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Draft Guidance on how to reflect changes in hydrographical conditions in relevant assessments

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Guidance Document on how to reflect changes in hydrographical conditions in relevant assessments

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1 Introduction

1.1 Background and context

The aim of the Ecosystem Approach (EcAp) is to improve the way human activities are managed for the protection of the marine environment. Following the 2002 World Summit on Sustainable Development, the EcAp has been adopted by many International Conventions and Regional Seas Organizations. The Contracting Parties to the Barcelona Convention have decided to progressively apply the EcAp to the management of human activities that may affect the Mediterranean marine and coastal environment for the promotion of sustainable development in January 2008 at their meeting in Almeria, Spain (15th Meeting of the Contracting Parties to the Barcelona Convention - COP15). Since then, the EcAp strategy has been recognized as a guiding principle for the overall work under the Barcelona Convention. The main added-value of EcAp in the context of the Barcelona Convention is a renewed emphasis on the implementation and integration of cross-cutting issues and challenges.

In 2012 (COP17), the Contracting Parties agreed on an overall vision and goals for EcAp based on 11 ecological objectives, operational objectives and indicators for the Mediterranean. The timeline for implementing the ecosystem approach until 2019 was also adopted, based on a 6-year cyclic review process of its implementation. The second EcAp cycle will start in 2016 until 2021.

One of the key EcAp tasks is the development of a regional integrated monitoring programme for the on-going assessment of the marine and coastal environment. A specific timeline was adopted in 2014 (the so-called “COP18 EcAp Decision”), on how to develop an Integrated Mediterranean Monitoring and Assessment Programme by the 19th Meeting of the Contracting Parties (COP19) in 2016 and how to implement it following the 6-year EcAp cycle structure. During the COP18 in 2014, targets for achieving Good Environmental Status (GES) of the Mediterranean Sea and its coastal zone by 2020 were also adopted.

Correspondence Groups on Monitoring (CORMONs) were set up with the aim to further specify the common indicators, discuss methodologies and parameters related to them and as such form the core of the Integrated Monitoring and Assessment Programme. These groups tackle the issues covered by the ecological objectives, namely Pollution and Litter; Coastal Ecosystems and Landscapes and Hydrographical conditions; and Biodiversity and Fisheries. 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.

One of the 11 EcAp ecological objectives is Ecological Objective 7 (EO7) *Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems*. EO7 is dedicated to assess permanent alteration of hydrographical conditions due to human activities causing impacts at local or broader scales and reflecting long-term changes in the ecosystems. By definition the term ‘hydrography’ is meant to include depth, tidal currents and wave characteristics of marine waters, including the topography and morphology of the seabed.

EO7 corresponds to Descriptor 7 (Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems) of the European Marine Strategy Framework Directive (MSFD). 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. EO7overlaps 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) on the assessment of the effects of certain plans and programmes on the environment, assessments undertaken under Marine Spatial Planning (MSP) and in the context of integrated coastal zone management (ICZM). These assessments can be seen as tools to support the control of activities which can result in permanent alterations of hydrographical conditions. Other linkages with regional policies exist through the Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil under the Barcelona Convention.

1.2 Purpose of the Guidance document

In relation to EO7, the key recommendation of the Integrated CORMON was to develop a guidance document on how to reflect changes in hydrographical conditions in relevant assessments, such as EIAs and others. In response to this recommendation, this document aims to define a methodological approach for assessing alterations of hydrographical conditions and the impact this may have on habitats due to permanent constructions and activities on the coast or at sea. This methodological approach is primarily developed in line with the EIA/SEA processes but some aspects could be also relevant to the more overarching processes undertaken in the framework of MSP and ICZM. It builds on the good practices from the countries (such as France, Spain, Italy) to assess physical, ecological, biological impacts (UNEP(DEPI)/MED WG.411/6).The guidance document will be presented and discussed at the next EcAp Coordination Group in September 2015.

This guidance document is structured as follows:

- Section 2 describes the relevant assessments i) EIA and SEA and ii) MSP and ICZM;
- Section 3 provides information on the scope, parameters, monitoring, existing guidance documents and challenges related to the implementation of EO7;
- Section 4 presents a methodological approach for the consideration of EO7 in EIA and SEA, as well as in MSP and ICZM. The best practice modelling methods are also discussed;
- Section 5 provides examples on the reflection of EO7 in the assessment of hydrographical changes.

2 Relevant assessments

2.1 EIA and SEA

An **Environmental Impact Assessment (EIA)** is a tool for identifying, assessing and predicting the environmental impacts of a proposed project/development at an early stage. It has a structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the development process; finding ways and means to reduce adverse impacts; shaping projects to suit the local environment; and presenting the predictions and alternatives to decision-makers[1]. Typically, EIAs are "reactive" in their approach (i.e. carried out once project has already been planned) and focus on a specific project and affected site. They are considered as a short-term, one-off project-based study.

EIA takes place within the legal, policy and institutional frameworks established by individual countries and international agencies. In Europe, the EIA Directive (2011/92/EU) sets out the legal basis of the environmental assessments undertaken for individual projects. Although legislation and practice vary around the world, the fundamental components of an EIA are based on the following steps: a) screening; b) scoping; c) assessment of impacts; d) compilation of EIA report; e) consultation; f) decision-making and g) monitoring, in the post-development phase to establish whether the predicted impacts and proposed mitigation measures occur as defined. Monitoring is not obligatory under the EIA Directive but is nevertheless used in some Member States. While the stages of the EIA process are largely undertaken chronologically, the EIA process is an iterative one and some aspects of it may require re-evaluation as new information becomes available (e.g. after consultation or field survey) and is fed back into the process. EIAs are generally based on the following principles: they must be preventative, scientific, transparent and participative, and must deal with broad environmental concerns.

The application of impact assessment to policies, plans and programmes is commonly called **Strategic Environmental Assessment (SEA)**. SEA extends the aims, principles and approach of EIA to the higher levels of decision-making when major alternatives are still open. There is far broader scope than at the project level to integrate environmental considerations into development goals and objectives. In contrast to EIA, SEA is commonly described as being proactive and "sustainability driven". It covers a wider range of activities or a wider area and often over a longer time span than the EIA for projects. To ensure that development meets the objectives of sustainable development, both SEA and EIA are desirable; the broad scope and low level of detail of the SEA complemented by the narrow scope and relatively high level of detail of the EIA. It is important that the impact assessment of a project is 'nested' within a strategic environmental assessment, thus ensuring that it is contextually sound and consistent with broader development objectives. In this respect, the issues of cumulative impacts e.g. on biodiversity and/or ecosystem services are best addressed at a regional or sectoral scale through SEA, rather than on a project-by-project basis.

In Europe, the SEA Directive (2001/42/EC) limits the assessment to plans and programmes, which means that policies are not included. Although the SEA and EIA procedures are very similar, there are some differences[2]:

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[1] https://www.cbd.int/impact/whatis.shtml

[2] http://ec.europa.eu/environment/eia/sea-legalcontext.htm

- the SEA requires the **environmental authorities** to be consulted at the screening stage;
- **scoping** (i.e. the stage of the SEA process that determines the content and extent of the matters to be covered in the SEA report to be submitted to a competent authority) is obligatory under the SEA;
- the SEA requires an assessment of reasonable **alternatives** (under the EIA the developer chooses the alternatives to be studied);
- under the SEA, countries must **monitor** the significant environmental effects of the implementation of plans/programmes in order to identify unforeseen adverse effects and undertake appropriate remedial action;
- the SEA obliges countries to ensure that environmental reports are of a sufficient **quality**.

2.2 MSP and ICZM

Marine spatial planning (MSP) is a participatory process of mapping, analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that are usually specified through a political process (Ehler and Douvere, 2009). Effective MSP is **ecosystem-based**, balancing ecological, economic, and social goals and objectives toward sustainable development; **integrated**, across sectors and agencies, and among levels of government; **place-based or area-based**; **adaptive**, capable of learning from experience; **strategic and anticipatory**, focused on the long-term; and **participatory**, stakeholders actively involved in the process. MSP is used as a tool to resolve conflicts among human uses (user-user conflicts) and conflicts between human uses and the marine environment (user-environment conflicts).A new EU directive on Maritime Spatial Planning (2014/89/EU) has been recently adopted with the aim of establishing a framework for maritime spatial planning to promote the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources.

The principal output of MSP is a comprehensive spatial management plan for a marine area or ecosystem. This management plan sets out priorities for the area and defines what these priorities mean in time and space, providing a vision for the future development. Such a management plan takes into account the cumulative and interactive impacts of different human activities that are often most included in traditional single-sector management approaches.

In many ways MSP is similar to **integrated coastal zone management (ICZM)**. Both MSP and ICZM are integrated, strategic and participatory. Both aim to maximize compatibilities among human activities and reduce conflicts between human uses and the environment. In the Mediterranean region, anew Protocol on ICZM under the Barcelona Convention was signed in 2008 and ratified in 2010[3], to provide a common framework for the Contracting Parties to promote and implement integrated coastal zone management. The Protocol defines ICZM as “a dynamic process for the sustainable management and use of coastal zones, taking into account at the same time the fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interactions, the maritime orientation of certain activities and uses and their impact on both the marine and land parts”. The Protocol states that “taking into account the fragility of coastal zones, the Parties shall ensure that the process and related studies of **environmental impact assessment** for public and private projects likely to have significant environmental effects on the coastal zones, and in particular on their ecosystems, take into consideration the specific sensitivity of the environment and the inter-relationships between the marine and terrestrial parts of the coastal zone. In accordance with the same criteria, the Parties shall formulate, as appropriate, a **strategic environmental assessment** of plans and programmes affecting the coastal zone. The environmental assessments should take into consideration the **cumulative impacts** on the coastal zones, paying due attention, *inter alia*, to their carrying capacities”. This establishes a clear link to the assessment of impacts caused by coastal activities undertaken in EIA and SEA processes. In addition, in the environmental section, the Protocol calls for prior assessment of risks associated with different human activities and infrastructure.

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[3] Council Decision 2010/631/EU

3 Ecological Objective 7

3.1 Scope of EO7

Ecological Objective 7 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, either at broad scale or through acting cumulatively with other developments. It is recommended to focus on constructions in coastal waters or open sea (including wind farms, ocean energy device arrays, offshore airports, artificial islands, and aquaculture facilities) (UNEP(DEPI)/MED WG.411/3).Changes in hydrographical regime can also occur due to the maritime traffic in shallow areas and waterways accessing coastal infrastructure. As a first approach, permanent alterations in hydrographical conditions refer to constructions lasting for more than 10 years (UNEP(DEPI)/MED WG.411/3), implying an irreversible situation.

Three operational objectives and seven indicators have been defined for EO7 - Hydrographical conditions (Table 1).With regards to this ecological objective, indicator 7.2.2 'Location and extent of habitats impacted directly by hydrographic alterations' was agreed as a common indicator (Table 2). In this context, marine habitats that may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads) are amongst the most important sensitive receptors to take into consideration.

Table 1 List of operational objectives, indicators, GES and proposed targets for EO7

Operational objective	Indicator	GES	Proposed Targets
7.1 Impacts to the marine and coastal ecosystem induced by climate variability and/or climate change are minimized	7.1.1 Large scale changes in circulation patterns, temperature, pH, and salinity distribution	Ecosystems are resilient enough to adapt to climate change.	Anthropogenic impacts which may alter ecosystems' adaptive capacity are reduced.
	7.1.2 Long term changes in sea level		
7.2 Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimized	7.2.1 Impact on the circulation caused by the presence of structures	With new structures in place, near shore wave- and current patterns maintain as natural as possible.	Marine and shore based new structures planned, constructed and operated in a way to maintain the natural wave and current pattern as much as possible
	7.2.2 Location and extent of the habitats impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures	Negative impacts due to new structure are minimal with no influence on the larger scale coastal and marine system	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.
7.3 Impacts of alterations due to changes in freshwater flow from watersheds, seawater inundation and coastal freatic intrusion, brine input from desalination plants and seawater intake and outlet are minimized	7.3.3 Changes in key species distribution due to the effects of seawater intake and outlet	Water circulation in coastal and marine habitats, and changes in the levels of salinity and temperature are within thresholds, to maintain natural/ecological processes	Site specific tolerable limits of key species in immediate proximity of seawater intake and outlet structures are considered while planning, constructing and operating such infrastructure

Source: COP18 Decision IG.21/3

Table 2 Description of common indicator 7.2.2 under EO7

Common Indicator **description**	**DESCRIPTION** **Parameters and/or Elements, matrix**	**Assessment Method**	**Monitoring Guidelines** **Sampling and Analysis Reference Methods** **QA/QC**	**Recommendations** **/Additional Data needed**
Common Indicator 9 COP18 Indicator 7.2.2: **Location and extent of the habitats[4] impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures** With Ecological Objective 7.2 Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimised Pressure, Impact	Parameter: Area (e.g. km^2) where alterations in hydrographical conditions may be expected to occur (modeling orSemi-quantitative estimation). Area of habitat and theproportion of the total habitat if that type is expected to be affected by the permanent alteration in hydrographical conditions (modeling or semi -quantitative estimation).	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 subsequent use of models. Modeling potential changes in the spatial extent of habitats affected by permanent alterations, using field data and validated model data. Main aim of the models is to assess changes in the condition and extent of areas affected by permanent alterations. Models should be calibrated and continuously supported and validated with “in situ” monitoring datasets.		Implementation of the indicator by modeling the changes in hydrographical conditions to assess the extent of the possible affected area and the intensity of the changes to determine the area of habitat(s) affected. Models should be supported by “in situ” monitoring datasets.

Source: UNEP(DEPI)/MED WG.411/3)

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[4] To be chosen on the basis of the list determined under Ecological Objective 01

3.2 Parameters

According to the monitoring and assessment methodological guidance on EO7 (UNEP(DEPI)/MED WG.411/3), the physical characteristics to be monitored are: bathymetric data, seafloor topography, current velocity, wave exposure, turbulence and turbidity. Other additional parameters to take into account are salinity and temperature, which determine the seawater density and buoyancy, driving the extent of ocean stratification and circulation (Table 3).

Table 3 List of parameters to be monitored under EO7

Parameter	Description	Requirements
Bathymetry/seafloor topography	Measure of water depth variations/seafloor features	Depth variations relative to sea level/morphological variations
Current velocities	Result of the action of tides, wind, Coriolis effects and density differences	Measure of the dominant currents (speed and direction)
Wave exposure	Classification scale to describe the degree of exposure to waves (Extremely exposed, Very exposed, Exposed, Moderately exposed, Sheltered, Very Sheltered)	Measure of wave direction, wave height and exposure of the coast
Turbulence	Regime of fluid motion that is rotating and swirling as opposed to laminar flow	Related to bed shear stress that provides an index of fluid force per unit area on the stream bed
Turbidity	Measure of the degree to which the water loses its transparency due to the presence of suspended particulates.	Related to the concentration of suspended sediment in the water column
Salinity	Measure of the concentration of dissolved salts in water	Spatial and temporal distribution
Temperature	Together with salinity, temperature determines the density of seawater	Multi-annual, annual and seasonal variations

3.3 Monitoring

The monitoring of hydrographical conditions could be treated in two ways (UNEP(DEPI)/MED WG.411/3):

- Monitoring to provide baseline information at different spatial and temporal scale on variations of hydrographical conditions which might not be connected (at least not directly) to the human activities;
- Specific monitoring to assess the extent of area affected by alterations and impacts with a focus on the list of areas where alterations could be expected due to new developments.

These two types of monitoring activities are discussed further in Section Methodological approach.

3.4 Existing guidance documents

With respect to EO7, an advice document on hydrographical conditions (Descriptor 7) in the context of MSFD was published by OSPAR Commission (2012)under the auspices of the Environmental Impact of Human Activities (EIHA) Committee. A recent scientific and technical review of the MSFD Commission Decision 2010/477/EU in relation to Descriptor 7 was also carried out by the EC JRC, together with experts nominated by EU Member States, the Regional Sea Conventions and other stakeholder groups. This document is currently available for consultation (EC JRC, 2015)[5]. Other useful documents on the implementation of EO7 include the draft Integrated Monitoring and Assessment Programme (UNEP(DEPI)/MED WG.411/3), in which the monitoring strategy for EO7 is outlined.

A number of guidance documents on how to reflect changes in hydrographical conditions resulting from coastal and offshore developments in relevant assessments exist. For example, CEFAS (2004) provides scientific guidance on the collection, interpretation and presentation of data within EIAs for offshore wind farms, as part of the consent application process in England and Wales. All developments should be assessed according to site-specific basis, direct impacts on hydrodynamics and sediment dynamics and indirect impacts of these on other disciplines (e.g. benthos, fisheries, coastal protection, water quality, sediment quality, conservation-designated sites). A comprehensive guidance document on best practice methods for the application and use of numerical models to predict the potential impact of offshore wind farms was published by COWRIE Ltd (Lambkin et al. 2009).In another study by Royal Haskoning DHV (2012), an investigation on how different European Member States cope with the uncertainties in EIA and Appropriate Assessments (AA) for investigating the impact of major port development projects in the estuarine environment was conducted. This work was commissioned by the Antwerp Port Authority, as part of the EU Interreg project on Tidal River Development (TIDE).Practical guidelines on how to assist developers, planners, environmental practitioners and regulators in their approach to marine fish farm EIA were prepared by RPS (2007).

At European level, the European Commission prepared a guidance document on how best to ensure that wind energy developments are compatible with the provisions of relevant European Directives, in particular the Habitats and Birds Directives and their relationship with the EIA and SEA Directives(European Commission, 2011).The European Marine Energy Centre (EMEC Ltd, 2005) published a guidance document in response to queries about EIA requirements from developers of both wave and tidal energy converters.

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[5] ComDecRev_D7 (https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp)

3.5 Challenges

Through the consultation of the recent scientific and technical review of the MSFD Commission Decision 2010/477/EU in relation to Descriptor 7,a number of challenges in its implementation have been highlighted. These challenges, which are also relevant to the implementation of EO7 under EcAp, relate to the lack of coherence in definitions, standard approaches in the development and application of indicators and in the assessment of impacts and the complexity of achieving a common understanding of GES. Although the assessment of cumulative impacts from adjacent developments is crucial, guidance on how to approach this is lacking and the development of methodological standards is needed. It was proposed to integrate EO7 with other assessments, yet no standard approaches (e.g. for model calibration) in EIA procedures are available to quantify impacts. Likewise, there is a clear need to collate information from EIA-based monitoring, but no standardised methods have been yet defined for monitoring.

4 Consideration of EO7 in environment assessments

4.1 EIA and SEA

Figure 1below gives an overview of the main EO7 considerations in each step of the EIA process. This scheme can be also applied to SEA, as the key steps and principles of SEA are similar to that of EIA.

- to determine which projects or developments require a full or partial impact assessment study.

- to identify which **potential impacts** are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement);
- to identify **alternative solutions** that avoid, mitigate or compensate adverse impacts;
- to derive **terms of reference** for the impact assessment.

- to provide information that describes the **baseline environment**
- **to predict and identify the likely environmental impacts** of a proposed project or development, including the detailed **elaboration of alternatives.**

- Reporting the **Environmental Impact Statement (EIS) or EIA report**, including an environmental management plan (EMP), and a non-technical summary for the general audience.

- based on the terms of reference (scoping) and public (including authority) participation.

- on whether to approve the project or not, and under what conditions (unconditional approval; conditional approval; rejection)

- to **monitor whether the predicted impacts and proposed mitigation** measures occur as defined in the EMP;
- to verify the **compliance** with the EMP;
- to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion.

- Does this project/development concern a **new development**?

- Does this project/development concern a **large-scale development**?

- Does the implementation of the project have the potential to alter **hydrographical conditions**, either at **broad scale** or through acting **cumulatively** with other developments?

- Are the potential alterations in hydrographical conditions considered to be **permanent**?

- Which are the potential **changes in hydrographical conditions** in the context of EcAp?

- Which are the potential **impacts on affected habitats**?

-Which are the potential **cumulative impacts** with other activities in the area?

- Are there ways to **optimize the design and mitigate** potential impacts?

- What is the **size of the area affected**?

- Which are the **baseline values for the physical parameters** describing hydrographical conditions?

- Are the changes in the **physical parameters describing hydrographical conditions significant?**

- Which are the **impacts on the different habitats** in the area affected?

- How can the **design be optimized to mitigate** potential impacts?

- Which **mitigation measures** can be applied to minimize significant alterations in hydrographical conditions (physical parameters) and impacts on habitats?

- What **alternatives** are there to tackle significant changes in hydrographic conditions?

- How will the alterations in **hydrographical conditions** be **monitored**?

- How will the **impacts on affected habitats** be **monitored**?

- How will **mitigation measures** be **monitored**?

- How will monitoring be used to show the **achievement of "GES"**?

Figure 1Schematic diagram of how to reflect EO7 in each step of the EIA/SEA process. Adapted from: https://www.cbd.int/impact/whatis.shtml

Important to consider:

- EIA is a short term, project-based study. The EcAp is a longer-term process with a 6-year review cycle.
- Type of projects that require an EIA are normally specified. No agreed lists of human activities subject to EO7 assessment are yet established.
- Monitoring of environmental effects may not be mandatory in an EIA procedure (e.g. not required by the EIA Directive). However, it is a fundamental part in the EcAp programme through the development of an integrated monitoring programme, and the SEA procedure.
- EIAs do not necessarily take into account cumulative impacts.

4.1.1 Methodological approach

A methodological approach of how to reflect the objectives of EO7, in particular of indicator 7.2.2, in the main steps undertaken in an EIA (and SEA) procedure is proposed below (Figure 2). The identified steps provide a coherent and logic approach to assess the impacts of a construction/development in coastal and marine areas, both on the hydrographical conditions as well as marine habitats. Modelling is proposed as the main tool for the quantitative assessment of impacts, with the ultimate goal of achieving GES within the scope of EO7.

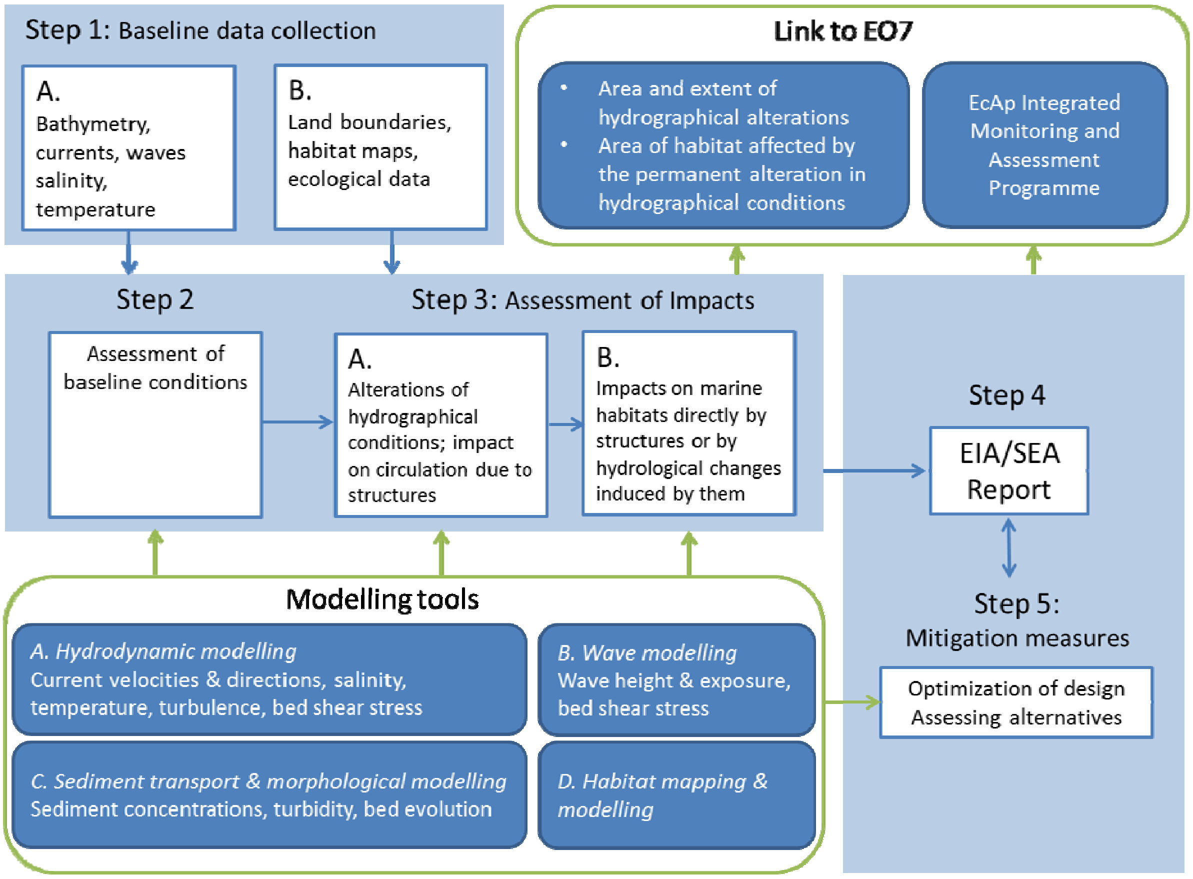

Figure 2Methodological approach of how to integrate the EIA/SEA process with the implementation of EO7.

Step 1: Baseline data collection

As a first step, the existing data and information on the site selected for development is collected. This is essential in order to get an understanding of the phenomena/drivers dominating the local dynamics. Relevant data may be available at various organizations, such as organizations conducting oceanographic monitoring, other authorities, research institutes etc. A desk-based evaluation of all relevant information (e.g. local hydrography, the distribution of seabed sediments and the associated benthic fauna and other man-made activities) should provide a good characterisation of baseline conditions. This step should also include the identification and distribution of the potential sensitive receptors, which will determine the choice of and need for certain specifications in subsequent steps (e.g. modelling in Steps 2 and 3). Additional information to be collected includes information on construction/development itself, including site plans etc.

In the case where existing data sources do not provide sufficient information and resolution on the domain of interest, monitoring may be required as a way of supplementing existing data and providing sufficient baseline information at different spatial and temporal scales. In line with the monitoring strategy defined for EO7 (UNEP(DEPI)/MED WG.411/3), if the hydrographical conditions are largely unknown, they are initially monitored over the entire marine area to characterize the hydrographical regime and to provide background information for physical characteristics. Particular attention would be given to monitoring hydrographical conditions in sensitive areas, such as marine protected areas, spawning, breeding and feeding areas and migration routes of fish, seabirds and marine mammals. Apart from physical characteristics, other surveys may be required for mapping habitats, including photographic recordings, video imagery, field target notes and benthic sampling. Additional monitoring may also be required for setting up hydrographical and habitat models to be used in the assessment of impacts (Step 3). Parameters, monitoring positions and frequencies are defined based on the local natural variability, both in time and space (UNEP(DEPI)/MED WG.411/3).

Important to consider:

- The resolution of the bathymetric data will depend on the local topography. If topography is uniform, low resolution data is sufficient; if very complex, high resolution bathymetric data is required.
- Hydrographical/nautical charts provide information on local hydrodynamic regime. Although of interest, it must be noted that in general these charts are generated for navigational purposed and do not provide the resolution needed for detailed assessments.
- Differences between coastal and offshore locations: detailed hydrographic records and charts are more likely to be available for coastal areas. There is generally a greater degree of understanding of coastal areas due to greater interest and more intensive studies. Detailed bathymetric charts may not be available for offshore areas. Bathymetric surveys for offshore locations are more likely to be required as part of the initial data collection step.
- Shoreline data (land boundaries) are required in case of coastal developments.
- Although not included in the EO7 list of parameters, meteorological data (wind statistical data), usually collected by local meteorological stations, should be part of the baseline data collection. Wind data gives information on the dominant wind direction and magnitudes, providing important input data for hydrodynamics and wave modelling (see Step 2).
- Any sediment monitoring campaign should have far-field spatial coverage, with consideration of the controlling hydrodynamic flows, sediment pathways and sites of particular interest.
- The digitization of data in Geographic information system (GIS) maps will enable the integration of field data with modelling (see Step 2).

Step 2: Assessment of baseline conditions

In order to assess the baseline conditions and potential impacts of a proposed development, a full understanding of the natural physical environment of the site and the surroundings must be first established. This system understanding/expert judgement is often coupled to the use of numerical models. Mathematical models are powerful tools to integrate data from various sources, to produce combined new data layers, to complement insufficient field data, to fill in the spatial and temporal gaps and to increase the understanding of a particular site. Numerical models are especially useful for a quantitative evaluation of impacts but as a first step, the baseline conditions should be simulated sufficiently accurate.

Different types of models are needed to assess the baseline hydrographic conditions. Hydrodynamic models are primarily used to describe water movement, providing current velocities, turbulence, temperature and salinity as output parameters, as well as information on residence times and stratification. The output of a wave model is a description of the wave spectra. Results are typically summarized by the significant wave height[6], the period and propagation direction of the dominant waves[7].An important output of hydrodynamic and wave models is bed shear stress; the force at the seabed that influences sediment texture and distribution, (micro) topography and benthic habitat formation and distribution. Sediment transport models, coupled to hydrodynamic models, describe the movement of sediment due to water motion caused by currents and tides, which affects turbidity. Morphodynamic models describe the impact of sediment transport on the bed evolution. Together with data collection, the use of modelling in the assessment of baseline conditions provides information on EO7 parameters (Section 3.2) which should be regarded as the target variables.

Habitat analysis and mapping generally relies on the use of GIS as a spatial analysis tool. GIS provides the ability to construct models of habitat that rely on existing or readily obtained information (e.g. surveys, bathymetric maps). As habitat maps from surveys are very costly and time consuming, full coverage habitat maps are produced from low resolution maps and models to 'predict' seafloor habitat types. Such models offer the possibility of optimizing monitoring and focusing field activities in much smaller areas. A number of marine habitat maps for the Mediterranean basin were produced in the *Mediterranean Sensitive Habitats* project (MEDISH; 2011-2013)[8] through the compilation of historical and current data on the locations and the status of seagrass beds, coralligenous and mäerl beds, the identification and mapping of suitable areas for Posidonia, coralligenous and mäerl communities by developing habitat distribution models at different spatial scales(Figure 3).Marine habitat maps for Western Mediterranean can also be found in EMODnet Seabed Habitats[9] (Figure 4).Maps of expected seabed-habitat types can be generated by combining a series of proxy measurements such as water depth, sediment type and light levels amongst others, using statistical analysis and GIS modelling.

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[6] The significant wave height, is the average height of the one-third largest waves

[7] https://en.wikipedia.org/wiki/Wind_wave_model

[8] http://mareaproject.net/contracts/5/overview/

[9] http://www.emodnet-seabedhabitats.eu/

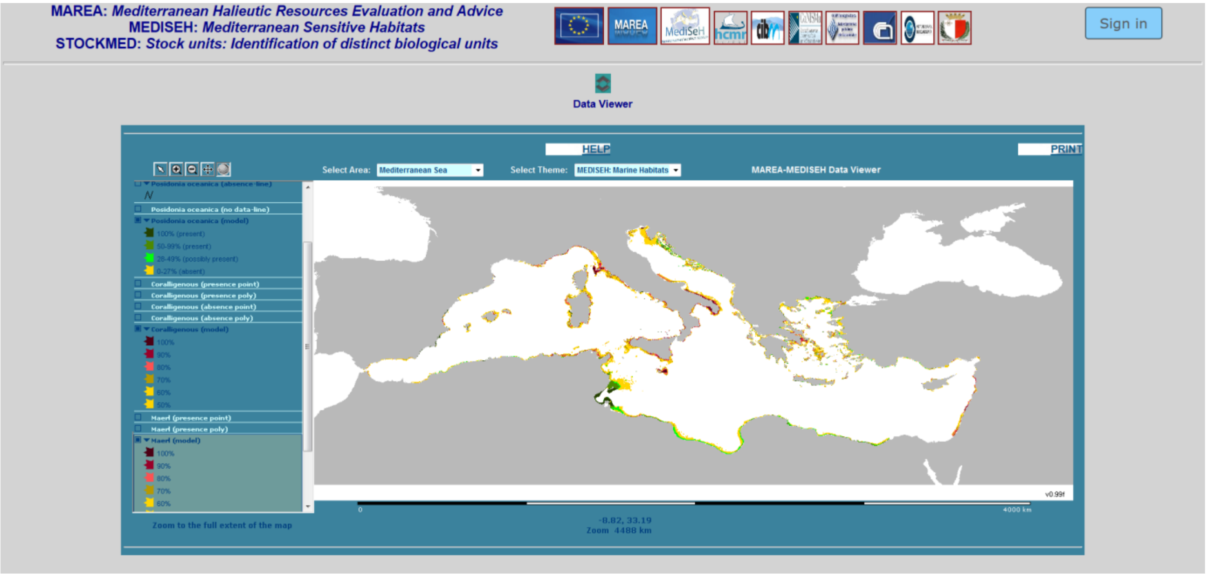

Figure 3 Marine habitat maps from MEDISEH project. Source: http://mareaproject.net/medviewer

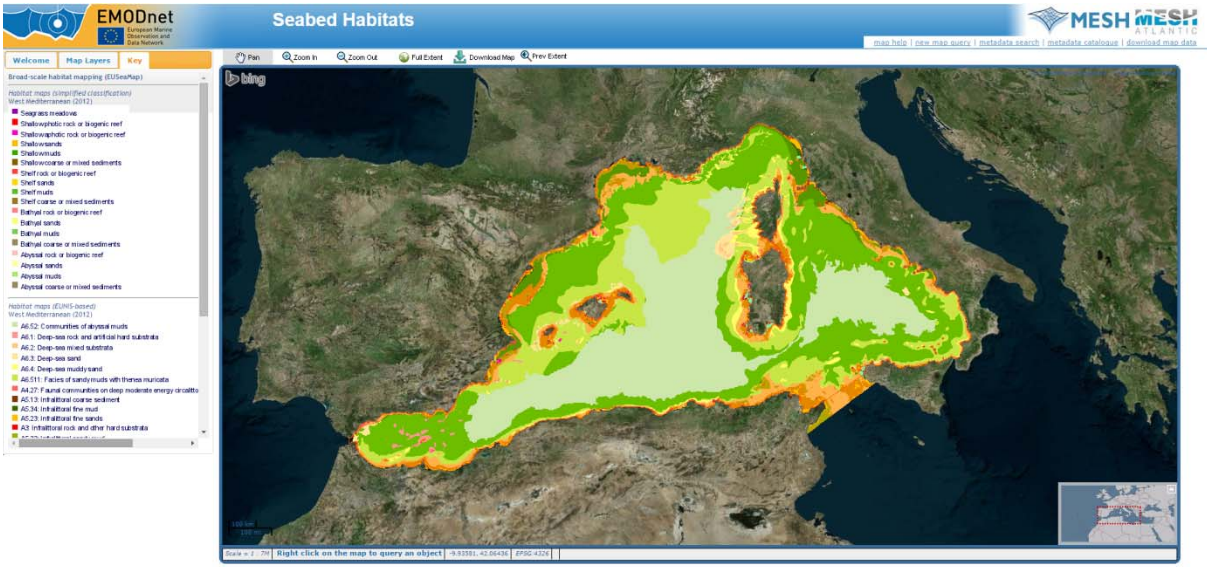

Figure 4 Example of broad-scale habitat map for the Western Mediterranean. Source: EMODnet Seabed Habitats[10]

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[10] http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974&LAYERS=HabitatsAggMed,HabitatsMed,Region&zoom=5&Y=39.66361966161909&X=6.686503905631556

Important to consider:

- Numerical models should be validated and calibrated in order to evaluate the accuracy of the model performance. The required accuracy needs to be determined as part of Step 1.
- Sensitivity analysis to determine the level of certainty of any model results and an estimate of errors to enable confidence levels to be applied to model results are also required.
- The characterisation of the local regimes (hydrodynamic, wave, sediment, habitat) will determine the type of models to be used, their spatial and temporal scales and resolutions, and the type of data that needs to be collected.
- As the tidal range in the Mediterranean is very low (< 1 m), larger scale transport hydrodynamics are typically dominated by wind-induced circulation patterns.
- Hydrographic conditions may be subject to significant natural variability. Longer data sets may be required to assess the importance of natural temporal variability. Climate change data aimed to identify shifts in existing baselines and longer-term climate-induced hydrographical changes, such as increased temperatures and wave action, should also be taken into consideration in the assessment of baseline conditions.
- Many parameters exhibit pronounced seasonal cycling (e.g., wind, waves, temperature, stratification). As changes to the seasonal cycles may be of relevance to ecology, typical winter and summer baseline conditions may be considered.
- According to the draft monitoring and assessment programme for EO7, it is pertinent to choose a baseline in the (very) near future, from which monitoring for good status can be based upon (UNEP(DEPI)/MED WG.411/3).
- Depending on the required scale and resolution, it is possible to extract local spatial and temporal distribution of parameters from regional models, such as the products and services for the Mediterranean Sea as part of the Copernicus Marine Environment Monitoring Service[1].

Step 3: Assessment of impacts

With knowledge on the site and its surroundings, informed by the baseline data collection and assessment (Steps 1 and 2), the magnitude and significance of the impact of the development are qualitatively and quantitatively assessed in Step 3. The impact of the development is assessed in terms of alterations in hydrographic conditions and impacts on marine/coastal habitats. The latter includes direct impacts on habitats caused by the construction/development, as well as indirect impacts due to changes in hydrographical conditions. Changes in the sediment transport regime and in bathymetry due to new developments may in turn cause alterations in the hydrographic regime, in particular in coastal areas. Although changes in currents, waves or sediment processes are not in themselves significant environmental impacts, they should be nevertheless evaluated due to the effects physical changes may have on sensitive receptors. The assessment of impacts is related to both the water column and the sea-floor, and consequently to their biological communities(EC JRC, 2015).

It is recommended to first concentrate on modelling of the changes due to human activities in the area, using appropriately calibrated models, validated with *in situ* datasets prior to the monitoring of the effects of hydrographical changes (UNEP(DEPI)/MED WG.411/3). The use of a combination of modelling tools (hydrodynamic, wave, sediment and habitat modelling with GIS mapping)and *in situ data* presents a robust tool, in particular for the quantitative evaluation of impacts. After that a representation of the construction is included in the modelling system set up in Step 2,the effect on target variables is assessed against the baseline conditions. The extent of alternations and the period over which such changes occur vary considerably, depending on the type of modification. The significance of the resulting changes should be also assessed under consideration of longer-term climate-induced hydrographical changes. As major long-term (permanent) infrastructure projects are most likely to be vulnerable to significant progressive changes in hydrographical conditions due to climate change, the assessment of impacts should differentiate local-scale impacts caused by the development from longer term global hydrographic changes.

Important to consider:

- It is not the scale of the construction/development that is important but the scale of the impacts.
- A case-by-case approach is required, which should provide for adequate elements to assess potential impacts on the marine environment, including transboundary considerations.
- Differences between coastal and offshore locations: coastal areas are more dynamic and more complex. They may be relatively more sensitive to change. Offshore areas are potentially less dynamic due to deeper waters. Due to the less frequent exposure of the seabed to wave action, they are potentially more spatially uniform. As a result, they may be less sensitive to change. Nevertheless, offshore locations may be sensitive to changes in bottom currents.
- Hydrographical conditions can exhibit a significant natural variability depending on timescale due to strong interaction with (sub) regional-scale environmental features. To assess a “permanent change”, very long time series are required to provide the proof that the change is permanent and not a signal of natural variability. This will avoid “snapshot” analyses.
- Large-scale trends and changes in the bottom topography or bathymetry are generally predicted on the basis of historical bathymetric maps through expert judgement, supported by empirical relations and sediment transport models of initial changes of the bathymetry due to a construction. It is not feasible to produce long-term morphological predictions with satisfactory accuracy on the basis of numerical sediment transport models alone.
- Although modelling could be used to help quantify the impacts, there are still regional-scale changes in ecosystem processes that cannot be predicted using models at present (e.g. regime changes).
- More research efforts should be dedicated to develop modelling, applying a common methodology, reducing uncertainties in the assessment of impacts and increasing our understanding of pressure-impacts relations.
- If the impacts are difficult to predict with acceptable certainty, the associated risks should be then identified.
- The assessment of impacts should be based on the precautionary principle, acknowledging any assumptions and limitations of current knowledge.

Step 4: EIA/SEA Report

The outcome of Steps 1-3 is compiled in an EIA report (also known as the Environmental Impact Statement - EIS). This full disclosure document details the process through which a project was developed, analyses the potential impacts, includes the consideration of a range of reasonable alternatives and their respective impacts, and demonstrates compliance with other applicable environmental laws and executive orders. Transparency of assumptions and assessment of uncertainties either through statistical methods or through expert judgement should be practiced throughout the EIA report. The EIA is reviewed based on the terms of reference derived in the scoping phase and public participation, including relevant authorities.

The project-specific outcomes resulting from an EIA process are integrated in the Plan and Environmental Report of a SEA, which assesses the potential impacts of the project within broader development objectives. The aim of the SEA is also to address cumulative impacts of multiple projects/developments related to an area, region or sector of development in a consistent and holistic way and to apply an integrated approach to planning and assessment.

Important to consider:

- EIA legislation and practice vary around the world. Yet the fundamental components are similar.
- SEA practices have mostly been observed in developed countries. However, the practice of this subject is becoming more important for the developing countries aiming sustainable development.

Step 5: Optimization of design

The EIA process allows for the optimization of the design of activity and comparison of different alternatives. This step also considers potential mitigation measures, through the use of technology and management options which will minimize the identified adverse impacts. For example, deterioration by new permanent structures or activities can be prevented by mitigation by facilitating development of habitats that were lost or by improving the quality of the remaining habitat (OSPAR Commission, 2012). In some cases, possible compensation measures can also be taken.

4.1.2 Link to EO7

Operational Objective 7.2 requires that *Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimised*. Its implementation requires that the area where human activities may cause permanent alterations of hydrographical conditions is mapped and the impact assessed using common indicator 7.2.2:

- Extent of area affected by altered hydrographic conditions (e.g. km^2)
- Extent of affected habitat (e.g. km^2) and the proportion of the total habitat (%) if that type is expected to be affected by the permanent alteration in hydrographical conditions

In this context, alterations in hydrographical conditions may be defined as a % change in a target variable with respect to baseline value, on top of the natural variability. In OSPAR Commission (2013) a threshold of 5 % is proposed. Such a threshold could be considered as a starting point but must be explicitly assessed and reviewed on a case-by-case basis. A modelling or semi-quantitative approach is proposed to compute the area where alterations are expected. Field measurements will be necessary in areas where the changes are large enough (e.g. > 5 % change) to have significant effects on the marine ecosystem, at which point ground-truthing will be considered appropriate (UNEP(DEPI)/MED WG.411/3).

As hydrographical changes can affect the full water column and are not restricted to the sea floor, in a recent review on the implementation of Descriptor 7 (EC JRC, 2015), it was suggested to use volume to assess the geographical extent affected by altered hydrographic conditions in pelagic systems. Areas would be more suitable for assessing benthic systems. If modelling is used as a tool to implement indicator 7.2.2, both areas and volumes can be readily quantified.

A clear link between EO7 and other ecological objectives, such as EO1 (Biodiversity) and EO6 (Sea-floor integrity exists. Such links need to be determined on a case-by-case basis. For example, the definition of functional habitats under EO1 could help identify the priority benthic habitats for consideration in EO7. Ultimately, the assessment of impacts, including cumulative impacts, is a cross-cutting issue for EO1, EO6 and EO7. Such an integrated assessment of impacts calls for additional research efforts on habitat modelling, pressure mapping and cumulative impacts, along with monitoring of potentially affected areas. Additional knowledge is also required on how to aggregate assessment outcomes on a habitat level to the ecosystem level.

The approach to EO7 would be to track and record the licensing applications of any proposed developments that would be considered large enough to have the potential to alter hydrographical conditions. Any proposed development that has the potential to affect hydrographical conditions should be recorded to confirm whether there is need for any additional licensing, monitoring or assessment requirements (UNEP(DEPI)/MED WG.411/3). In coupling the implementation of EO7 with other assessments (e.g. EIA/SEA), monitoring could be identified and implemented as a mitigation measure. Any monitoring programme tailored to meet the requirements of EO7 should be designed to determine the extent and intensity of any changes in the hydrographical regime resulting from human activities (UNEP(DEPI)/MED WG.411/3).One way would be to link monitoring measures to the conditions set in development consent as a result of the EIA procedure. For example, in offshore renewable energy developments, monitoring is typically enforced as conditions attached to development consents to test and verify the conclusions of the EIA process and to establish the actual impacts. Monitoring also aims to provide an early indication of any mitigation measures that fail to achieve the acceptable standards and to take timely remedial action if unexpected problems or unacceptable impacts arise. A monitoring plan should describe in detail what (biotic and abiotic factors), how (methods), when (during and after the activities), frequency and how long the specific items will be monitored to be sure there are no significant effects. The design of a modelling programme should make optimal use of the modelling approach used in the assessment of the baseline conditions (Step 2) and impacts (Step 3).

4.2 MSP and ICZM

MSP takes into consideration the mapping of human activities in marine areas (e.g. oil and gas, fisheries, shipping, wind farms), as well as the biophysical complexities and processes across a variety of scales. In line with the ecosystem-based approach, the management of the biophysical environment requires the understanding of processes, connections, space and scales. In this respect, MSP should be used as a tool to incorporate environmental concerns when installing new structures in the marine environment in order to minimise impacts on habitats and biota. The appropriate modelling and assessment should be undertaken through proposals coming forward through the licensing system i.e. as licensing applications and during EIA (OSPAR Commission, 2012).

A number of steps have been identified in the process of MSP (Ehler and Douvere, 2009), including iterative and feedback loops (Figure 5).Although the scope of MSP is overarching, direct overlap exists between the steps defined under the methodological approach for EIA/SEA (Figure 2) and the steps for the MSP process. The main linkage concerns the definition of existing and future conditions, particularly the mapping of important ecological areas (Figure 5- Step E. i), mapping existing areas of human activities (Step E. iii) and identification of alternative spatial scenarios (Step F. ii). Other linkages may exist with the monitoring and evaluating performance (Step I).

As opposed to single-sector management plans, MSP process takes fully into account the management of the cumulative effects resulting from adjacent (small-scale) developments and co-existing sectors in the marine environment (spatial component).The significance of the aggregated effects of many small-scale changes, as well as the longer term climate-induced changes in the biophysical systems (temporal component) should also be considered in the cumulative impact assessment. Currently, no guidance on assessing cumulative impacts exists and the development of methodological standards is needed.

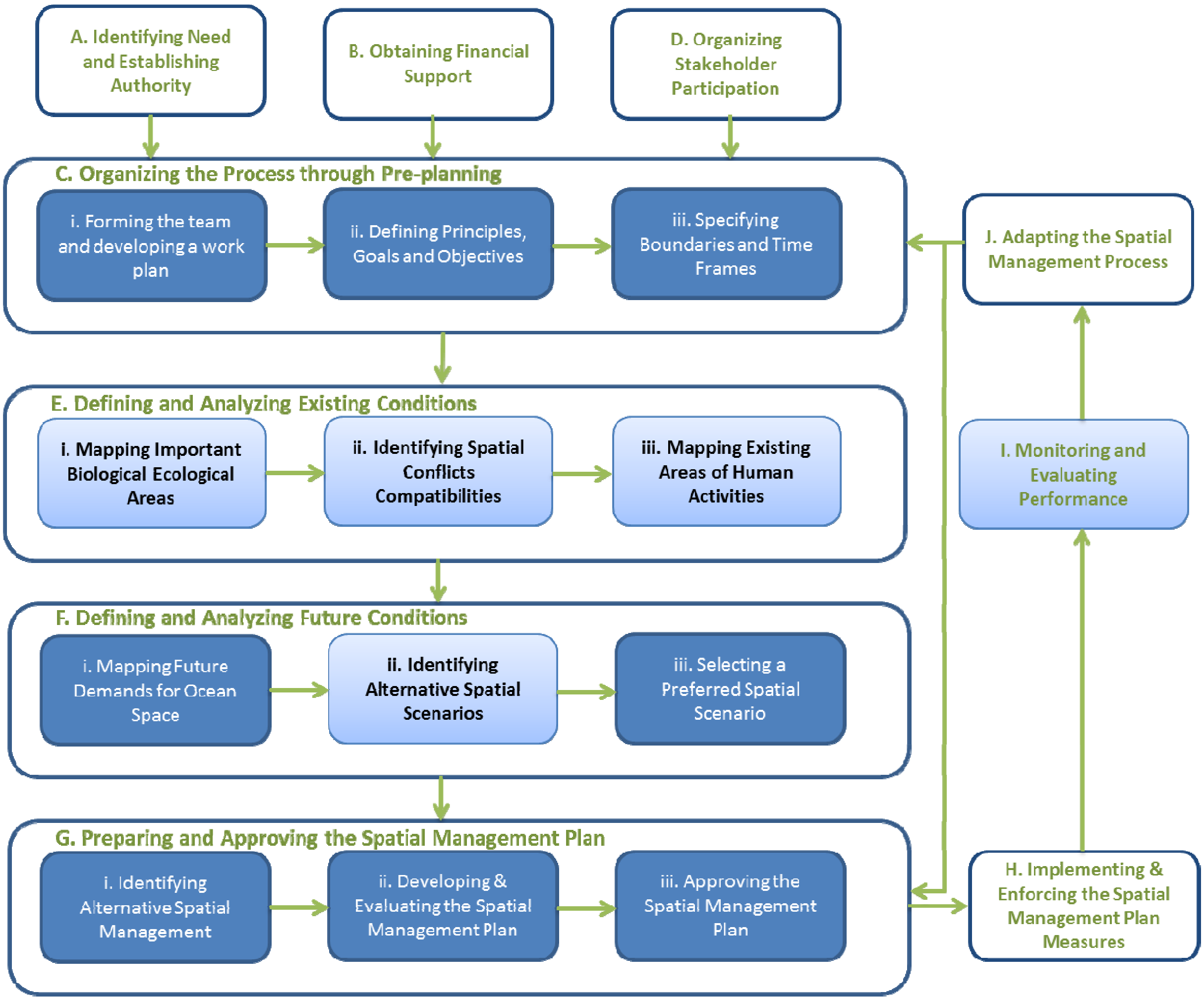

Figure 5Step-by-step approach to MSP, identifying the (sub)steps (light blue boxes) where the scope of EO7 should be taken into consideration. Source: Modified from Ehler and Douvere, 2009.

In analogy to MSP, ICZM provides a framework for the management of the coast using an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries. ICZM seeks to balance environmental, economic, social, cultural and recreational objectives over the long-term, all within the limits set by natural dynamics. The three main pillars of ICZM frameworks are defined as a) institutional, b) socio-economic and c) biophysical environment. The assessment of the biophysical environment takes into account the hydrographical conditions, as well as the ecosystem components. In this respect, a direct link to the scope of EO7 can be made, as illustrated in Table 4 below.

Table 4 Scope for EO7 integration in each step of the ICZM framework

Steps in ICZM	Key tasks	Potential Outputs	Scope for EO7 integration
Establishment establish an operational foundation for the subsequent steps of the ICZM process	• Establishing practical mechanisms for the ICZM Process • Defining the territorial scope • Defining the governance context • Scoping the problems and issues, pressures and drivers, and risks • Engaging stakeholders and preparing communication strategy • Proposing a potential vision for the coastal area. • Deciding on Strategic Environmental Assessment (SEA)	• Inception Report • Work plan • Scoping report, including a preliminary assessment of the problems, issues, drivers, pressures.	• Permanent alteration of hydrographic conditions from development/activities in coastal areas to be included in scope of biophysical characterization and issues. • Identification of pressures and impacts, including cumulative pressures and impacts.
Analysis and Futures add substance to the issues and aspirations initially identified in the preceding ESTABLISHMENT stage	• Describe the present “state” and likely future trends. • Generate and test alternative views of the future through the use of tools, such as scenarios. • Pilot actions and the identification of future funding sources	• Diagnostic Report on the state and future trends. • Alternative scenarios, including the preliminary schedule of future funding sources for implementation, and the first pilot actions, where appropriate.	• Link to baseline data collection (Step 1) and assessment of baseline conditions (Step 2) for the description of the present state. • For future trends, link to assessment of impacts (Step 3) and assessment of alternative (Step 5),
Setting the vision build on and substantiate the findings of the ESTABLISHMENT and ANALYSIS and FUTURES stages	• Consensus building • Setting the direction • Measuring success - selecting the indicators to measure the success of both the ICZM process and its outcomes	• A single Vision Statement including priorities and objectives, along with supporting interpretive material and reports of the participation process, as well as the Indicator Matrix (to be "populated" throughout the following stages of the ICZM Process and its implementation).	• Link to EO7 monitoring and indicators

Designing the future based on a combination of instruments including concrete actions materialised through an investment portfolio, awareness-raising, institutional adjustments, and policy changes - ultimately transforming the governance culture and the community's understanding and care for the coastal zone	• Formulating the ICZM strategy, plan or programme • Establishing management structure • Embedding	Draft ICZM strategy, plan or programme including: • The terrestrial and marine areas as defined in previous stages • Proposed long-term implementation structure: key national and local agencies that can enable or facilitate the delivery of the strategy, plan or programme and their actions • Implementation Programme - the action plan including short (3-6 years), medium (5-10 years) and long-term actions.	• Integrating the outcomes of the 6-year review of EcAp with the short/medium term implementation of ICZM strategy, plans or programmes.
Realising the vision ICZM strategies, plans or programmes for coastal areas will deploy a combination of policy instruments, management processes and actions	• Implementation – implementing legal, economic and spatial instruments and management process • Actions – awareness raising, partnerships, financing and investment • Monitoring and Review - constant feedback into the review of the strategy, plan or programme and its action plan	• A review on an agreed timescale. This may include proposal for a feedback to the process in the form of a revision, if deemed necessary. • The cross-sectoral management or steering group with Terms of Reference and clear lines of responsibility and reporting • Outputs as defined in the programme of implementation or its review.	• Integrating the objectives of EcAp with the long-term implementation of ICZM strategy, plans or programmes.

Source: http://www.pegasoproject.eu/wiki/ICZM_Process_diagram

4.3 Best practice modelling methods

As indicated in the methodological approach (Figure 2), modelling should be employed as a tool for assessing the baseline conditions, the scale of the effects and extent of impacts, for optimizing the layout of the development in a way to minimize the impacts and designing the monitoring programmes. In this way, unnecessary and costly monitoring on habitat level can be optimized or avoided. In particular for the larger and more complex projects, numerical modelling is strongly recommended. In some cases, it may be possible to resort to expert opinions for a preliminary impact assessment and to decide on the need and/or scope of more detailed modelling.

The modelling approach strongly depends on the configuration of the domain (offshore, coastal, inclusion of rivers etc.) but also on the physical characteristics of the area and phenomena that need to be captured or predicted. Hence the information and knowledge gathered on the site during the baseline data collection step and system understanding is a key step in determining the processes to be included in the modelling and selecting the most suitable modelling approach.

4.3.1 Type of numerical models

Process-based models are generally employed, aimed to simulate the target variables through hydrodynamics, waves, sediment transport and habitats modelling. Generally, if an area is well mixed, two-dimensional (2D) depth-averaged models provide a good representation of the local hydrodynamics, unless information on the vertical profile of certain parameters is required. If the area in consideration is strongly stratified, then a three-dimensional (3D) approach is recommended, to take into account the internal dynamics that take place in the water column due to vertical density variations. Although 3D models would most likely give the best and most detailed results, they have a drawback in terms of computational time and storage capacity. For the general coastal modelling applications, if vertical stratification is strong and hence vertical density gradients are important in controlling the local flow conditions, a pseudo-3D model[11] can be employed.

4.3.2 Spatial scale and resolution

In the context of numerical modelling, two main spatial scales are considered:

- Near-field, i.e. the area within the immediate vicinity of the development
- Far-field, e.g. the coastline, non-immediate areas of scientific and conservation interest

Near-field effects occur within a short distance from the human activity (e.g. structure), which is typically considered 5 times the obstacle length scale (Lambkin et al., 2009). These effects normally present complex 3D patterns of flow acceleration, vortices and recirculation. The resolution of flow in the vicinity or around the human activity itself can be done through Computational Fluid Dynamics (CFD). However, CFD models are not recommended for the purpose of impact assessments due to the significant time and expense required to set them up.

As for the determination of the extent of the domain to be considered, this will depend on the distance from the specific human activity to areas subject to impact and areas of specific interest, for example adjacent coasts or bays, or sensitive habitats. A clear identification of the sensitive

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[11] In a pseudo-3D model, the vertical dimension of the water column is represented through horizontal planes (called sigma and/or z layers) where the vertical terms are accounted for by continuity.

receptors, such as local habitats, fauna and/or flora and habitat/ecosystem functions, and their natural extent is a key input for the determination of the spatial scale, as the boundaries of the model might need extending or adjusting to fully include these into the computational domain. The scale determination should therefore take into account the scales used for theEO1/EO6 habitat assessments. The EIHA of the OSPAR Commission advises to consider the spatial scale equivalent to EUNIS level 3[12] as the most appropriate scale for assessing Descriptor 7.

In order to reduce the computational time, unstructured grids are generally employed. In contrast to structured grids, these allow for a flexible grid resolution which is smoothly refined in areas where detailed information is required, e.g. in the area around the proposed development, areas in close proximity to priority benthic habitats, and areas where the complexity of the local processes is important to the local or overall results (at **the Next Generation Hydro Software Symposium, Delft,** 2013.

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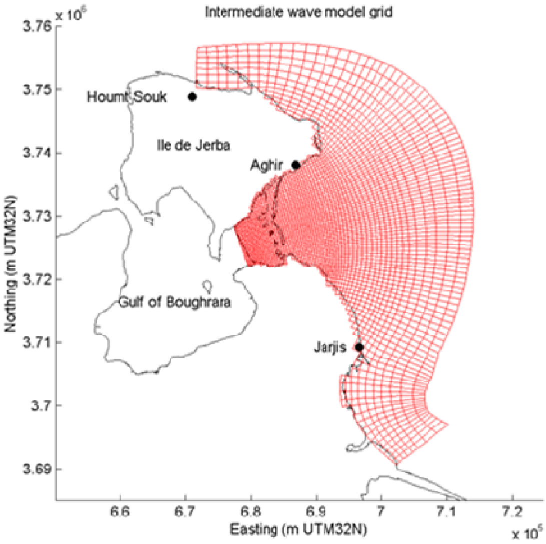
[12] EUNIS system (European Nature Information System) is a classification scheme for habitats for managing species, site and habitat information.



). For example, finer vertical resolution is normally required near the ocean surface, and finer horizontal resolution near coasts where the variability is greater. Another option for reducing computational time is through nesting, in which the area of interest is represented by a high resolution 3D model, embedded into a coarser model domain with lower resolution (Figure 7). 1D models can be nested within 2D or pseudo-3D models as well. This is typically done for cases where the flow circulation from several river branches out to the open sea is modelled. The choice of spatial resolution depends upon the requirements of the study and the particular choice of model used, i.e. scale and type of physical processes included in the different model types.

Figure 6Example of unstructured grid for Venice Lagoon with refinement in the coastal areas and along rivers. Source: Presentation by Technital S.p.A and Deltares at the Next Generation Hydro Software Symposium, Delft, 2013.

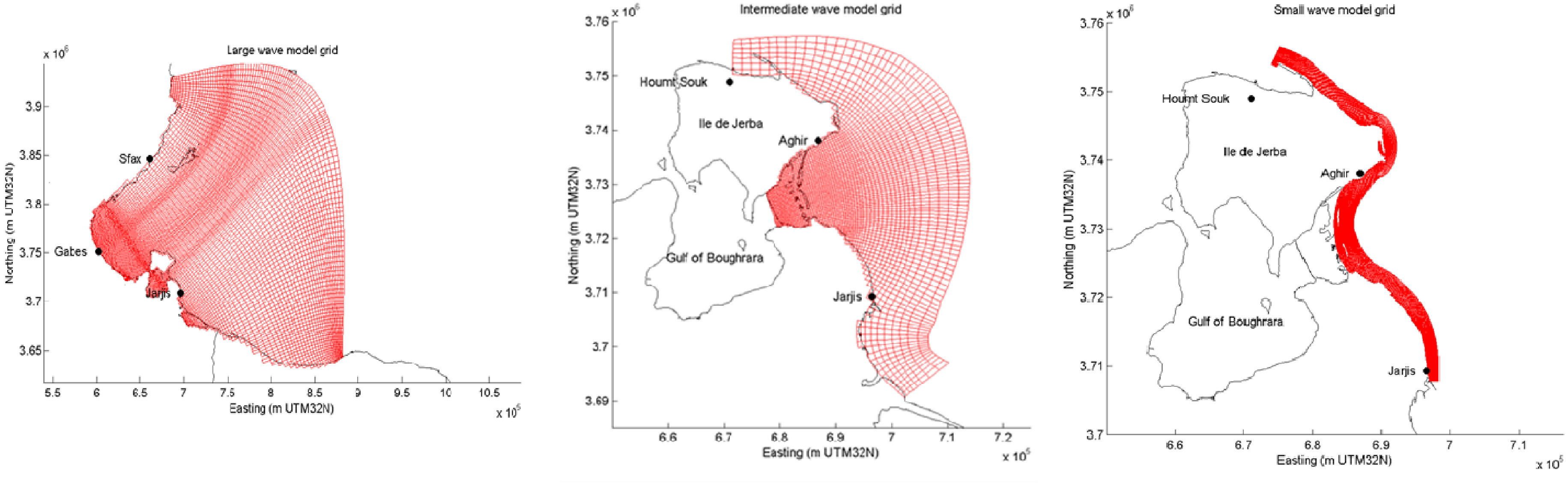


Figure 7Model domains used for nested wave modelling in the area of Gulf of Gabes, Tunisia. Source: Deltares, 2011.

4.3.3 Temporal scale and resolution

Two temporal scales can be distinguished in coastal and marine processes: short-term (hours/days/weeks/(months)) and long-term ((months)/years/decades). Short-term processes are largely instantaneous and include the swift response of processes occurring on these time scales. These include transient processes like tidal movements, local currents, waves, as well as storm events and initial scour[13] in mobile sediments. Long-term processes tend to describe the cumulative effects of short-term processes. They often refer to changes in larger-scale background circulations, changes in regimes, e.g. residual currents, salinity and temperature, morphological evolution of seabed and/or coastline due to a development (steady), and extreme events, such as storms. With respect to EO7, the 10-year time period associated to the definition of “permanent” should be taken into account for a long-term impact analysis assessment. However, since short-term processes need to be resolved in order to perform an assessment of the long-term effects, the first step is to predict these processes on a short term and assess the initial changes (2-3 years).

The choice of assessment method, e.g. model, must allow for obtaining the required information at the appropriate temporal scale. For example, a model that is required to assess the effect of a structure on currents must be able to resolve changes in current speed and direction on a suitable timescale, typical minutes to hours. A model that is required to simulate the morphological evolution on the long term does not need to resolve the individual wave spectra on a short time scale but rather calculates the net response to a statistically-described wave climate or to a long-term residual transport pattern (Lambkin et al., 2009). In this respect, the selection of the model time step should also take into account the natural time scales of the processes/phenomena that are captured by the model.

4.3.4 Advantages and disadvantages of using numerical models

A number of advantages and disadvantages can be identified associated to the use of numerical models as tools for the assessment of impacts.

One of the main advantages is that models provide an integrated interpretation of the system, based on multiple data sources and available scientific evidence base, as compared to the spatially and temporally-discrete information obtained from monitoring alone. They are extremely useful for the quantitative evaluation of potential impacts of large-scale complex projects. They present a practical and potentially cheaper method for assessing the footprints of impacting structures, i.e. the location and extent of habitats impacted directly by the alterations and/or the circulation changes induced by them, and for optimizing the design of monitoring programmes.

On the other hand, modelling may be a costly endeavour, requiring specific scientific expertise and computational capacities. The successful application of models is generally constrained by the availability of field data with sufficient spatial and temporal resolution. In the case of EO7, a combination of monitoring methods, such as satellite products, autonomous devices (UNEP(DEPI)/MED WG.411/3), can be considered. Since permanent *in situ* observations are likely to be the most expensive component of any operational system, it is important to optimise the monitoring network in relation to the modelling system for the requisite forecasts.

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[13] Scour is the removal by hydrodynamic forces of granular bed material in the vicinity of coastal structures. Scour is a specific form of the more general term “erosion”.

Modelling results are subject to a number of uncertainties arising from the inherent limitation of the model to accurately represent certain processes, the spatial and temporal resolution of some processes and the accuracy limitation of computers. The accuracy of the modelling analysis will be in line with the quantity and quality of data available used to calibrate and verify the model performance. Currently, there is lack of guidelines for methodologies, standardization and analytical techniques in addressing EO7.

Modelling is mostly valuable when the impacts on the receptors can be quantified and categorised as significant or not significant. In order to assess the significance of an impact on a sensitive receptor, the sensitive threshold must be first quantified. This is currently a major source of uncertainty in impact assessment studies, such as EIAs. There is little benefit in undertaking costly and complex modelling if the pressure-impact relations are not sufficiently understood.

5 Examples/case studies

For the WFD assessment of hydromorphology status of coastal water bodies, the indicator *changes in waves and currents due to human permanent structures* was proposed in France. This indicator is very similar to Indicator 7.2.2 under Ecological Objective 7. Although it is not yet possible to assess this indicator for the whole French coast, a first step to study the feasibilty of such an approach is described below.

The goal is to assess this indicator for already existing structures. Until now, a few tests on groyne configuration for a very simple bathymetry have been performed, as shown in Figure 8.

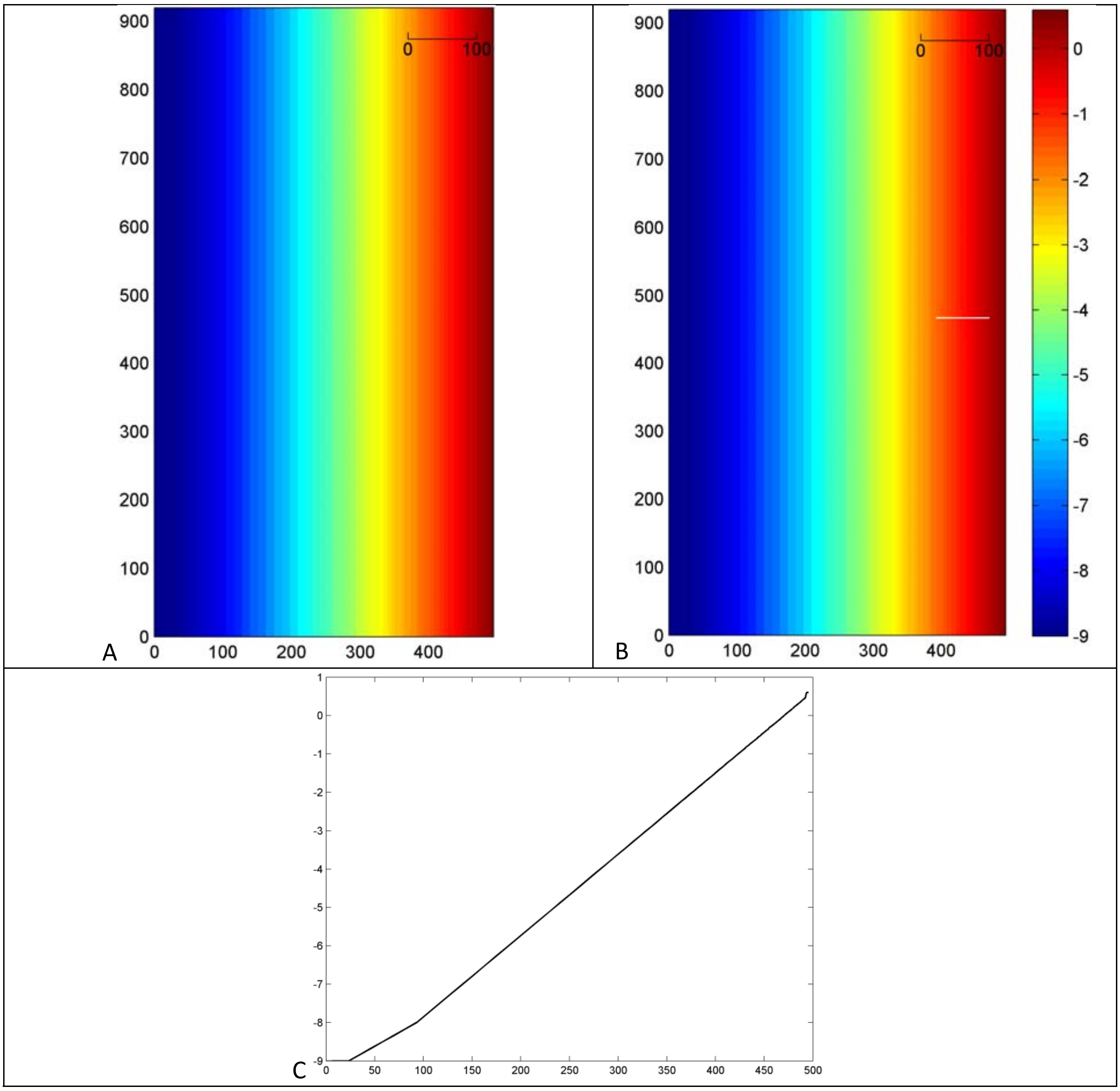


Figure 8Initial topo-bathymetry without (A) and with groyne (B), and corresponding profile (C).

For the two configurations (without and with groyne), a simulation of 7 hours for the following hydrodynamic conditions (constant water level, wave: significant wave height =1m, Period = 5s and propagation direction coming from the South with an angle of 70° relatively to the normal of the coast) was performed with the code XBEACH (eXtreme Beach behavior, Roelvink et al. 2009). The results obtained after 7 hours are presented in Figure 9.

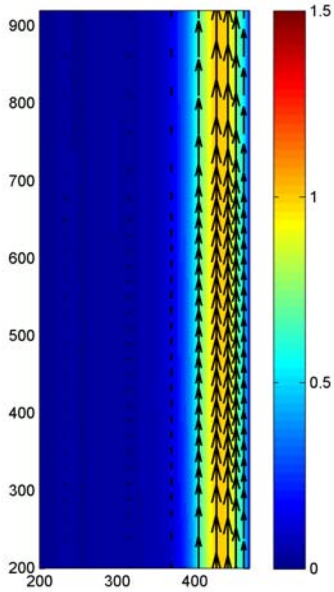
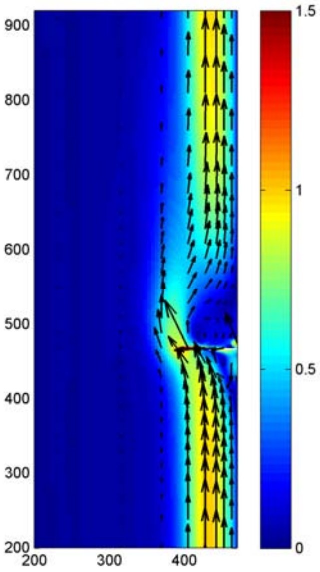
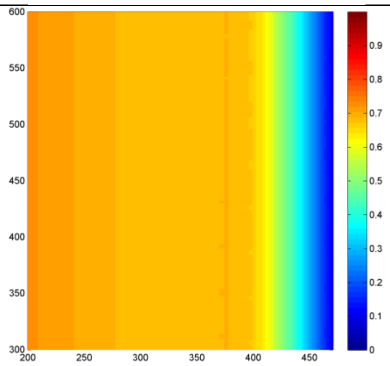
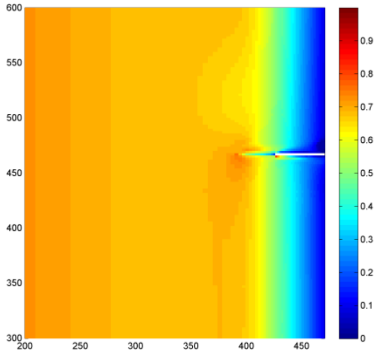
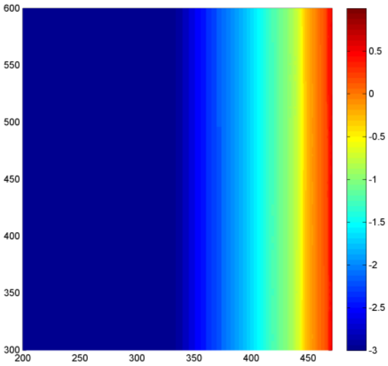
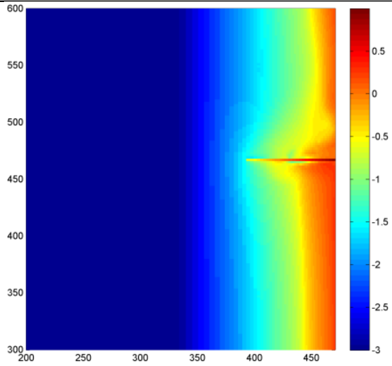
	Without groyne	With groyne
Currents		
waves (zoom on the center of the domain)		
Topo-bathymetry obtained at the end of the simulation (zoom on the center of the domain)		

Figure 9Results of the simulation after 7 hours, for currents, waves and final topo-bathymetry.

To compare the two configurations, the relative difference in currents and waves and the absolute difference for the topo-bathymetry is plotted (Figure 10).

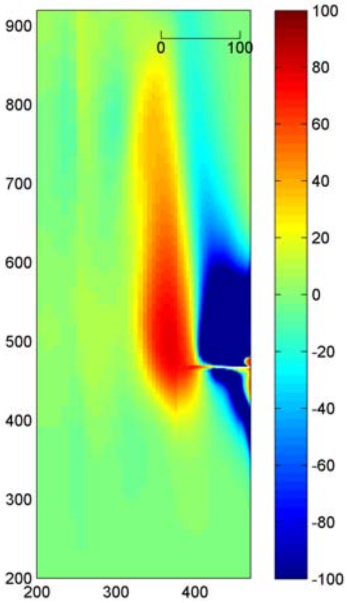
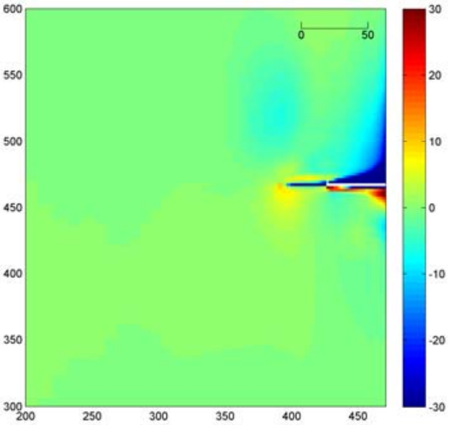
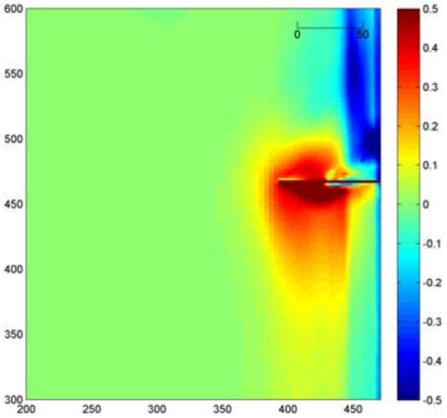
Relative difference of currents fields between configuration with and without groynes (% of changes in currents velocity)	
Relative difference of RMS wave height between configuration with and without groynes (% of changes in RMS wave height)	
Absolute difference (in meter) of topo-bathymetry between configuration with and without groynes	

Figure 10 Relative difference in currents and waves and the absolute difference for the topo-bathymetry.

As shown by this example, changes in currents are wider than changes in waves. To assess the area where currents are modified, the modified area is plotted as a function of the percentage of change (divided by the square of the groyne length) in Figure 11. Ifcurrent changes greater than 5 % are considered, the corresponding area is about 8.5 times the square of groyne length. If velocity currents greater than 30% are considered, the corresponding area is about 5 times L².

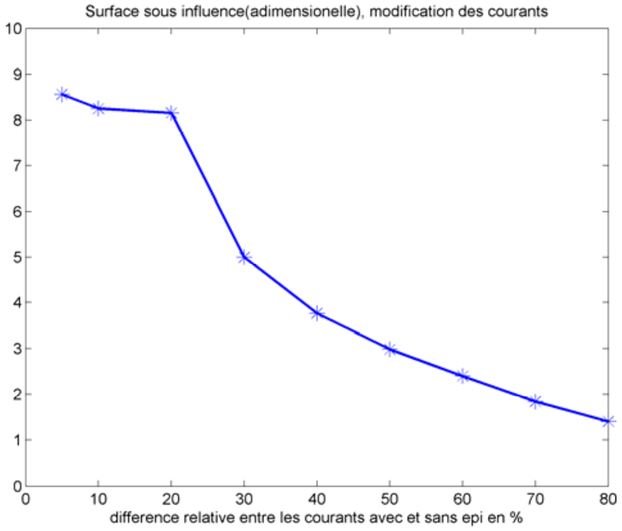


Figure 11 Dimensionless area of currents changes function of percentage of changes (relative difference)

Assessing changes in hydrography needs long term data to evaluate the impacted area for the whole conditions. In this approach, the worst conditions (i.e. the conditions that maximize the impacted area) are considered, rather than all the different possible conditions.

In principle, it is possible to apply such an methological assessment to the whole Mediterranean coast. As this would be a costly exercise, a simplified approach that defines different idealized coastal typologies (coastal areas characterized by relatively similar hydrodynamic conditions etc.) could be developed. For each typology, simulations could give an approximation of the maximum impacted area for different kinds of structures (groynes, harbour) depending on their length, confirguration etc. It will provide a first and coarse approximation of the area where hydrographical alterations are present.

Concering the impact of structures on habitats, the impact of structures and beach nourrishment on *Posidonia oceanica* in a number of sites in France, Italy and Monaco was assessed in a study by Boudouresque et al. (2006) (in French).

6 References

Boudouresque C.F., Bernard G., Bonhomme P., Charbonnel E., Diviacco G., Meinesz A., Pergent G., Pergent-Martini C., Ruitton S., Tunesi L. (2006). Préservation et conservation des herbiers à Posidonia oceanica, RAMOGE pub. : 1-202, N°ISBN 2-905540-30-3. In line at : www.ramoge.org

CEFAS (2004). Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements.

COP18 EcAp Decision on the Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and targets (UNEP(DEPI)/MED IG.21/9)

Deltares (2011). Etudes hydrodynamiques et de qualité de l'eau du Golfe de Gabès et de la lagune de Bou Ghrara. Rapport R4: Etude du système par modélisation numérique et propositions de solutions d'aménagement. Report no. 1002604-000

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. *Document currently in consultation.*

Ehler C., F. Douvere (2009). Marine Spatial Planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6. Paris: UNESCO.

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

European Commission (2011). EU Guidance on wind energy development in accordance with the EU nature legislation.

Lambkin D.O., J.M. Harris, W.S. Cooper, T. Coates (2009). Coastal Process Modelling for Offshore Wind Farm Environment Impact Assessment: Best Practice Guide .COWRIE.

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.

Roelvink J., A. Reniers, A. Van Dongeren, J. Van Thiel de Vries, R. McCall, et J. Lescinski. 2009. Modelling storm impacts on beaches, dunes and barrier islands, Coastal Engineering, 56, 1133- 1152.

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.

RPS (2007). Environmental Impact Assessment Practical Guideline Toolkit for Marine Fish Farming.

UNEP/MAP (2015). Main elements of a draft Integrated Monitoring and Assessment Programme (UNEP(DEPI)/MED WG.411/3)

UNEP/MAP (2015). Report of the Meeting of the Integrated Monitoring Correspondence Group (UNEP(DEPI)/MED WG.411/6)