evolution of the coastal zones.
The results of this pilot are presented in document UNEP(DEPI)/MED WG.420/Inf.18.

As for the protocols of the Barcelona convention, The ICZM protocol identifies the need of balanced use of coastal zones in several articles.
For example, the **Article 5** sets the objectives of integrated coastal management:

(a) to facilitate, through the rational planning of activities, the sustainable development of coastal zones by ensuring that the environment and landscapes are taken into account in harmony with economic, social and cultural development;
(b) preserve coastal zones for the benefit of current and future generations;
(c) ensure the sustainable use of natural resources, particularly with regard to water use;
(d) ensure preservation of the integrity of coastal ecosystems, landscapes and geomorphology;

In **Article 6**, where general principles of ICZM are discussed, it is highlighted that the formulation of land use strategies, plans and programs covering urban development and socioeconomic activities, as well as other

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

relevant sectoral policies, shall be required (f). In addition, the Article 6 calls for the allocation of uses throughout the entire coastal zone to be balanced, and unnecessary concentration and urban sprawl to be avoided(h).

The **Article 8** calls to Contracting Parties to ensure that their national legal instruments include criteria for sustainable use of the coastal zone. Some of such criteria ask for "identifying and delimiting, outside protected areas, open areas in which urban development and other activities are restricted or, where necessary, prohibited" (a). In addition, it asks for limiting the linear extension of urban development and the creation of new transport infrastructure along the coast(b).

In addition, the EU's Habitats Directive (92/43/EEC), Birds Directive (2009/147/EC), as well as Convention of Biological Diversity can also be relevant for policy context regarding land cover change.

Targets

- No further construction within the setback zone
- Change of coastal land use structure, dominance of urban land use reversed
- Keep, and increase, where needed, landscape diversity

Interpretation of targets and setting the measures to achieve them should be left to the countries.
The reason is the strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions in each country. In other words: although the indicator is a simple tool to show trends in land-cover changes for interpretation purposes, additional criteria should be taken into account i.e. due to strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions the interpretation should be left to the countries.
These targets should be taken as general guidelines that need to be considered in light with the local knowledge. Given the relevance of the socio-economic, historic and cultural dimension, in addition to specific geographical conditions, local experts will provide the needed input in support to this indicator.

Policy documents

ICZM Protocol (available in different languages at
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22009A0204(01))

Convention on Biological Diversity (www.cbd.int)

Habitats Directive (92/43/EEC)
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043

Birds Directive (2009/147/EC)
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147

Indicator analysis methods

Indicator Definition

Land use/land cover change is the change of purpose to which land is profited by humans (e.g., protected areas, forestry for timber products, plantations, row-crop agriculture, pastures, or human settlements). Different parameters can be considered for evaluation of indicator on land use/land cover change. The parameters are summed in Table 1. The combined analysis of these parameters entails an inventory of the urbanization pressures on coastal ecosystems. In practice the parameters can identify: (i) where pressures are higher (by amount of change and by pace of the process); (ii) spatial trends (along the coast and landwards); and (iii) areas for priority action. However, responsible (local) institutions are necessary to correctly interpret these processes and to understand the drivers behind them.

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

Table 1. ***Description of the parameters calculated for the indicator Land Cover Change***

Parameter	*Units*	*Data required*	*Reporting units*	*Meaning*
Area of built-up land in coastal zone as a proportion of the total area in the same unit	*% of artificial areas*	*Artificial surfaces at a single time shot*	*Coastal zone as defined by the country* *Also coastal strips (<300m*, 300m-1km, 1-10 km).*	*State of urban areas at a particular time. This is used as a baseline, i.e. initial condition for the analysis of changes.*
Area of built-up land in coastal units as a proportion of the area of built-up land in the wider coastal unit	*% of artificial areas*	*Artificial surfaces at a single time shot*	*Narrower coastal strips within the wider ones (or even within the whole coastal unit).*	*This parameter shows to what extent the process of urbanization has been more intense on the coast than on the inland. It also reflects the relevance of economic activities on the coast as a driver of urban development.*
Land take as % initial urban area on the coastal zone	*% of increase of urban areas*	*Artificial surfaces at t_0 and t_1*	*Coastal zone as defined by the country.* *Also coastal strips (<300m*, 300m-1km, 1-10 km)*	*Intensity of the process of urbanization in a given period of time.*
Change of forest and semi-natural areas	*% of change of forest and semi-natural areas*	*Forest and semi-natural land at t_0 and t_1*	*Coastal zone as defined by the country.* *Also coastal strips (<300m*, 300m-1km, 1-10 km)*	*This parameter would reflect to what extent management is leading to an increase, maintenance or decrease of forest and semi-natural areas. This represents the land cover closer to "natural land" excluding wetlands (specific indicator).*
Change of wetlands	*% of change of wetlands*	*Wetlands at t_0 and t_1*	*Coastal zone as defined by the country.* *Also coastal strips (<300m*, 300m-1km, 1-10 km*	*This parameter will indicate how effective is the protection of wetlands, in terms of coverage. The indicator could reflect and increase, maintenance or a decrease of wetlands.*
Change of protected areas	*% of change of protected areas*	*Protected areas at t_0 and t_1*	*Coastal zone as defined by the country.* *Also coastal strips (<300m*, 300m-1km, 1-10 km*	*This parameter shows how the extent of protected areas changes in time.*

**the 300m wide coastal strip is proposed as relevant representation of the coastal setback (also considering the resolution issues)*

Methodology for indicator calculation

*1. **Data compilation** - Land cover classes are typically mapped from digital remotely sensed data through the process of a supervised digital image classification or, alternatively, determined by in situ monitoring. Land cover classes needed for the indicator are listed in the Table 2. If more detailed classification is available, then it could be provided making the clear link with Table 2.*

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

Table 2. ***Land cover classes for the Land Cover Change indicator***

LU/LC class	*Definition*
Artificial surfaces (also referred as built-up areas)	*Surfaces with dominant human influence but without agricultural land use.* *These areas include all artificial structures and their associated non-sealed and vegetated surfaces.* *Artificial structures are defined as buildings, roads, all constructions of infrastructure and other artificially sealed or paved areas. Associated non-sealed and vegetated surfaces are areas functionally related to human activities, except agriculture.* *Also, the areas where the natural surface is replaced by extraction and / or deposition or designed landscapes (such as urban parks or leisure parks) are mapped in this class.* *The land use is dominated by permanently populated areas and / or traffic, exploration, non-agricultural production, sports, recreation and leisure.*
Agricultural	*It includes: arable land, permanent crops, pastures and heterogeneous agricultural areas (complex cultivation patterns, land principally occupied by agriculture, with significant areas of natural vegetation).*
Forest and semi-natural land	*It includes: forests, scrub and/or herbaceous vegetation associations, open spaces with little or no vegetation*
Wetlands	*Inland marshes, peatbogs, salt marshes, salinas, intertidal flats*
Water bodies	*Water courses, water bodies, coastal lagoons, estuaries, sea and ocean.*
Protected areas	*Surfaces with any of the protection status (such as Natura 2000, IUCN or national-specific categories with the objectives to protect biodiversity, habitats, species, landscapes and alike in the coastal zone)*

2. ***Data processing***

Data processing includes the following steps (Figure 2):

(i) Pre-processing

Land cover data could be available in two formats: vector data (polygons) or raster data (grid). For practical reasons, and to simplify the computing process, the first step is to ensure that all the data is in a grid of 1 ha. Conversion of vector data to a grid, or raster, is a common procedure in GIS techniques. Most of the GIS software provides different options to convert vector data into a grid. Here the 'Maximum area' criterion is suggested as one of the most standard methods.

(II) Combining data

Once the data is available in 1 ha grid, the different layers are combined. This process is automatically done by any GIS software and creates an associated table with all the information available for each cell in the grid. The layers to be combined are listed as follows:

1. *Baseline land cover data (y0).*
2. *Land cover change data (y0-y1)*
3. *Delimitation of coastal zone*

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

4. *Administrative unit where the coastal zone belongs (NUTS3 or equivalent)*

Therefore the minimum information that the resulting table should contain is as follows:

1. *Grid ID. Unique identifier for each cell in the grid of 1 ha*
2. *Coastal zone. Yes/No. Boolean parameter that indicates if the cell is within the coastal zone, as defined by the country*
3. *Administrative unit. Code that identifies the administrative unit where the cell is located (NUTS3 of equivalent).*
4. *Land cover class at t_0. Code for the land cover class of the cell.*

(iii) <u>extracting statistics</u>

As a result of the previous step a table should be available with the unique code of each cell of the 1 ha grid and all related parameters. Therefore the extraction of the statistics for the calculation of the indicator could be done in a spreadsheet and does not require any GIS processing (see Data analysis and assessment outputs section for the details).

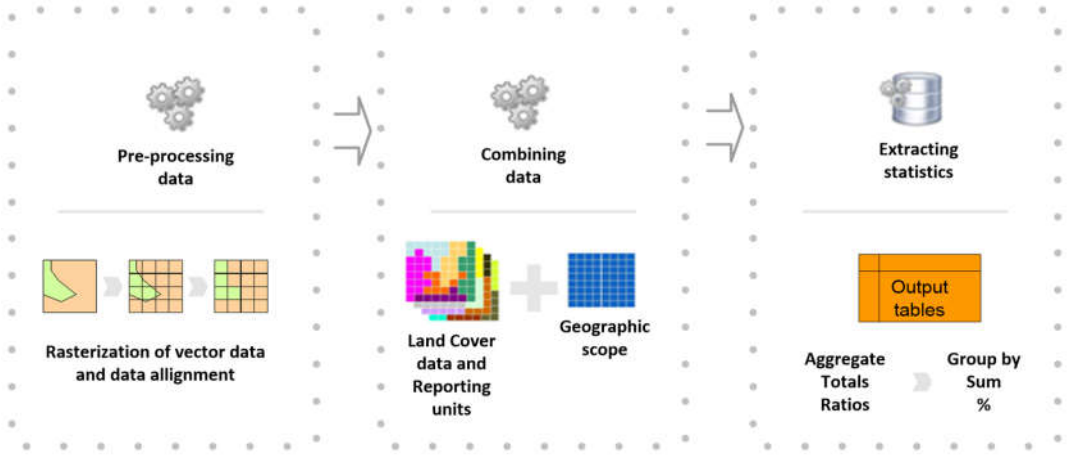

Figure 2. ***Data processing for the Land Cover Change indicator***

Indicator units

The first monitoring will focus on the base line. The indicator units are indicated below:

1. *km^2 of built-up area in coastal zone*
2. *%of built-up area in coastal zone*
3. *%of other land cover classes in coastal zone*
4. *% of built up area within coastal strips of different width (see Table 1) compared to wider coastal units*
5. *% of other land cover classes within coastal strips of different width (see Table 1) compared to wider coastal units*
6. *km^2 of protected areas within coastal strips of different width*

For second monitoring the following units will also be relevant:

7. *% of increase of built-up area, or land take*

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

8. *% of change of other land cover classes*
9. *% of change of protected areas*

List of Guidance documents and protocols available

Pilot project in the Adriatic on testing the candidate common indicator 'Land use change' in the Mediterranean, by: Anna Marín. Raquel Ubach. and JaumeFons-Esteve. Coordinated by: Marko Prem, PAP/RAC. URL: http://www.pap-thecoastcentre.org/pdfs/Pilot%20Adriatic_Final_Sep2015.pdf

Data confidence and uncertainties

Production of land use/land cover data from remote sensing is always a compromise between precision and efforts required to derive the information from satellite images. The data sources listed below (see Available data sources) have been validated by the responsible institutions or providers of the data. Additionally, if analogue maps from official institutions are available they could be digitalised and used accordingly. Quality assurance/control always involve a selection of percentage of points where the derived information is checked against "ground truth" –usually ancillary information like official maps, cadastre,... but also field inspections.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

The most elaborated guidelines are available from the Corine Land Cover programme (currently integrated in the Copernicus Programme).

http://www.eea.europa.eu/publications/technical_report_2007_17

Available data sources

The data sources listed below are transnational data bases (the first one only European, the rest global). Existing national data (official) is also suitable for this indicator.

- Corine land Cover (only European coverage)
http://land.copernicus.eu/pan-european/corine-land-cover

- GlobCover. Global land cover dataset at 300m resolution from the MERIS sensor on the ENVISAT satellite.
http://due.esrin.esa.int/page_globcover.php

-Climatge Change Initiative Land Cover map. Global land cover dataset at 300m resolution, for 1998-2002, 2003-2007, 2008-2012.
http://maps.elie.ucl.ac.be/CCI/viewer/index.php

-GLC-SHARE: Global Land Cover data combined from 'best available' national land cover maps. 1km resolution. http://www.fao.org/geonetwork/srv/en/main.home?uuid=ba4526fd-cdbf-4028-a1bd-5a559c4bff38

Spatial scope guidance and selection of monitoring stations

The exact territorial extent (coastal area for the analysis) of the monitoring should be defined. The Mediterranean ICZM Protocol defines the landward limit of coastal zone as the "limit of the competent coastal units as defined by the Parties (Article 3)." In other words, the landward limit will be country-specific, e.g. dependant on definition given by certain Contracting party when ratifying the Protocol.

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

As for the resolution of the source data it is a „compromise between precision and efforts needed in processing the satellite images. The following indications could be considered minimum requirements:

- *Minimum mapping unit of 25 ha and 100 m of linear elements*
- *Minimum change detection 5 ha*

Temporal Scope guidance

The temporal scale should be 5 years, in order to be effective on the counteracting negative effects and taking early actions on problematic areas.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

The statistics can be computed as follows:

1. *Percentage of built-up area in coastal zone.*
    a) *Filter the data by the grids belonging to the coastal zone*
    b) *Calculate total area by counting the total number of cells. This is the area in km^2.*
    c) *Filter, within the coastal zone, by land cover "artificial areas" (see Table 1 for the definition of land cover classes).*
    d) *Calculate area of "artificial areas" by counting the number of cells. This is the area in km^2.*
    e) *Divide 1d by 1b in order to obtain the percentage of artificial area on the coastal zone.*
2. *Percentage of other land cover classes on the coastal zone. As complementary to "Percentage of built-up area in coastal zone" the same procedure could be applied to each land cover class as defined in Table 1. In that case the procedure described in 1 will be replicataed by changing "artificial areas" with the other land cover classes*
3. *Area of built-up land in coastal units as a proportion of the area of built-up land in the wider reference region.*
    a) *Filter the data by the grids belonging to the entire administrative unit where the coastal zone belongs (NUTS3 or equivalent).*
    b) *Filter by land cover "artificial areas" (see Table 1 for the definition of land cover classes).*
    c) *Calculate area of "artificial areas" by counting the number of cells. This is the area in km^2.*
    d) *Sum 1d with 3c.*
    e) *Divide 1d by3d. This value is the percentage of built-up area within the administrative unit that is located on the coastal zone.*
4. *Land take as % of initial urban area on the coastal zone. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t_0).*
    a) *Filter the data by the grids belonging to the coastal zone.*
    b) *Calculate total area by counting the total number of cells. This is the area in km^2.*
    c) *Filter, within the coastal zone, by land cover "artificial areas" (see Table 1 for the definition of land cover classes) for t_0.*
    d) *Filter, within the coastal zone, by land cover "artificial areas" (see Table 1 for the definition of land cover classes) for t_1.*
    e) *Calculate 4d-4c and then divide by 4c. This provides the percentage of land take compared to*

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

the initial built-up area.

5. *Change of forest and semi-natural land. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t_0).*
   a) *Filter the data by the grids belonging to the coastal zone.*
   b) *Calculate total area by counting the total number of cells. This is the area in km^2.*
   c) *Filter, within the coastal zone, by land cover "Forest and semi-natural land" (see Table 1 for the definition of land cover classes) for t_0.*
   d) *Filter, within the coastal zone, by land cover "Forest and semi-natural land" (see Table 1 for the definition of land cover classes) for t_1.*
   e) *Calculate 5d-5c and then divide by 5c. This provides the percentage of change of forest and semi-natural areas for the given period.*
6. *Change of wetlands. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t_0).*
   a) *Filter the data by the grids belonging to the coastal zone.*
   b) *Calculate total area by counting the total number of cells. This is the area in km^2.*
   c) *Filter, within the coastal zone, by land cover "Wetlands" (see Table 1 for the definition of land cover classes) for t_0.*
   d) *Filter, within the coastal zone, by land cover "Wetlands" (see Table 1 for the definition of land cover classes) for t_1.*
   e) *Calculate 6d-6c and then divide by 6c. This provides the percentage of change of wetlands for the given period.*

The above mentioned analysis can be complemented with the following ones that provide additional insight on the land cover indicator.

7. *Additional analytical units*
   a) *Setback zone (if defined by country). Given the relevance of this part of the coastal area, as referred on the ICZM protocol, the indicators on % of built-up and land take can be analysed for this specific zone.*
   b) *Elevation breakdown within the coastal area. Distance to the coast and elevation are elements that configure different habitat distribution and patterns. With available local knowledge 3 to 5 elevations classes could be considered to be analysed independently within the coastal area in order to better link the pressure of land take to specific habitats. An example follows: < 50 m asl, 50 – 300 m, >300 m).*
8. *Additional parameters*
   What has been lost by urbanization?
   a) *Filter the data by the grids belonging to the coastal zone.*
   b) *Calculate total area by counting the total number of cells. This is the area in km^2.*
   c) *Develop a pivot table with land cover classes at t_0, on rows, and land cover classes at t_1 on columns. Cells in this matrix will contain the area that has changed from certain land cover class at $t_0$to a new class in t_1.*
   d) *Select the column for "Built-up areas".*
   e) *Values on the rows indicate the different land cover classes at t_0 that have been converted into built-up area.*
   f) *Values from 5 can be divided by the corresponding area of the same class at t_0. This will provide the percentage of certain land cover class that has been converted into built-up.*

Ecological Objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
Indicator Title	*Land cover change*

Expected assessments outputs

The outputs are detailed below:

- *Digital map with the land cover classes for the coastal area. Land cover classes should follow the classification provided in Table1. If more detailed classification is available, then it could be provided making the clear link with Table 1. The following specifications will ensure the interoperability of the maps provided by different institutions/countries:*
  - *Format: raster GeoTIFF (Geographic Tagged Image File Format) 1 ha*
  - *Metadata:*
    - *Title of the map*
    - *Geographic reference.*
      - *Bounding box.*
      - *Coordinate reference system*
    - *Temporal reference (year)*
    - *Responsible organisation*
- Spreadsheet with the calculated indicators as described in the methodology.
- Starting with the second monitoring, additional maps will be provided indicating areas of land take (new urbanization). The specifications for these maps are the same as indicated above.

Known gaps and uncertainties in the Mediterranean

The definition of the analytical units of the coastal zone could be revised in view of more detailed data on habitats distribution, or input from national experts. In any case it is important to take into account the implications of the different delineations on the interpretation of the results.
The use of remote sensing and the selected resolution is the main constrain when analysing the outcomes

- *Not all changes are observed since there is minimum change detection. Therefore, the patterns observed indicate that changes are underestimated. In any case the proposed approach is still relevant since it provides an idea of the magnitude of the processes of urbanization.*
- *Given the resolution and processing, linear elements are not well captured; therefore, linear elements perpendicular to the coast, for example, are not detected.*
- *The information currently available does not allow identifying built-up on the territorial waters.*

Since these limitations arise from the definition of the resolution, there is space for improvement if it is needed. However, there is always a trade-off between resolution and efforts required to obtain the information.

In addition, countries may obtain data from different sources (different resolution, different level of precision) which may make comparability of data difficult.

Contacts and version Date

Key contacts within UNEP for further information

Version No	**Date**	**Author**
V.1	27/6/16	PAP/RAC
V.2	20/07/16	UAB
v.3	01/04/19	PAP/RAC