



UNITED
NATIONS

EP

UNEP/MED WG.502/Inf.3



UNEP



UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

31 May 2021
Original: English

Fifteenth Meeting of SPA/BD Focal Points

Videoconference, 23-25 June 2021

Agenda Item 5: Conservation of Species and Habitats

Guidelines for the assessment of environmental impact on coralligenous and maërl assemblages

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Acronyms

BQE: Biological Quality Element

CBD: Convention on Biological Diversity

CITES: Convention on International Trade of Endangered animal and plant Species

EC: European Community

EcAp: Ecosystem Approach of the Barcelona Convention

EIA: Environmental Impact Assessment

EU: European Union

GES: Good Environmental Status

ICZM: Integrated Coastal Zone Management

IMAP: Integrated Monitoring and Assessment Program

IUCN: International Union for Conservation of Nature

MAP: Mediterranean Action Plan

MedMPAnet: Mediterranean Marine Protected Areas Network

MEFWA: Ministry of Environment, Forests and Water Administration

MPA: Marine Protected Area

MSFD: Marine Strategy Framework Directive

OG: Official Gazette

RVA: Rapid Visual Assessment

SCI: Site of Community Interest

SEIAS: Strategic Environmental Impact Assessment Study

SPAMI: Specially Protected Areas of Mediterranean Interest

SPA/RAC: Regional Activity Centre for Specially Protected Areas

STAR: STAndaRdized coralligenous evaluation procedure

TFEU: Treaty on the Functioning of the European Union

UNEP: United Nations Environment Program

UNFCCC: United Nation Framework Convention on Climate Change

WFD: Water Framework Directive

General premises

The two most important and characteristic calcareous formations of biogenic origin in the Mediterranean Sea are represented by coralligenous reefs (Fig. 1), an endemic complex habitat considered as the climax biocenosis of the circalittoral zone (Pérès and Picard, 1964), and maërl/rhodoliths seabeds (Fig. 2) (UNEP/MAP-RAC/SPA, 2008). These bioconstructed habitats develop in the Mediterranean circalittoral zone and are built-up by coralline algal frameworks that grow in dim light conditions. Coralligenous is characterised by high species richness, biomass and carbonate deposition values comparable to tropical coral reefs (Bianchi, 2001), and economic values higher than seagrass meadows (Paoli et al., 2016).

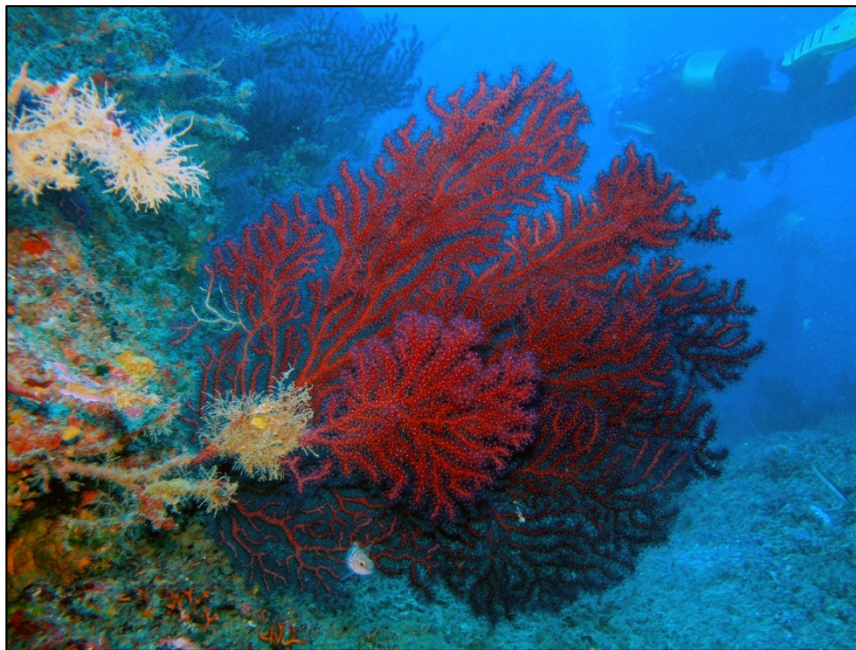


Figure 1: Coralligenous habitat. Photo by Monica Montefalcone.



Figure 2: Rhodoliths habitat. Photo from UNEP/MAP-RAC/SPA (2015).

In the context of the Mediterranean Action Plan (UNEP/MAP, 2008), the Contracting Parties to the Barcelona Convention adopted in 2016 (Decision IG.22/12) an Action Plan for the conservation of coralligenous and other calcareous bio-concretions in the Mediterranean Sea (UNEP/MAP-SPA/RAC, 2017). This plan aims at conserving bioconstructed habitats by introducing suitable management tools. Regulations and specific laws must thus protect biogenic formations and prevent their degradation, in order to maintain these habitats in a satisfactory state of conservation. To successfully comply with these aims, it is firstly necessary to gain a better knowledge of the Mediterranean calcareous bio-concretions in terms of:

1. distributional range (geographical and bathymetrical)
2. structure of the formations and their general features
3. current ecological status
4. reference historical status, i.e. the baselines, when different from the current status
5. stresses and disturbances to which they may be subjected
6. possible physiological responses to and effects of environmental alterations.

In the framework of the Barcelona Convention Ecosystem Approach (EcAp) implementation, SPA/RAC has recently developed standardised monitoring protocols for coralligenous and maërl habitats in the context of the Integrated Monitoring and Assessment Program (IMAP) common indicators and related assessment criteria, in order to ease the task for the countries when implementing their monitoring programs. The main methods used in the Mediterranean for inventory and monitoring coralligenous and maërl habitats have been recently summarised in the “Guidelines for monitoring coralligenous and other calcareous bioconstructions in Mediterranean” (UNEP/MAP-SPA/RAC, 2019a). In these guidelines, the methods to define the Common Indicator 1, i.e. habitat distributional range and extent of coralligenous and maërl in the Mediterranean, and to define the Common Indicator 2, i.e. condition of the habitat’s typical species and communities, are reported.

Once the above information has been obtained, all the necessary tools to properly manage and effectively conserve these formations become available. However, laws and specific regulations must be introduced or strengthened to guarantee a formal protection to these important bio-constructed habitats. Establishment of Marine Protected Areas (MPA) and Sites of Community Interest (SCIs) are examples of effective interventions that allows for the protection of coralligenous and maërl habitats. This notwithstanding, sensitivity of coralligenous and maërl habitats to human disturbance asks for specific impact studies when a development project is planned in the marine environment where these habitats occur. Indeed, before the approval of any proposed development project along the coastline and offshore, it is thus compulsory to establish all the possible detrimental effects that may affect coralligenous and maërl habitats, before that the projects are put into effect. Environmental Impact Assessment (EIA) studies become necessary to predict all possible impacts (environmental, social, and economic) of a project, to decide whether or not to proceed with a project and to suggest measures to be taken to mitigate the predicted impacts on the environment, eventually integrating with possible compensatory strategies.

Although bioconstructed formations are considered of high conservation interest because of their biogeographic uniqueness, their highly varied physical structure, their high biodiversity, their highly diversified occurrence stratified throughout the different benthic marine zones and their slow growth (Ballesteros, 2006), very few Mediterranean countries seem to have specific regulatory frameworks that allow these bioconstructed formations to be taken into account in environmental impact procedures and thus to be properly conserved. This is mainly due to the lack of formal international and national regulations that specifically address these formations. Coralligenous and maërl habitats

are not directly listed among the priority habitats defined by the EU Habitat Directive (92/43/EEC), although in the Mediterranean the habitat 1170 “Reefs” includes coralligenous, while maërl and rhodoliths beds are included in the habitat 1100 “Sandbank”. In any case, the two main species (*Phymatolithon calcareum* and *Lithothamnion corallioides*) that usually constitute maërl habitat are listed in Annex V of the EU Habitat Directive. Only one European law (Council Regulation EC n. 1967/2006) prohibits destructive fishing over Mediterranean coralligenous and maërl communities, but it remains ineffective in the current scenario due to the lack of relevant geospatial data (UNEP/MAP-RAC/SPA, 2008).

Based on these premises, the Action Plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea (UNEP/MAP-SPA/RAC, 2017) asked for the elaboration of guidelines for the assessment of environmental impact on coralligenous and maërl assemblages. It becomes thus necessary to draft guidelines that enable all the Mediterranean countries to carry out impact environmental studies. In 2000, in the framework of the Action Plan for the conservation of marine vegetation in the Mediterranean Sea, SPA/RAC elaborated the guidelines for impact assessment on seagrass meadows (Pergent-Martini and Le Ravallec, 2007). These guidelines were updated in 2007 and have been considered as an example to draw the guidelines for the assessment of environmental impact on coralligenous and maërl assemblages here presented.

The Guidelines aim to:

- briefly describe the main features of coralligenous and maërl habitats and identify the main threats to which they are affected
- review the current state on the regulation on impact studies in the Mediterranean marine environment
- review the current state on the regulation on impact studies regarding coralligenous and maërl habitats
- suggest a standardised procedure of impact assessment that should be carried out when an EIA on coralligenous and maërl habitats is requested
- propose standardised protocols to define distributional range and extent and to evaluate the ecological condition of coralligenous and maërl habitats in the context of EIAs.

The reviewing process on the current situation about the regulations on impact studies in the Mediterranean and about the regulations on impact studies regarding coralligenous and maërl habitats has been done after consultancy with the focal points of the contracting parties of the Barcelona Convention, and using the legislative texts to which it was possible to have access. Unfortunately, for many countries a little information on the regulations on environmental impact studies was available. Even more, regulations on impact studies in almost all countries lack of specific references to coralligenous and maërl habitats. The synthesis here reported of the reviewing process does not claim to be an exhaustive, detailed and complete analysis of the present legislations in each of the Mediterranean countries as regard to environment, coralligenous and maërl habitats.

The proposed standardised procedure and protocols to define distributional range and extent and to evaluate the condition of coralligenous and maërl habitats in the context of EIAs are those reported in the “Guidelines for monitoring coralligenous and other calcareous bioconstructions in Mediterranean” (UNEP/MAP-SPA/RAC, 2019a), recently updated and adopted by the contracting parties to the Barcelona Convention. The descriptors and methods proposed have been chosen according to the ease of their implementation and because they represent the most adopted parameters at the Mediterranean scale.

Coralligenous and maërl assemblages in the Mediterranean

Coralligenous habitats are hard bottoms of biogenic origin that are mainly produced by the accumulation of calcareous encrusting algae growing in dim light conditions (< 3% of the surface irradiance; Ballesteros, 2006). Light represents the main factor limiting bioconstruction, and coralligenous reefs are able to develop from about 20 m down to 120 m depth. Although more extended in the circalittoral zone, they can also develop in the lower infralittoral zone, provided that light is dim enough to allow growth of coralline algae that produce the build-up.

Coralligenous formations result from the dynamic equilibrium between bioconstruction, mainly made by the encrusting calcified Rhodophyta belonging to Corallinales and Peyssonneliales (such as the genera *Lithophyllum*, *Lithothamnion*, *Mesophyllum*, *Neogoniolithon*, and *Peyssonnelia*), with an accessory contribution by serpulid polychaetes, bryozoans and scleractinian corals, and destruction processes (by borers and physical abrasion), which creates a morphologically complex habitat where highly diverse benthic assemblages develop (Ballesteros, 2006). Encrusting coralline algae with other encrusting animals develop the basal layer (*sensu* Gatti et al., 2015b) of this complex habitat. The dominant organisms in terms of number of species and biomass are filter feeders, which characterise the intermediate and the upper layers (*sensu* Gatti et al., 2015b) of the habitat. Borers (living inside the concretion) and soft-bottom fauna (in the sediment deposited in cavities and holes) are other important components of coralligenous.

Two main coralligenous typologies can be defined, coralligenous developing on the circalittoral rocks (cliffs or outcrops) creating rims, and coralligenous developing over circalittoral soft/detritic bottoms creating biogenic platforms (Ballesteros, 2006; UNEP/MAP-SPA/RAC, 2019a). Also, the upper mesophotic zone (where a few light is still present, from 40 m to about 120 m depth), embracing the continental shelf, is shaped by extremely rich and diverse coralligenous assemblages dominated by animal forests that grow over biogenic rocky reefs.

A global map showing the distribution of coralligenous in the Mediterranean (Fig. 3) has been produced based on the review of available information (Giakoumi et al., 2013). Coralligenous formations cover a surface area of about 2763 km² and are reported in 16 Mediterranean countries, i.e. Albania, Algeria, Croatia, Cyprus, France, Greece, Italy, Israel, Lebanon, Libya, Malta, Monaco, Morocco, Spain, Tunisia, and Turkey. All the other biogeographical regions present a lower coverage, with the Alboran Sea having the lowest. Very limited data on the presence of coralligenous formations was found in the southern and the eastern coasts of the Levantine Sea. Coralligenous formations occur primarily in the northern part of the Mediterranean basin, with few records from the eastern or the southern basin. Nonetheless, there is very limited knowledge from the East and the South Mediterranean.

The coralligenous habitat is classified, by the recently revised EUNIS classification system, with the following codes, according to the bathymetric zone and the substrate type: MB151a Facies and association of coralligenous biocenosis (in enclave), MC151 Coralligenous biocenosis, MC251 Coralligenous platforms, MC252 Mediterranean circalittoral biogenic habitat. The recently revised Barcelona Convention classification (UNEP/MAP-SPA/RAC, 2019b) classifies the coralligenous habitat with the following codes: MB1.55 Coralligenous (enclave of circalittoral), MC1.51 Coralligenous, MC1.52 Shelf edge rock (coralligenous outcrops), MC2.51 Coralligenous platforms.

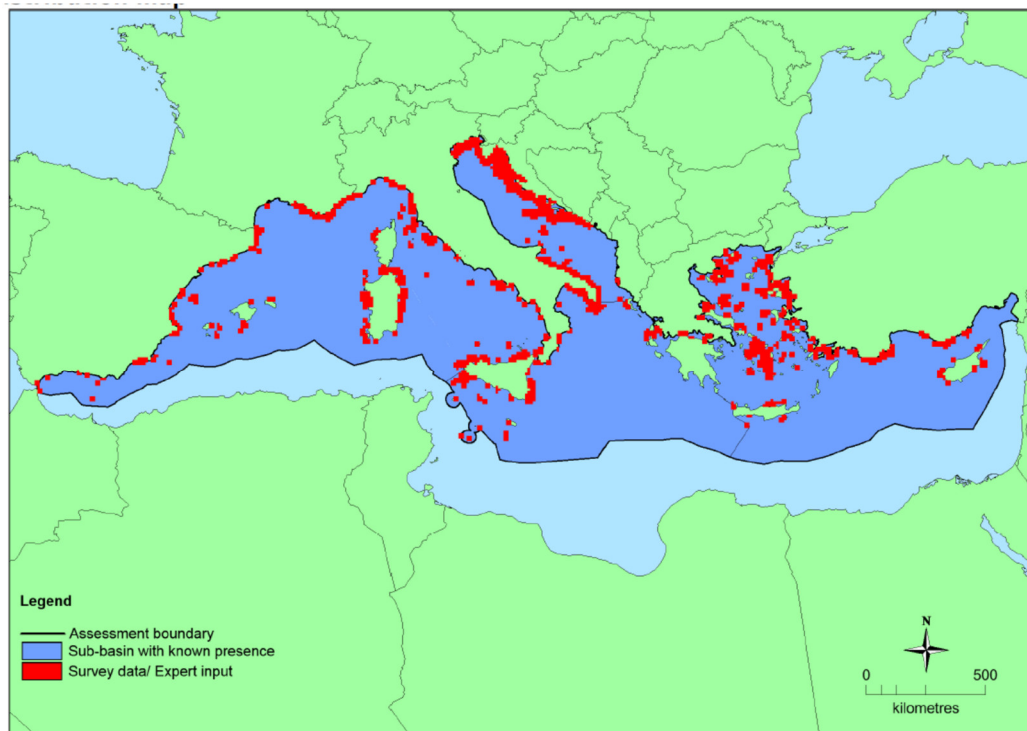


Figure 3. Coralligenous habitats distribution in the Mediterranean Sea (red areas). Data from IUCN, based on Giakoumi et al. (2013).

Rhodoliths beds are composed by a variable thickness of free-living aggregations of live and dead thalli of calcareous red algae (mostly Corallinales, but also Peyssonneliales) and their fragments, creating a biogenic, unstable, three-dimensional habitat typically exposed to bottom currents, which harbours a greater biodiversity in comparison to surrounding habitats, and are thus viewed as an indicator of biodiversity hotspot. They mostly occur on coastal detritic bottoms in the upper mesophotic zone, between 30-60 m depth. These algae can display a branching or a laminar appearance, can sometimes grow as nodules that cover all the seafloor, or accumulate within ripple marks.

In the literature, the terms rhodoliths and maërl are often used as synonyms (UNEP/MAP-RAC/SPA, 2009). Maërl is the original Atlantic term to identify deposits of calcified non-nucleated algae mostly composed by *Phymatolithon calcareum* and *Lithothamnion corallioides*. Rhodoliths are intended as unattached nodules formed by calcareous red algae and their growths, showing a continuous spectrum of forms with size spanning from 2 to 250 mm of mean diameter. Rhodoliths bed is thus recommended as generic name to indicate those sedimentary bottoms characterised by any morphology and species of unattached non-geniculate calcareous red algae with > 10% of live cover (Basso et al., 2016). The name maërl should be restricted to those rhodoliths beds that are composed by non-nucleated, unattached growths of branching, twig-like coralline algae.

A global map showing the distribution of maërl habitats (Fig. 4) in the Mediterranean has been produced based on the review of available information (Martin et al., 2014). Knowledge on maërl seabeds was somewhat limited compared to coralligenous. Maërl habitats cover a surface area of about 1654 km². Only sporadic and punctual information is available, mainly from the North Adriatic, the Aegean Seas, and the Tyrrhenian Sea. Datasets are available for Greece, France (Corsica), Cyprus, Turkey, Spain, Malta, and Italy. This low-resolution global map is still incomplete being the available information highly heterogeneous due to the high variability in the mapping and monitoring efforts across the Mediterranean basin.

Rhodoliths/maërl habitat is classified by the recently revised EUNIS classification system with the codes: MB3511 Association with rhodolithes in coarse sands and fine gravels mixed by waves, MB3522 Association with maërl (= Association with *Lithothamnion corallioides* and *Phymatolithon calcareum*) on Mediterranean coarse sands and gravel, MC3523 Association with maërl (*Lithothamnion corallioides* and *Phymatolithon calcareum*) on coastal detritic bottoms. The recently revised Barcelona Convention classification (UNEP/MAP-SPA/RAC, 2019b) classifies this habitat with the code MC3.52: Coastal detritic bottoms with rhodoliths.

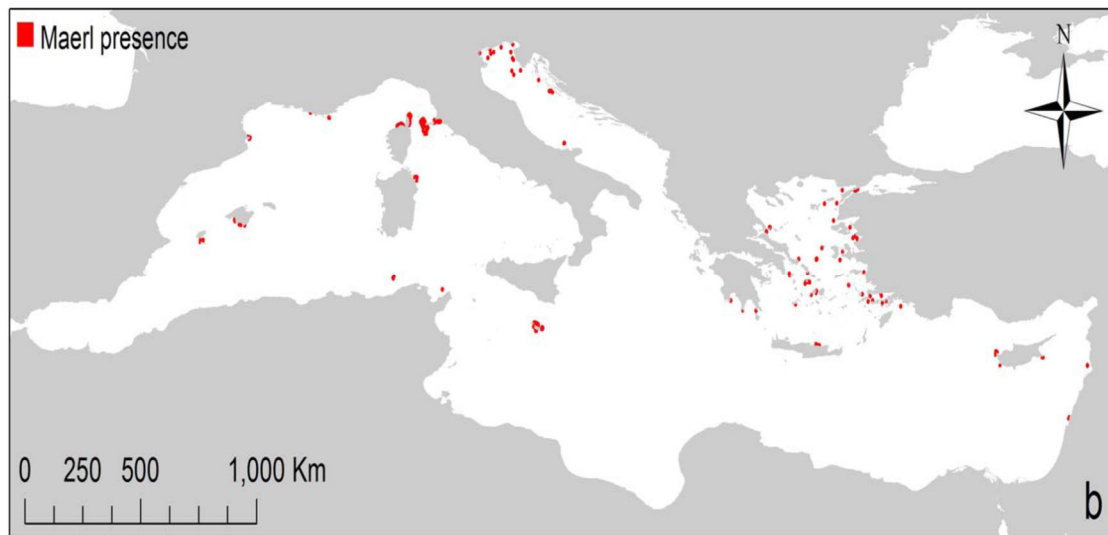


Figure 4: Distribution of maërl habitats in the Mediterranean Sea (red areas). Data from Martin et al. (2014).

Threats to coralligenous and maërl assemblages

Coralligenous reefs provide different ecosystem services to humans (Paoli et al., 2017), but are vulnerable to both global and local disturbances. Coralligenous and maërl assemblages are threatened by direct human activities, such as nutrient enrichment, increase of sedimentation and water turbidity, changes in land use, coastal infrastructure construction, urbanization, trawling, scuba diving, illegal exploitation of protected species, artisanal and recreational fishery, aquaculture, and are also vulnerable to the effects of global climate change (e.g., positive thermal anomalies and ocean acidification) (UNEP/MAP-SPA/RAC, 2019a). Some invasive algal species (e.g., *Womersleyella setacea*, *Acrothamnion preissii*, and *Caulerpa cylindracea*) and the proliferation of mucilage can also pose severe threats to these communities, either by forming dense carpets or by increasing sedimentation rate. Furthermore, synergic effects among global stressors such as warming, invasive species and acidification, as well between global and local stressors can cause drastic decline in the extent and the quality of coralligenous and maërl assemblages. Ocean acidification must be considered a dangerous threat to biogenic habitats, as it has been reported that small changes in the seawater pH (as those predicted for the end of this century) may force drastic shifts in community composition, if not the complete disappearance of the bioconstructor species. Effects of stress and disturbance on coralligenous and maërl assemblages are poorly understood (Montefalcone et al., 2017), and there is no data at all on the capacity of these environments to recover (with the exception of fish stocks recovery after fishing ban). However, as the most abundant and structuring species of coralligenous assemblages are long-lived and slow-growing species with limited recruitment rates, local recover can be difficult and extremely slow so that resilience of calcareous formations is likely to be very low. Besides the designation of marine protected areas and fisheries reserves, beneficial measures for the conservation of coralligenous and

maërl habitats might include improvement in the water quality, prohibition of trawling in areas with coralligenous outcrops, and management of traditional and recreational fisheries.

Several episodes of gorgonians and sponges mass mortality have been detected in the north-western Mediterranean due to global warming, as well as large-scale mortality events that affected shallow water assemblages (10-40 m depth) in some other areas of the central-western Mediterranean and the Aegean Sea. The heat wave occurred in 2003 triggered necrosis and mass mortalities in over 80% of gorgonian colonies in some NW Mediterranean sites (Cerrano et al., 2000). Long-term (> 50 years) quantitative analyses at Punta Mesco and Portofino rocky reefs (Italy, NW Mediterranean) showed a significant decline of the gorgonian populations, changes in community composition and invasion by the alien *Caulerpa cylindracea* (Gatti et al., 2015a, 2017).

There are few spatio-temporal studies or baseline data over large spatial scales regarding coralligenous and maërl formations. Data available from literature for coralligenous show an ongoing decline in its quality. There are no evidences of a general decline in its extent in the available information; however, taking into account the impacts that affect this habitat, a reduction in its original extent is more than likely. Considering its decline in habitat extent and quality, the coralligenous habitat is classified as “Near Threatened” by the IUCN Red List using the EU 28 criterion and as “Data Deficient” using the EU 28+ criterion (Gubbay et al., 2016). Both quality and quantity decreases are expected to continue in the future given the predicted scenarios under climate change for the Mediterranean: a revision of the assessment in the next 5-10 years is thus suggested to provide more quantitative evidences as the habitat is close to the “Vulnerable status”.

European regulation on the protection of marine environment

Environmental policy has always been an important issue for the EU. Its environmental policy is described in the Treaty on the Functioning of the EU (TFEU), being set out in the Treaty of Rome. The preamble to the TFEU sets the context for environmental protection at an early stage, stating that the EU is determined to promote economic and social progress for its people, taking into account the principle of sustainable development and within the context of environmental protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progresses in other fields. The TFEU states that the EU aims at a high level of protection and improvement of the quality of the environment and that it will work in order to foster the environmental development of developing countries. It is committed towards ensuring sustainability by developing international measures to preserve and improve the quality of the environment. TFEU explicitly deals with the environment, and the Art. 191 specifies the objectives of the EU policy on the environment as follows:

- preserving, protecting and improving the quality of the environment;
- protecting human health;
- ensuring a prudent and rational utilisation of natural resources;
- promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change.

The protection of biological diversity at the EU level is governed mainly by two directives: the 1979 Birds Directive and the 1992 Habitats Directive. The Habitat Directive (92/43/EEC) provides a legal framework for the conservation of wild plants and animals and their habitats within the Annex I (natural habitat types of community interest), Annex II (Animal and plant species of community interest), Annex IV (strictly protected species), and Annex V (species whose exploitation is regulated). The Habitat Directive protects biodiversity through the conservation of natural habitats and wild fauna and flora occurring in the European terrestrial and marine territory. Pursuant to the Habitat Directive, member states must “maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of community interest” (Art. 2.2), listed in Annexes I and II of the Directive. In order to comply with the Directive’s provisions, ‘Special Areas of Conservation’ (SCIs) are designated by member states, with a protective legal regime on those species and habitats defined as ‘priority’. These special areas of conservation are part of the European ecological network called ‘Natura 2000’, which aims at preserving biodiversity throughout the territory of the European Community. The Natura 2000 network covers all European Community states

and nine biogeographic regions with distinct climate, geology and flora. The purpose of this network is to “enable the natural habitat types and the species’ habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range” (Habitat Directive, Art. 3.1), while taking into account economic, social and cultural requirements, as well as the regional and local context. In this context, the only marine coastal habitat defined as ‘priority’ in the list of habitats of community interest is the *Posidonia oceanica* seagrass meadow (Habitat 1120, Annex I, Habitat Directive). For all the habitats included in the SCIs, an environmental impact assessment study is formally requested by the law, as well as national monitoring programs for the periodic evaluation of their conservation status.

The Barcelona Convention, established in 1976 as the “Convention for the Protection of the Mediterranean Sea against Pollution” under the aegis of UNEP (United Nations Environment Program), is the legal and operational instrument of the United Nations Action Plan for the Mediterranean (MAP) (Council Decision, 1977), with the Regional Activity Centre for Specially Protected Areas (SPA/RAC) as the executing agency. The MAP is a regional cooperation effort that today involves 21 countries bordering the Mediterranean Sea and the European Union. Amended in 1995 as the “Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean”, the Barcelona Convention represents the institutional framework for the challenges on the effects of climate change on marine and coastal biodiversity in the Mediterranean. As part of the MAP, the contracting parties to the Barcelona Convention and its protocols are committed to protecting the marine coastal environment, with an Integrated Coastal Zone Management (ICZM), strengthening regional and national plans to achieve the sustainable development. The main obligations of the contracting parties refer to precautionary actions to prevent, combat and eliminate pollution from the Mediterranean Sea area and to protect and valorise the marine environment. For this purpose, the Convention has 7 implementation protocols, including the SPA/BIO Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean sea within the Annex II (endangered or threatened species) and Annex III (species whose exploitation is regulated), which came into effect in 1999, and the ICZM Protocol.

With the enactment of the recent European Framework Directives (Water, WFD 2000/60CE and Marine Strategy, MSFD 2008/56CE) the ‘ecological’ and ‘ecosystemic’ approach is followed for the first time by European regulations. The WFD (European Commission, 2000) introduces an innovative approach in European water legislation, both from an environmental and an administrative-management point of view. It establishes a reference framework for the protection and management of water resources, such as inland, transitional, and coastal waters. The WFD pursues ambitious objectives: prevent qualitative and quantitative deterioration, improve the quality of waters, and ensure their sustainable use, based on the long-term protection of available water resources. For these purposes, WFD requires short and long term monitoring plans, based on the analysis of anthropogenic pressures, as well as programs of measures aimed at the restoration of the good ecological condition of water bodies when monitoring highlights their deterioration. The integrated approach of the MSFD (European Commission, 2008) represents an innovative tool for the protection of our seas as it constitutes the first binding regulatory framework for the member states that considers the marine environment in a systemic perspective. To prevent degradation and restore damaged ecosystems, each country must implement all measures necessary to achieve (or maintain) the ‘Good Environmental Status’ (GES) of marine waters, which refers to the state of the marine environment that allows preserving the ecological diversity and the vitality of unpolluted, healthy and productive seas and oceans, and the use of the marine environment at a sustainable level. Compared to the previous WFD, the MSFD enlarges its regulatory horizons to both coastal and offshore environments, and from a methodological point of view it passes from a ‘structural’ approach, based on Biological Quality Elements (BQEs) defined on the scale of the water bodies, to the holistic/functional approach where a set of 11 descriptors summarises the environmental status of the entire system defined at the marine sub-regional scale. In this framework, the marine habitat as a whole and not the single BQE is the object of monitoring programs for the definition of the GES. Although based on opposed approaches, the two Directives converge where the assessment of the condition of the habitat under the MSFD necessarily passes through the analysis of the quality of biological elements. This can be done by applying the habitat-specific multi-metric indices already used in the frame of the WFD, or the new proposed indices as in the case of coastal environments not regulated by the WFD (as for instance in the circalittoral hard bottoms). The integrated process proposed by the MSFD does not only concern the ecosystemic methodological approach, but also the regulatory framework, which requires that the application of the Directive is conducted in a coordinated and synergistic way with the previous Directives. In particular, in the area of legal overlap of the two

Framework Directives (1 nautical mile away from the coast), a synergism in the monitoring covering the entire range of sensitive habitats occurring in marine-coastal waters is required, to ensure the complementarity between the two Directives while avoiding unnecessary overlaps. The MSFD also contributes to respect the obligations undertaken by the member states within the framework of the numerous relevant international agreements relating the protection of the marine environment. In particular, the Barcelona Convention and its protocols assumes in part a binding character thanks to the convergence of key elements of the IMAP guidelines and the criteria that define the MSFD descriptors.

In the Mediterranean all countries have also ratified the Convention on Biological Diversity (CBD), the United Nation Framework Convention on Climate Change (UNFCCC), and the Kyoto protocol.

Regulation on coralligenous and maërl habitats in the Mediterranean

Despite their high complexity and biodiversity and the occurrence of many species with high ecological value (some of which are also legally protected, e.g. *Savalia savaglia*, *Spongia officinalis*, *Phymatolithon calcareum*, and *Lithothamnion corallioides*), coralligenous and maërl habitats are not directly listed among the priority habitats defined by the EU Habitat Directive (Directive 92/43/EEC), even if the former is included under the more general habitat ‘1170 Reefs’ and the latter under the habitat ‘1100 Sandbanks’ listed in the Annex I of the Directive. This implies that the most important Mediterranean bioconstructions still remain without formal protection as they are not included within the Annex I list of priority habitat types of community interest, whose conservation requires the designation of Special Areas of Conservation (SCIs).

The last EU Executive Decision 2019/22 (European Commission, 2019), which adopts the twelfth update of the list of SCIs for the Mediterranean biogeography region, extends this formal protection to some of the most valuable coralligenous habitats in the Mediterranean. However, in line with the regulatory framework of the Directive, the protection constraint is not specific to coralligenous habitat as such, but rather it is linked to its occurrence within a SCI.

As already stated, two maërl forming species, *Phymatolithon calcareum* and *Lithothamnion corallioides*, are protected under the EU Habitat Directive in the Annex V and, in some locations, maërl is also a key habitat within the Annex I list of habitats of the Directive and therefore is given protection through the designation of special areas of conservation (SCIs).

Few years after the adoption of the Habitat Directive, coralligenous reefs and other calcareous formations were listed among the ‘special habitats types’ needing rigorous protection in the Strategic Action Program for the Conservation of the Mediterranean Biodiversity and the Protocol concerning the Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BIO) under the Barcelona Convention. The Barcelona Convention and its protocols, however, constitute legally non-binding acts for which the concept of ‘rigorous protection’ has remained essentially vague and indefinite and, therefore, lacking concrete indications on the type and method of intervention to protect coralligenous and other calcareous habitats. The list of reference habitats to be protected in the frame of the Barcelona Convention, which contains coralligenous and maërl habitats, has been recently reviewed and updated (UNEP/MAP-SPA/RAC, 2019b). Only recently, with the adoption of the “Action Plan for the Conservation of Coralligenous and other Mediterranean bioconstructions” (UNEP/MAP-SPA/RAC, 2017) adopted by the contracting parties to the Barcelona Convention in 2008 and then updated in 2016, the conservation of coralligenous and maërl assemblages has been encouraged with concrete actions for their protection, through the establishment of new MPAs, and emphasizing the need to adopt standardised monitoring programs (UNEP/MAP-SPA/RAC, 2019a). However, the Action Plan indicates the paths and the actions to be taken to protect and conserve coralligenous and other bioconstructions, but it is not a legally binding program. Therefore, today, legislation aimed at conserving coralligenous and other bioconstructions is not yet available and, consequently, specific monitoring and management plans are still missing.

With the WFD (2000/60CE) the regulatory framework on the protection and conservation of coralligenous did not change: consistently with the previous Habitat Directive, the legislation on coastal marine waters only referred to *Posidonia oceanica*, which was included among the benthic biological indicators of anthropogenic impact, together with macrozoobenthos in soft bottoms and macroalgae in shallow water (from 0 to 3 m depth) hard bottoms. All other hard bottom marine communities, animal and plant, occurring down to 3 m depth remain excluded from the definition of the ecological quality status of water

bodies, including the coralligenous communities of the circalitoral zone. A turning point in the process of European legislation aimed at protecting coralligenous habitat has been reached thanks to the MSFD (2008/56/EC), with a regulation that introduced for the first time the obligation for the member states to assess the extent and the condition of coralligenous habitats as part of the process for defining the status of the two descriptors ‘biodiversity’ and ‘seafloor integrity’ when assessing the GES of the marine environment. Biogenic structures, such as coralligenous reefs and maërl beds, have thus been recognised as important biological indicators of environmental quality because of their high ecological value and sensitivity to anthropogenic pressures.

More than ten years later from the enactment of the two European Framework Directives (WFD and MSFD), the coralligenous habitat has become today the proposed object of specific and targeted legislations. The lack of a formal legislation aimed at protecting coralligenous and other calcareous concretions has also caused, as a direct consequence, the failure in building a standardised database at the national and Mediterranean level to be used as a cognitive and management tool for habitat conservation.

Coralligenous has been recently included in the European Red List of marine habitats by the International Union for Conservation of Nature (IUCN), where it is classified as ‘Data deficient’ (Gubbay et al., 2016; IUCN, 2016), thus demonstrating the urgent need for thorough investigations and accurate monitoring plans, already highlighted in the previous years by the UNEP/MAP Action Plan. This need can be partly satisfied by the monitoring plans on coralligenous and maërl seabeds conducted in application of the MSFD requirements. Maërl/Rhodoliths seabeds have been included in the Natura 2000 sites and in the Red List of the Mediterranean ‘Threatened’ habitats by IUCN. Besides the designation of protected areas and fisheries reserves, specific measures aimed at protecting the coralligenous habitat might include improvement in water quality, prohibition of trawling in areas with coralligenous outcrops and in their vicinity, and management of traditional and recreational fisheries to prevent stock depletion of target fish and crustaceans.

There are some conventions and directives that indirectly concern the protection of coralligenous and maërl habitats. On 21 December 2006, a Council Regulation of the European Community (EC) n. 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea has been published, amending EC Regulation n. 2847/93 and repealing EC Regulation n. 1626/94, which states that “Fishing trawl nets, dredges, shore seines or similar nets above coralligenous habitats and maërl beds shall be prohibited” (Article 4.2) and that this prohibition “shall apply to all Natura 2000 sites, all special protected areas and all Specially Protected Areas of Mediterranean Interest (SPAMI), which have been designated for the purpose of the conservation of these habitats under either the Habitat Directive 92/43/EEC or Decision 1999/800/EEC” (Article 4.4).

Coralligenous and maërl habitats are not considered in the European Directive on the EIA (see below). However, anthropogenic activities performed in the vicinity of coralligenous and maërl habitats should be regulated in order to reduce their effects at a level compatible with the sustainability of the assemblages and their populations. Specific measures aimed at protecting coralligenous and maërl environments might include the following (Ballesteros, 2006):

- waste water dumping should be banned over coralligenous and maërl bottoms, and in their vicinity;
- trawling must be completely prohibited in areas with maërl beds and coralligenous outcrops and in their vicinity, with the aim to avoid not only the physical damage caused by trawling over coralligenous/maërl assemblages but also the indirect effects due to increased turbidity and silting;
- any other anthropogenic activity involving an increase in water turbidity and/or sediment removal (e.g., coastline modification, beach regeneration, dredging, aquaculture projects) should be avoided in the vicinity of coralligenous outcrops or maërl beds;
- correct management of traditional and recreational fisheries must be implemented in order to prevent stock depletion of target fish and invertebrates. Fishing nets have to be avoided in places with populations of long-lived erect invertebrates (e.g., gorgonians, some erect and massive sponges) and structuring algae (e.g., *Laminaria rodriguezii*);
- impact of scuba diving must be compatible with the normal functioning and conservation of the coralligenous environment and their species;
- enactment of suitable legislation concerning the introduction of alien species is urgently needed.

Regulation on the protection of marine species in the Mediterranean

Although the lack of a specific legislation aimed at protecting coralligenous and other calcareous concretions in the Mediterranean Sea, some of the species that are typical components of these habitats are legally protected under specific international regulations on the protection of marine species in the Mediterranean. In Table 1 are listed all the species that can be found in coralligenous and maërl habitats that are subjected to a formal legal protection by one or more of the following legislations.

The Annex 1 of the Convention on International Trade of Endangered animal and plant Species (CITES) lists the “Severely endangered species for which trade is strictly prohibited”. The Annex 2 of the CITES lists “Species whose trade is regulated to avoid exploitation incompatible with their survival”.

The Bern Convention relates to the conservation of Europe’s wild life and natural environment. Formulated under the aegis of the European Community in 1979, it applies to all European countries with the Decision of the EC Council n. 82/72 G.U.L. 38, done on 10 February 1981. The convention provides that the signatory countries adopt conservation measures for the flora and fauna listed in its Annexes, as well as for those habitats that are important for the conservation of the species. In particular, attention is paid to the species and the habitats vulnerable/endangered and to endemic species. Countries are committed to plan monitoring activities to evaluate conservation status of flora and fauna and are committed to promote education on this topic. The Annex 1 of the Bern Convention lists the species of wild flora for which is intentionally forbidden to seize, collect, cut or uproot. The Annex 2 of Bern Convention lists the species of wildlife for which there is a prohibition of capture, killing, deterioration and destruction of breeding/resting sites, disturbance (especially in periods of reproduction, parental care and hibernation), collection/destruction/detention of eggs, keeping and trading of live or dead animals or parts of animals. It also underlines the protection of habitats, with particular attention to the protection of wintering, migration, gathering, and feeding areas. The Annex 3 of Bern Convention lists the species that must be subject to regulation in order to not compromise their survival (temporary or local prohibition of exploitation, regulation of transport or sale, etc.). The contracting parties prohibit the use of non-selective means for capture and killing, which could cause disappearance or compromise the life of the species (regulated collection is allowed as long as it does not compromise the conservation status of the species). There are closed hunting periods, and local hunting derogations. The conservation of habitats, with particular attention to the protection of wintering, migration, gathering, and feeding areas is also recommended. In the event of capture, selective methods will be used, prohibiting the use of means that can create local disappearance or affect the welfare of a species. Ban on the use of sampling methods is listed in the Annex 4.

In the Annex 2 of the Habitat Directive (92/43/EEC) on the conservation of natural and semi-natural habitats and of wild flora and fauna, are listed animal and plant species of community interest, whose conservation requires the designation of special areas of conservation (SCIs). In the Annex 4 of the Habitat Directive are listed animal and plant species of community interest that require strict protection. In the Annex 5 of the Habitat Directive are listed animal and plant species of community interest for which the collection and exploiting from nature may be the objective of management measures.

In the frame of the Barcelona Convention, in 1995 UNEP promoted the establishment of protected areas, named SPAMI, in order to preserve the components of biological diversity, as well as specific Mediterranean ecosystems or habitats of threatened species and of scientific, aesthetic and cultural interest. These areas can be coastal areas under the jurisdiction of countries or areas partially/entirely offshore. The participating countries are committed to maintaining marine flora and fauna in good condition and to guarantee maximum protection for the species listed in the annexes of the protocol, and to develop national Action Plans for the conservation of protected species. The Convention has been in force since 1999 (and beyond) in contracting parties of the Mediterranean countries. The Annex 2 of the SPAMI protocol lists the endangered or threatened species. The protocol provides that countries guarantee protection and conservation measures for the species listed in the Annex 2, prohibiting killing, trade, and disturbance during the periods of reproduction, migration, wintering and other periods in which animals are subjected

to physiological stress. The Annex 3 of the SPAMI protocol lists the species whose collection must be regulated. The protocol also provides that the adhering countries undertake conservation and management measures for the species listed in Annex 3, authorizing and regulating the collection of these species in order to guarantee a favourable conservation status.

Finally, in the Mediterranean IUCN Red List, *Corallium rubrum* is classified as ‘Endangered’, *Paramuricea clavata* as ‘Vulnerable’, *Eunicella* species as ‘Near Threatened’.

Table 1. List of the legally protected species that can be found in the coralligenous and maërl habitats, according to the international legislations. Ha4 = Annex 4 of the Habitat Directive; CIT 2 = Annex 2 of the CITES Convention; Bern 1, 2, 3 = Annex 1, 2, 3 of the Bern Convention; Asp 2, 3 = Annex 2, 3 of the SPAMI Protocol.

ALGAE

<i>Cystoseira zosteroides</i>		Bern 1	Asp 2-3
<i>Laminaria rodriguezii</i>		Bern 1	Asp 2-3

PORIFERA

<i>Axinella polypodes</i>		Bern 2-3	Asp 2-3
<i>Axinella cannabina</i>			Asp 2-3
<i>Spongia agaricina</i>		Bern 2-3	Asp 2-3
<i>Spongia officinalis</i>		Bern 2-3	Asp 2-3
<i>Aplysina aerophoba</i>			Asp 2-3
<i>Aplysina cavernicola</i>		Bern 2-3	Asp 2-3
<i>Sarcotragus spinosulus</i>			Asp 2-3
<i>Sarcotragus pipetta</i>			Asp 2-3

CNIDARIA

<i>Astroides calycularis</i>		CIT 2	Bern 2-3	Asp 2-3
<i>Corallium rubrum</i>	Ha4		Bern 2-3	Asp 2-3
<i>Antipathella subpinnata</i>		CIT 2		
<i>Antipathes dichotoma</i>		CIT 2		
<i>Antipathes fragilis</i>		CIT 2		
<i>Savaglia savaglia</i>		CIT 2	Bern 2-3	Asp 2-3

<i>Caryophyllia (Caryophyllia) inornata</i>	CIT 2		
<i>Caryophyllia (Caryophyllia) smithii</i>	CIT 2		
<i>Hoplangia durotrix</i>	CIT 2		
<i>Polycyathus muelleriae</i>	CIT 2		
<i>Phyllangia americana mouchezii</i>	CIT 2		
<i>Cladocora caespitosa</i>	CIT 2		
<i>Dendrophyllia ramea</i>	CIT 2		
<i>Dendrophyllia cornigera</i>	CIT 2		
<i>Leptopsammia pruvoti</i>	CIT 2		
<i>Madracis pharensis</i>	CIT 2		
<i>Madrepora oculata</i>	CIT 2		
<i>Errina aspera</i>		Bern 2-3	Asp 2-3

CRUSTACEA

<i>Homarus gammarus</i>		Bern 2-3	Asp 2-3
<i>Palinurus elephas</i>		Bern 2-3	Asp 2-3
<i>Scyllarides latus</i>	Ha4	Bern 2-3	Asp 2-3
<i>Maja squinado</i>		Bern 2-3	Asp 2-3

BRIOZOA

<i>Hornera lichenoides</i>			Asp 2-3
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MOLLUSCA

<i>Lithophaga lithophaga</i>	Ha4	CIT 2	Bern 2-3	Asp 2-3
<i>Charonia lampas</i>			Bern 2-3	Asp 2-3
<i>Pinna rudis</i>			Bern 2-3	Asp 2-3
<i>Luria lurida</i>			Bern 2-3	Asp 2-3

ECHINODERMATA

<i>Centrostephanus longispinus</i>	Ha4		Bern 2-3	Asp 2-3
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PISCES

<i>Epinephelus marginatus</i>		Asp 2-3
<i>Raja alba</i>	Bern 2-3	Asp 2-3

Impact studies in the marine environment

An Environmental Impact Assessment (EIA) is a regulatory approach to assess the possible detrimental effects that a proposed project may have on the environment, consisting of the environmental, social and economic aspects, before it is put into effect. The purpose of the assessment is to ensure that decision-makers consider the impacts (environmental, social, and economic) when deciding whether or not to proceed with a project (UNEP, 1996). Information consists of (i) a prediction of the possible changes to the environment after the project is started, and (ii) opinions on how the project should be carried out so that the disturbance it is expected to cause would be as slight as possible.

EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision-makers to account for environmental values in their decisions and to justify those decisions in the light of detailed environmental studies and public participation and comments on the potential environmental impacts.

The idea of the impact study appeared in 1970 in the USA, in the law on environmental protection. The need to make a report on the impact at the environment for bills and other action, which could significantly affect the quality of the environment, was clearly stated. The impact report was always published. This procedure has rapidly been adopted internationally; it appeared in Canada from 1973 and in Europe from the late 1970s.

The EIA procedure typically consists of the following steps:

- the developer requests the competent authority to say what should be covered by the EIA information to be provided by the developer (scoping stage);
- the developer provides a precise description of the planned project (e.g., the project's aims, the site where it will be put into effect, the size, the operational techniques planned for its completion);
- a detailed analysis of the original condition of the area where the project will be put into effect (i.e., the reference state, or 'zero' state);
- an exhaustive inventory of the effects linked to the project on the human and natural environment or engendered by its future exploitation;
- modify and improve the design of a development proposal and identify alternatives to the development proposal;
- a suggestion about measures to be taken to mitigate the predicted impacts on the environment, integrating possible compensatory measures. The latter aims at compensating, as far as possible, the damage caused by the project;
- propose monitoring requirements and specific management;
- stakeholders (including the public) are informed on the decision and can challenge the decision before the courts.

The EIA shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors:

- population and human health;
- biodiversity and ecology, with particular but not exclusive attention to species and habitats protected under national and international legislations, including the Conservation of Wild Birds Regulations and the Flora, Fauna and Natural Habitats Protection Regulations;
- physical environment, land, soil, water, air and climate.

The whole of the dossier must be made available to (i) the public, to be able to express an opinion, and (ii) the administrative structures responsible for authorising all or part of the project. Similarly, the decision to give permission and the appended conditions, which authorise the project's being put into effect, must be made available to the public. If the national law permits, the elements that justified the agreement may be made available to the public.

In order to implement this approach, the Environmental Impact Assessment Directive (85/337) was issued to assess the effects on the environment of certain public and private projects, which was subsequently amended by the Directives 97/11, 2003/35 and 2009/31. The original Directive of 1985 and its three amendments were codified by the Directive 2011/92 on the assessment of the effects of certain public and private projects on the environment. Following an extensive consultation process, a newly amended Environmental Impact Assessment Directive (2014/52) (hereafter referred as the EIA Directive) entered into force on 15 May 2014 to simplify the rules for assessing the potential effects of projects on the environment. It is in line with the drive for smarter regulation, so as to reduce the administrative burden. It also improves the level of environmental protection, with a view of making business decisions on public and private investments more sound, more predictable and sustainable in the longer term. The EIA Directive applies to a wide range of defined public and private projects, which are defined in the Annexes I and II. Annex I defines projects considered as having significant effects on the environment. Studies must be done for all building activities or other installations or works or operations in the environment, including the exploitation of soil resources. Only projects for national defence, or adopted by a particular national law, are excluded from this procedure. Projects that systematically give rise to impact studies concern (excluding particular exemption):

- oil refineries (excluding the production of lubricants);
- large-scale gasification or liquefaction installations (minimum 500 tons of coal or bituminous schist per day);
- thermal power stations (at least 300 MW) or nuclear power stations (excepting those research structures whose maximum power is under 1 kW of permanent thermal duration);
- installations for eliminating, processing or stocking hazardous waste;
- large installations for the disposal of non-hazardous waste and treatments of waste water;
- steelworks;
- installations where asbestos is extracted and, according to production level, processed;
- chemical installations;
- heavy-use communication routes (long-distance railway lines, motorways, express roads) and airports (with a basic runway length of over 2.1 km);
- port infrastructures or maritime routes concerning buildings of over 1350 tonnes.

An EIA is thus mandatory for each of the above listed projects. The projects listed in the Annex II are generally less significant and at smaller-scale, and national authorities have discretion to decide whether an EIA is needed. This is done by a 'screening procedure', which determines the effects of projects on the basis of thresholds or criteria or a case-by-case examination. In any event, national authorities must take into account the criteria laid down in the Annex III, relating to the characteristics of the project, its proposed location and its potential impact.

The 2014 revision of the EIA Directive was a response to the fact that the 1985 Directive was not significantly changed for more than 25 years since its first introduction, although the policy, legal and technical contexts evolved considerably over the same period. The 2014 amendments aimed at correcting identified and persisting shortcomings, at reflecting current environmental and socio-economic priorities and challenges, at aligning the Directive with the principles of smart regulation. Article 5 and the Annex IV

of the EIA Directive were amended to include a new provision with respect to the completeness and quality of the EIA report, requiring the developer to ensure that the EIA report is prepared by competent experts and the competent authority will ensure that all parties have the required expertise to examine and appraise the EIA report. Where necessary, the competent authority may request further information from the developer that is relevant for reaching a reasoned conclusion on the significant effects of the project.

The EIA Directive was transposed into law by means of the Evaluation of the Consequences on the Environment of Certain Projects Law 140 (I) in 2005, which was subsequently amended by Laws 42 (I) in 2007, 47 (I) in 2008, 80 (I) in 2009, 137 (I) in 2012 and 51 (I) in 2014 (hereafter referred as the EIA Law). The aim of the EIA Directive and, therefore, of the EIA Law is the establishment of a legislative framework to assess the potential effects on the environment of the preparation process of public and private projects, as outlined in the Annexes I and II of the EIA Law. The EIA is also made obligatory by other EC legislative arrangements, such as the WFD (2000/60/EC) that established a framework for community actions in the field of water policy.

The first report on the progress of the application of the EIA in Europe was published in 2003: the report from the Commission to the European Parliament and the Council of the application, effectiveness and functioning of the Directive 85/337/EEC, as amended by the Directive 97/11/EC. The report found problems on the level of admission thresholds for the EIA, on the quality control of the EIA procedure, on the splitting of projects and on the assessment of the cumulative effects on the environment. The needed improvements were evident: the training of local administration personnel, risk assessment and monitoring systems, raising awareness about the links between human health and the environment, the overlap of environmental authorization procedures, facilitating public participation. Today, impact studies are a tool for helping development, accompanied by technical advice, for an optimum result (UNEP, 1996). They encourage coordination between bodies responsible for the environment, and also associate local people and non-governmental organizations. Public consultation is increasingly encouraged and the studies devoted to an analysis of alternative solutions for the project under discussion are growing. Impact studies aim to become a tool for 'sustainable development', and are seeing their field of application expanding. They should in the long run be integrated in any drafting of management plans, or any definition of the regulatory processes (UNEP, 1996). Article 191 provides that EU policy on the environment will be based on the 'precautionary principle', the 'polluter pays principle' and shared responsibility, and that preventive actions should be taken and environmental damage should be combated at source.

The current situation on environmental impact studies and EIA procedures in all the 21 Mediterranean countries (i.e., the contracting parties) adhering to the Barcelona Convention on the protection of the marine environment and the coastal region of the Mediterranean, adopted in 1995, is here reported. The contracting parties are: Albania, Algeria, Bosnia-Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, and Turkey. The information on the status of the EIA legislation for each contracting party has been compiled according to the available literature and to consultancy by focal points. Although the idea of the impact study is familiar to many Mediterranean countries, it does not always appear systematically in their national law.

Regulation in Albania

The EIA in Albania follows the European Environmental Impact Assessment Directive 85/337/EEC of 27 June 1985 and its most recent amendment in the Directive 2014/52/EC, and is based on the Law on Environmental Protection n. 7664 of 21 January 1993. The 2011 Law on Environmental Impact Assessment, n. 10440, aims at improving the existing environmental impact assessment system. It fully transposes the European Directive “on the assessment of the effects of certain public and private projects on the environment”.

The contents of the EIA study in Albania are (Art. 14):

- ✓ Project description
- ✓ Baseline data
- ✓ Analysis of impacts
- ✓ Mitigation measure
- ✓ Natural and legal persons who could be affected
- ✓ Other data as required
- ✓ Conclusions

At the national level, the Ministry of Environment, Forests and Water Administration (MEFWA) is responsible for the protection of environmental values and in particular of protected areas. The law n. 8906 of 2002 regulates protected areas (declaration, preservation, administration, and management) and activities in protected areas such as tourism information and education.

Albania is signatory of numerous conventions and agreements, such as the Convention for the protection of the marine environment and the coastal region of the Mediterranean and participates to numerous programs developed under the Convention, like the Coastal Area Management Program (UNEP/MAP, 1996), the Convention on Biological Diversity (CBD) or the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

Other regulations concerning the protection of environment are:

- ✓ Law for “Protected Areas” (n. 8906 of 06/06/2002) amended by the Law “on some supplements and changes in Law n. 8906 of 06/06/2002” (n. 9868, 04/02/2008)
- ✓ Law on “Biodiversity Protection” (n. 9587 of 20/07/2006)
- ✓ Barcelona Convention (UNEP, 1976)
- ✓ Marine Strategy Framework Directive (2008/56/EC), which requires member states to put measures in place to achieve or maintain the GES in their waters by 2020.

Albania is also a member of the Mediterranean Marine Protected Areas Network (MedMPAnet), which leads to the creation of marine and coastal MPAs in several Mediterranean countries. In Albania, the partner of the MedMPAnet project is the Ministry of Environment, Forests and Water Administration (RAC/SPA and IUCN-Med, 2014a). In this context, RAC/SPA signed a Memorandum of Understanding in 2012 with the Centre for Mediterranean Cooperation of the International Union for the Conservation of Nature (IUCN-Med) considering that:

1. A comprehensive assessment of the legal and institutional framework for conservation of coastal and marine biodiversity and the establishment of protected areas in the Adriatic region has to be undertaken;

2. The analysis and recommendations of the legal and institutional framework for marine protected areas would contribute to the preservation and protection of marine biodiversity, as well as other natural resources constituting the Adriatic biodiversity assets.

Albania includes about the 13% of its territory under conservation status, but there are no formal MPAs. Through the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol), the contracting parties to the Barcelona Convention established the SPAMI's list in order to promote cooperation in the management and conservation of natural areas, as well as in the protection of threatened species and their habitats. The SPAMI's list includes 35 sites, one of which is located in Albania (Karaburun Sazan National Marine Park).

Coralligenous and maërl formations are not specifically mentioned in the EIA regulation of Albania, nevertheless there are regulations regarding some protected species that inhabit these habitats. The fishing of corals and sponges is not permitted, though special authorisations may be granted for research purposes (Article 22 of Law n. 7908 of 1995). With regard to bivalve molluscs, the fishing of *Litophaga litophaga* is prohibited throughout the year in any area of the Albania's territorial waters (Article 6.2 of Regulation n. 2 of 2000) (Cacaud, 2003).

Regulation in Algeria

The EIA in Algeria is regulated by the Environmental Law n. 83-03 of February 5, 1983, and the detailed legislation for EIA is included in the Executive decree n. 90-78 dated February 27, 1990 that refers to the protection of wild flora and fauna and natural habitats. According to this decree, an impact assessment study must be composed by:

- ✓ an analysis of the initial state
- ✓ an analysis of the environmental effects.

The EIA is administrated by the Ministry of Land Use and Environment, the General Direction of the Environment and the Environmental Inspector at Wilaya level. More recently, the Law n. 03-10 of July 19, 2003 is relative to environmental protection plans and states that development and construction projects would be subjected, according to the different cases, to an impact assessment study. The application clauses of this law are defined by regulations.

Marine ecosystems, however, are not included in the EIA regulations. Nevertheless, there are some regulations concerning fishing activities, Article 42 of the Decree and Article 27 of the Law n. 1-11 of 2001. It should be noted that the Ministry responsible for fishing is authorized to restrict or prohibit the use of any fishing gear (Article 38). Furthermore, Law n. 1-11 of 3 July 2001 stipulates that coral fishing must be rationally carried out and only using suitable diving equipment systems (Cacaud, 2003).

Regulation in Bosnia-Herzegovina

The EIA laws broadly adhere to the most recent version of the European Environmental Impact Assessment Directive (2014/52/EC). EIA is a widespread tool in the permitting process, in both the Federation of Bosnia and Herzegovina and the Republika Srpska. According to the Ministry of Environment and Tourism of the Federation of Bosnia and Herzegovina, 50 EIAs per year are launched on average. Bosnia and Herzegovina is party of 46 multilateral environmental agreements, including the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, and its four protocols (Dumping, Emergency, Land-based Sources, and Specially Protected Areas) (United Nations, 2018).

According to the 2017 Environmental Approximation Strategy of Bosnia and Herzegovina, the country has the following competences in environmental matters:

- Implementation of international treaties;
- Defining policies, general principles, coordinating activities and harmonizing plans of entity authorities and institutions at the international level within the competences of Bosnia and Herzegovina;
- Coordinating activities to approximate the legal system of Bosnia and Herzegovina with the EU requirements;
- Environmental statistics in cooperation with competent entity institutions;
- Ozone protection;
- Liquid fuels quality;
- Coordination of activities on phytosanitary protection;
- Freedom to access information and access to justice;
- Protection of animals used for scientific purposes;
- Mitigating noise from aircraft.

All other environmental competences fall under the area of competences of the Federation of Bosnia and Herzegovina, Republika Srpska and Brčko District.

A law concerning development also exists, the Law on Physical Planning and Utilization of Land at the Level of the Federation of Bosnia and Herzegovina (Official Gazette n. 2/06). In this law there is no mention on how to make an impact study, but the idea is mentioned in the regulatory text. Building activities must not endanger organisms and must enable the conditions of use of the site to be maintained. Development work must not give rise to any disturbance greater than that the environment can regulate, or affect people's health and safety.

Nature conservation in Bosnia and Herzegovina is regulated by the Law on Environmental Protection of the Federation of Bosnia and Herzegovina (OG n. 33/03, 38/09), which dates back to 2003. This law regulates conservation of nature, protection of the environment, air, water and waste management, and provide for establishment of a fund for environmental protection. No amendments were introduced in this law during the review period. In terms of implementation efforts, since 2011, the major focus has been to make the environmental permitting system work. All new installations receive environmental permits and go through an EIA, when required, before receiving an environmental permit. The problem occurs with existing installations that were built before the adoption of the Law on Environmental Protection and that cannot be closed for social reasons (i.e., jobs). The deadline for existing installations to apply for an environmental permit has been postponed; still, not all operators have applied for environmental permits.

In the Federation of Bosnia and Herzegovina, biodiversity protection and the sustainable use of natural resources are governed by the Law on Nature Protection and the Law on Environmental Protection. Relevant laws on the topic of biodiversity in the Federation also include the Law on National Park "Una" (OG n. 44/08) and the following legislations:

- Regulation of Natura 2000 sites;
- Rulebook on establishing a system of deliberate keeping and killing of protected animals (OG n. 46/05);
- Rulebook on establishing and managing an information system for protecting nature and monitoring (OG n. 46/05);

- Rulebook on new measures for research and preservation for the purpose of preventing negative impact on animal species either by capture or killing (OG n. 65/06);
- Rulebook on the requirements for accessing protected areas (OG n. 15/06);
- IUCN Red List of Endangered Wild Species and Subspecies of Plants, Animals and Fungi.

The 2017 Strategy and Action Plan for Protection of Biological Diversity in Bosnia and Herzegovina (2015-2020) and the 2014 Fifth National Report of Bosnia and Herzegovina to the Convention on Biological Diversity reported that there is a lack of high quality, valid and, in particular, recent data on biological diversity, including the marine environment. There is no system or institutional structure that is responsible for the collection, processing, integration and further updating of data on biological diversity in a systematic way.

As regarding the marine protection, there has been no specific marine regulation to date. No law relating to the water sector has been adopted at the state level but Laws on Water have been adopted by the entities, in January 2008 by the Federation of Bosnia and Herzegovina and June 2006 by the Republika Srpska. These two laws are broadly in line with the EU WFD (2000/60/EC), including coastal waters monitoring and management in the case of the Federation of Bosnia and Herzegovina. The WFD includes coastal waters issues up to one nautical mile at sea. All marine territory of Bosnia and Herzegovina, once clearly defined, will be included within this limit. Bosnia and Herzegovina will have to implement the EU MSFD (2008/56/EC) as well. This makes the setting up of a new marine environment policy of the outmost importance in the future.

In the EIA of Bosnia and Herzegovina there is no specific mention to coralligenous and maërl habitats and no regulation concerning their protection.

Regulation in Croatia

Croatia has transposed the European Environmental Impact Assessment Directive 85/337/EEC in March, 2007 and its recent amendment by the Directive 2014/52/EC. Regulations on the EIA in Croatia follow the Law on Environmental Protection (n. 82/94; n. 128/99) and it is administrated by the Ministry of Environmental Protection and Physical Planning (Ennabli and Whitford, 2005). Regulations also appear in the Decree n. OG 1324/59/2000, which has been modified in 2004 and 2006 (OG n. 136/04, 85/06).

Contents of EIA are:

- Description of the original condition (baseline data)
- Project description and purpose
- Relationship to physical plans
- Impacts expected
- Comparison of alternatives
- Mitigation measures
- Monitoring program
- Non-technical summary.

EIA studies in Croatia are made by private or public bodies, which have to prove experience, and have to be accredited by the administration concerned with environment management.

Croatia also follows the MSFD (2008/56/EC), which aims to achieve the GES of the EU's marine waters by 2020. To that end, member states must develop a marine strategy for their marine waters, and cooperate with the EU countries that share the same marine (sub)region. Croatian legislation has conformed to the MSFD since June 2017. For Croatia, the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) plays a significant role in achieving the goals required by the MSFD.

Some species of corals associated with coralligenous habitat are strictly protected according to Nature Protection Act (OG n. 80/2013) and Ordinance on strictly protected species (OG n. 144/2013). Article 228 of Nature Protection Act prescribes a fine for people who damage protected species.

According to Nature Protection Act and the Ordinance on habitat types, habitat map, endangered and rare habitats and habitat conservation measures (OG n. 119/09), coralligenous is an endangered habitat (RAC/SPA - UNEP/MAP, 2014a). Ordinance also lists general conservation measures for each main habitat type, both terrestrial and marine. Those measures are then incorporated into other sectorial plans or serve as guidelines for introducing stricter and more specific measures. Some of the general measures that concern also coralligenous habitat are:

- maintain or improve favourable physical and chemical characteristic of seawater;
- conserve favourable structure of seafloor and coast;
- conserve species important for habitat type;
- do not introduce alien species.

Marine Fisheries Act (OG n. 81/2013, article 76, item 19) prescribes a fine for violation of prohibition of fishing by trawl nets, dredges, shore seines or similar nets over coralligenous habitat and maërl beds, defined by Article 4.2 of the Council Regulation (EC) n. 1967/2006.

The National Classification of Habitats of the Republic of Croatia includes coralligenous biocenosis in the Habitat Directive. Conservation of protected areas is assured by nature impact assessment procedure, by effective management of sites and by conducting basic conservation measures. To some extent, coralligenous habitats are currently affected by the above listed pressures. The future prospects will depend on the nature of pressures (local versus global, direct versus diffuse action mode). For pressures such as fishing, eutrophication, and recreational diving effective management actions may be taken to reduce their impacts because they act at the local level and in a direct manner. In these cases regulation and control of the human activities can be effective in limiting or even reversing the degraded condition of affected areas. However, for other pressures conservation and management options are more challenging because these pressures act at larger scales in a diffuse manner and control of their sources is not possible. Finally, the interactions between pressures are difficult to forecast.

Regulation in Cyprus

Awareness of the environment has advanced considerably in Cyprus over the past few decades, particularly since Cyprus joined the EU. The EIA in Cyprus follows the European Environmental Impact Assessment Directive 85/337/EEC, and its recent amendment by the Directive 2014/52/EC. EIA services include:

- EIA management of certain projects
- Site surveys to evaluate current environmental conditions
- Analysis and evaluation of the current environmental state (natural environment)

- Analysis of the environmental impacts of the project
- Proposal of mitigation measures
- Presentation and client's support with the competent authorities.

The resulting EIA report is presented to the Committee (as stated by the national legislation) and the opinion of the members of the committee is taken into consideration for the final decision of the Department of the Environment on the proposed project.

The Directive on the assessment of the effects of certain plans and programs was aligned with the national law in 2005 by the Environmental Impact Assessment from Certain Plans and/or Programs Law n. 102(I)/2005. The aim of this Directive is to provide a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programs. The law covers plans or programs drawn up for the various sectors of the economy, such as agriculture, farming, forestry, fisheries, quarrying and mining, energy, industry, transport, waste management, water management, and tourism, which specify the framework for future permits of projects covered by the law on environmental impact assessment of projects.

During the preparation of a plan or program, in the initial stages of planning, the competent authority requests the opinion of the Environmental Authority whether the preparation of a Strategic Environmental Impact Assessment Study (SEIAS) is needed. If the Environmental Authority decides in accordance with the criteria laid down by the Law (listed in Annex II) that the plan or program is likely to have significant effects on the environment, it shall request the preparation of a relevant study. For the preparation of the plan or program, the competent authority prepares and submits the SEIAS to the Environmental Authority, while publishing a relevant notification in two daily newspapers and online, informing the public with respect to the plan or program, the areas and hours that the SEIAS may be inspected and the right of every person to submit opinions to the Environmental Authority within 35 days from the date of publication of the notification. The SEIAS is presented and assessed at the meeting of the committee of the Environmental Impact Assessment from Certain Plans and/or Programs, set up in accordance with the provisions of the Law.

The law on EIA makes no specific references to any species or habitats, and thus to coralligenous and maërl, even because the data about these two habitats in Cyprus seas are still scarce.

Cyprus is committed in the biodiversity conservation both nationally and internationally through, among others, the following instruments:

- ✓ Barcelona Convention 1976 (amended in 1995);
- ✓ Convention on Biological diversity (Biodiversity Convention of 5 June 1992);
- ✓ Habitats Directive (1992/43/EEC);

In the context of the enlargement of the European Union, among the many changes that will necessarily have to be made to a large number of EU laws, is the amendment of the annexes of Directive 92/43/EEC on Habitats and Directive 2009/147/EC on Birds. During the accession negotiations, Cyprus proposed the inclusion of Cypriot fauna and flora species and the habitat types, in the Annexes of the Directives on Habitats and Birds, which was accepted. Subsequently, these amendments were incorporated into the Accession Treaty.

Pressure on the Cyprus marine environment has increased in recent years as a result of the expansion of mariculture, hydrocarbon activities, expected increase in maritime traffic, desalination plants, and fisheries. As regards the protection of the marine environment, according to the Network of Managers of Marine

Protected Areas in the Mediterranean (MedMPAnet), Cyprus established in 1989 its first MPA, the Lara-Toxeftra MPA, which is the only SPAMI area of the country. Following the implementation of the Habitat Directive (92/43/EEC), six marine areas were then included in the Natura 2000 network, which protect important habitat types and species of flora and fauna of the Directive 92/43/EEC. Currently, in Cyprus there are 18 designated marine areas under various protection regimes, including the six coastal Natura 2000 areas, five coastal MPAs with fisheries restrictions, six MPAs with artificial reefs that are strictly no-take zones, and one offshore Fisheries Restriction Area. One additional offshore area has been proposed in 2019 for approval by the European Commission to be added in the Natura 2000 network. With the addition of this new offshore area (Oceanid, CY4000024), the percentage of the MPAs in Cyprus rises to 19.13% of its total marine area, meaning its territorial waters and Exclusive Economic Zone.

Regulation in Egypt

The EIA system in Egypt was introduced through the Environmental Protection Law no. 4/1994. EIA is one of the main preventive activities conducted by the Egyptian Environmental Affairs Agency, to assess the impacts of initiatives, projects, or developmental activities, with a view of identifying necessary actions to minimise negative impacts and maximise positive ones. In the context of an impact study, the envisaged project must be described, as well as the natural resources present and the steps likely to attenuate the impacts, or alternative suggestions. The package of elements is sent by the manager to the Egyptian Environmental Affairs Agency, more precisely the Environment Development Sector. The Environment Development Sector works with university professors and experts in each of the disciplines to assess the study that has been made.

Egypt required protecting its natural resources and marine biodiversity by establishing a network of six MPAs that are located in the Gulf of Aqaba and the Red Sea. Most of these areas include interconnected marine and terrestrial sectors aimed at conserving mainly coral reefs and accompanying systems. Other coastal Mediterranean habitats, such as coralligenous and other bioconstructions, are not specifically concerned by national regulations in EIA (Ahmad and Wood, 2002; Hegazy, 2017).

Regulation in France

France is probably the country where most of the environmental impact assessments are carried out. The development of conservation laws in France actually began after the second world war, in conjunction with the emergence of environmental concerns at international level. Environmental law has been developed in France with the two great laws of 1976, one on the protection of nature and one on the facilities classified for environmental protection (*Installations classées pour la protection de l'environnement*, ICPE). The Law on the Protection of Nature (*Loi de Protection de la Nature*, LPN) n. 76-629 of 10 July 1976 is codified in article L. 411-1 and following ones of the Environmental Code and provides an overview of these legal developments and regulation on impact studies, declaring the conservation of species, habitats and landscapes to be of public interest. The Decree of 12 October 1977 (Decree n. 77-1141) defines the general terms of the impact study. It states that the content of the study has to be related to the size of the planned work and its foreseeable effect on the environment (Sánchez, 1993). The 1993 Decree (Decree n. 93-245 of 25 February 1993) supplements and makes clearer the impact study procedure, which must provide:

- ✓ an analysis of the original condition of the site and of its environment in terms of natural richness and areas affected by the development;
- ✓ an analysis of the direct and indirect, temporary and permanent effects of the development on the environment, particularly on sites and landscapes, fauna, flora, soil, water, air, natural environments and biological balance, protection of property and the cultural heritage and possibly the environmental comforts (noise, vibration, smell, etc.), hygiene, public health or safety;
- ✓ an analysis of the methods used to assess the effects of the project on the environment, mentioning possible difficulties (technical or scientific) for making the assessment;
- ✓ the reasons why the suggested project has been accepted, particularly as regards the environment;

- ✓ the steps envisaged by the manager to suppress, reduce and where possible compensate for the project's harmful consequences for the environment, and an assessment of the corresponding expenditure;
- ✓ a non-technical summary to make easier consultation by the public.

Unlike the regulations for the other states, not only those kinds of projects requiring an impact study are appended to the decrees but also work for which the procedure is not obligatory. This means that the impact study must be the rule, and the exemption the exception. The criteria for screening projects to be submitted to EIA consist of both technical and financial thresholds. The law had established a negative list (that is, a list of projects that do not require the submission of an EIA), but the decree of application also defined a positive list of projects that must always be submitted to an EIA regardless of their size and amount of investment. Specifically excluded are maintenance work and big repair interventions. Since 1983, a law (n. 86-630 of 12 July 1983) has made a public inquiry obligatory for any development project, which by its nature or the character of the area concerned is likely to affect the environment. Financial thresholds are defined as application limits for an impact study: developments costing less than one million eight hundred thirty thousand Euros (a sum regularly updated) are not subjected to an impact study.

The impact study is usually elaborated by the manager. He is therefore the responsible if an incomplete or insufficient study has been made, but he is not obliged to make the study by himself. It is even recommended to contact specialists for all or part of the study. Where there is no impact study concerning a development for which this procedure is required, a stay of execution may be pronounced, causing the work to be stopped.

The laws of the European Union are today the main sources of environmental regulations in France. The European Environmental Impact Assessment Directive 2014/52/EC has been transposed in the Environmental Code in France. The Constitution and the Article L. 110-1 of the Environmental Code expose the principles governing the protection, enhancing, restoration, rehabilitation and management of natural areas, resources and habitats. The recent law 2016-1087 of 8 August 2016 for the reconquest of biodiversity, nature and landscapes has established a new governance of biodiversity, with the establishment of three bodies: 1) the National Biodiversity Council (*Conseil national de la biodiversité*), a consultation body at the service of the Government on strategic biodiversity issues; 2) the National Nature Council (*Conseil national de la nature*), consulted for its scientific and technical expertise on draft laws, ordinances and decrees; and 3) the French Biodiversity Agency (*Agence Française de la Biodiversité*, AFB), a public organization under the supervision of the Ministry of Ecology, established for the purpose of supporting public policy implementation in order to improve knowledge and to protect, manage and restore, terrestrial, aquatic and marine biodiversity (articles L. 131-8 to L. 131-17 of the Environmental Code). In addition, there are at the regional level the regional biodiversity committees (*Comités régionaux de la biodiversité*) provided in art. L. 371-3 of the Environmental Code. The 2016 Law on the Recovery of Biodiversity is becoming an increasingly important environmental policy in France over the past few years and has strengthened the role of these public policy tools. This law is built on three main pillars: i) the goal of no net loss of biodiversity; ii) the application of the avoiding-minimizing-offsetting sequence (*séquence éviter-réduire-compenser*, ERC) in the field; and iii) the implementation of the ecological equivalence criterion the case of compensation measures.

Following the adoption of a Strategic Plan for Biodiversity 2011-2020 during the 10th Conference of the Parties (COP10) of the Convention on Biological Diversity in Nagoya (Japan), France adopted a National Biodiversity Strategy (*Stratégie nationale pour la biodiversité*) and Regional Schemes of Ecological Coherence (*Schémas Régionaux de Cohérence Ecologique*), which should make it possible to halt the loss of biodiversity with the mobilisation of all actors and the integration of biodiversity conservation into all public policies. Its application is voluntary by public and private actors, but the State undertakes to be exemplary, in accordance with the provisions of article L. 110-

3 of the Environmental Code. As a result, a biodiversity framework bill for the restoration of biodiversity, nature and landscapes is currently being examined by the French Parliament. The purpose of this framework bill is to improve the balance between human activities and biodiversity. Many actions have already been taken nationally to tackle biodiversity loss: designation of new marine and land-based protected areas, mapping of green and blue infrastructure, definition of action plans for endangered species, strategies to control invasive species, spread of biodiversity practices, information and knowledge-building campaigns, and regional and international cooperation actions.

The legal framework for French protected areas is based on various legislative and regulatory instruments, which were consolidated in the year 2000 as part of the Environmental Code that codifies the laws and decrees relating to protected areas in France (Law of 10 July 1976 on nature protection, the law that established nature reserves; Law of 14 April 2006 relating to marine nature parks) (Guignier and Prieur, 2010). In the Environmental Code of France, it can also be found the legislation concerning the MPAs. In 2006 the MPAs Agency (*Agence des Aires Marines Protégées*, AAMP) was created as an administrative public entity under the authority of the minister in charge of environmental protection. MPAs Agency was later incorporated into the French Biodiversity Agency (*Agence Française de la Biodiversité*, AFB). Since January 1, 2020, the French Agency for Biodiversity and the National Office for Hunting and Wildlife have come together in the French Office for Biodiversity (*Office Français de la Biodiversité*, OFB). The Office follows two main goals related to marine protected areas: at the national level it leads “the network of French marine protected areas”, while internationally it “contributes to the involvement of France in the establishment and management of marine protected areas” (Environmental Code, Art. L.334.1-II). Most protected areas in France have management plans, and sometimes they also have evaluation tools to assess plan implementation. However, they still need to define methods for assessing management efficiency, diversifying funding mechanisms, improving monitoring and ensuring follow-up on the basis of shared indicators. The use of IUCN categories allows France assessing whether tools are consistent with management objectives, and, ultimately, improving the international readability of the French system.

No marine habitats explicitly appear in the regulation about impact studies and its notes. The protection of the coastal and marine environment and of its biological diversity at the EU level, as well as in France, is governed mainly by the 1992 Habitats Directive, through the conservation of natural marine habitats and wild fauna and flora occurring in the marine territory and by selecting special areas of conservation with a protective legal regime. The important areas selected in France are part of the European ecological network Natura 2000. The MSFD 2008/56 and the Directive 2014/89 establishing a framework for maritime spatial planning are also fully implemented in France.

In France, the coast is considered as a geographical entity that requires a specific development, protection and enhancement policy (article L. 321-1 Environmental Code). In order to guarantee the protection of marine natural resources and balance with the other interests, the law 86-2 of 3 January 1986, codified in the article L. 121-1 and following the Code of Urbanism, determines the conditions of the use of land, sea and lake spaces in coastal municipalities. The Coastal Protection Agency (*Conservatoire du littoral et des rivages lacustres*), a French public administrative body created by the law 75-602 of 10 July 1975, has the responsibility of conducting land-use policies for the protection of coastal areas, natural sites and ecological balance, after consultation with municipal councils and in partnership with interested territorial authorities (article L. 322-1 of the Environmental Code). With regard to the marine environment, a National Strategy for the Sea and Coast (*Stratégie nationale pour la mer et le littoral*) has recently been adopted via Decree 2017-222 of 23 February 2017 as a strategic framework for the environmental protection, for the realization or maintenance of the GES of the marine environment, for the sustainable use of marine resources and for the integrated and concerted management of coastal and maritime activities (article L. 219-1 of the Environmental Code). The National Strategy lays down the general principles and

guidelines concerning maritime areas under sovereignty or under national jurisdiction, the overlying airspace, the seabed and the sea subsoil, as well as the activities situated on the territory of the coastal administrative regions or on those of overseas collectivities and having an impact on these areas (Alogna, 2018).

Regulations in Greece

In Greece the first reference to the protection of the environment was made in the article 24 of the Greek Constitution in 2008 (Lampridi, 2016). Especially the paragraph 1 mentions that “The protection of the natural and cultural environment constitutes an obligation of the State. For its protection, the State must take particular preventive and repressive measures” (Constitution of Greece, 2008).

The institution of the Environmental Licensing of projects and activities started in 1990 with the harmonization of the Greek legislation with the European Environmental Impact Assessment Directive 85/337/EEC, in the context of the provisions of the Law n. 1650/1986 (G.G.1 160A/18.10.1986) “For the protection of the environment” and the issue of the JMD2 69269/5387/1990 (G.G. 678B/25.10.1990) “Ranking of projects and activities into categories, content of Environmental Impact Statements, setting the content of Specific Environmental Studies and other related provisions under the Law n. 1650/1986”.

The reforming of the institution of Environmental Licensing of projects and activities under the provision of Law n. 1650/1986 and the JMD 69269/5387/1990 was made by the Law n. 3010/2002 (G.G. 91A/25.04.2002) “Harmonization of Law 1650/1986 with the Directives 97/11/EU and 96/01/EU, determination process and regulation of matters regarding water courses and other provisions”. Subsequently, also the Directive 2001/42/EU was incorporated.

The EIA in Greece is subject to relatively recent national legislation (L. 3010/02, JMD 15393/2332/02, JMD 11014/703/F104/03) transposing the respective European Community Legislation. EIA is obligatory for four major categories of projects. Works and activities are classified in these categories mainly according to the type of work and its scale (JMD 15393/2332/02). The Greek EIA process for the four major categories is integrated into a two-cycle approach, linked first to a Preliminary Environmental Statement and a decision for authorization of the type of project in this location (putting the project into scope) and then to a full Environmental Statement and the decision granting final environmental terms for its implementation. This process has had a positive effect on the conservation of the natural environment as it allows for intervention in the design of the project and a better application of the precautionary principle.

The information presented in each case depends on the type and size of a project, as well as on the location it is proposed. Generally, the impact study has to include the following points:

- ✓ description of the original state
- ✓ the accomplishments foreseen
- ✓ expected impacts and harmful effects
- ✓ measures planned to reduce the harmful effects.

Depending on the type and size of the projects, authorisation lies within the competencies of Prefecture or Regional or central Environmental Services of the country (JMD 11014/703/F104/03). In case the project is in areas of the Natura 2000 network, environmental authorization is given by a more centralised scale of Services (e.g., Central Services are giving environmental authorization for works of A1 category. A2 category in Natura 2000 sites is authorized by central services, whereas authorization for works of A2 category in non Natura 2000 sites is given by the Regional authorities. Accordingly, Regional Services are giving environmental authorization for works of B3 and B4 category in Natura 2000 sites, whereas the same categories in non Natura 2000 sites are

authorized by Regional or Prefectural and Prefectural Authorities, respectively). Further on, for projects and activities of the first two categories of projects (A1, A2), the opinion of the Section of Nature Management of the Ministry of Environment is always sought.

Concerning the protection of the water bodies and of the marine environment, Greece, as a European Union state, follows the EU WFD (2000/60/EC) and the EU MSFD (2008/56/EC). Furthermore, in Greece there is a project called Mediterranean Sensitive Habitats, that is a framework contract (MAREA Consortium) financed by DG Mare, focusing on Mediterranean Sensitive Habitats in a double way. Within an ecosystem approach to fisheries, the project aims to the compilation of information on historical and current data on the locations and the status of seagrass beds, coralligenous and mærl beds all over the Mediterranean basin, the identification and mapping of suitable areas for *Posidonia oceanica*, coralligenous and mærl communities by developing habitat distribution models at different spatial scales.

In addition, information is compiled on existing MPAs in the Mediterranean area, as well as Fishing Restricted Areas that are under any form of national or international regulation. Within a fisheries oriented way, the project also focused on the compilation and mapping of the information that is associated to the location of nursery and spawning aggregations for six small pelagic and twelve demersal fish species included in Appendix VII of Council Regulation (EC) n. 199/2008, as well as for the species subject to minimum size (Council Regulation EC n. 1967/2006-Annex III). Integration and dissemination of the information is done through a Geographic Information System that integrates environmental dimension into fisheries management, operating as a consulting tool for spatial management and conservation planning.

Regulation in Israel

The law on buildings on the maritime domain comes under the Ministry of the Interior and the 1965 Law on development and construction. This Law, as well as providing development outlines, has enabled a Territorial Waters Committee to be set up, dealing with planning and building on the maritime territory and the coastline. The EIA regulation was later promulgated under the Planning and Building Law of 1982. The regulation requires conducting EIAs for projects and plans expected to have significant environmental impacts. The regulation categorizes and nominates plans that require EIAs. Before any development is permitted it has to be approved by the Territorial Waters Committee. The Territorial Waters Committee's decision is based on a general national plan for the coastal areas that essentially takes into consideration the use of the terrestrial area as regards the shoreline and a few hundred metres back. In addition to the Planning and Building Law, in 1997 the Territorial Waters Committee initiated an ICZM approach in a policy document with the aim to create an effective tool for management and planning territorial waters.

There are other several laws and regulations that relate to Israel's marine and coastal environment (Isaac et al., 2005). These include legislations that relate to pollution in the sea and on the coast, protecting the beach as an open space, protecting marine and coastal biodiversity. Some of these are:

- Prevention of Seawater Pollution by Oil Ordinance (new version), 1980: this law provides the legal basis for controlling marine oil pollution. It prohibits discharge of oil or oily substances into Israel's territorial and inland waters by any vessel or shore installation;
- Prevention of Sea Pollution Law (Dumping of Waste), 1983: this law prohibits the dumping of any waste from vessels and aircraft into the sea, except under permit issued by an interministerial committee, headed by the Ministry of the Environment;
- Prevention of Sea Pollution, Regulations, 1984: these regulations relate to the dumping permits granted by the Permits Issue Committee.

Israel has also participated in the Convention on Biological Diversity of 1992. One of the main objectives of this convention is the conservation and the sustainable use of its components. The convention aims to promote the protection of ecosystems, natural habitats and the maintenance of viable population of species in natural surroundings. Israel signed the Convention on June 11, 1992 and ratified it in 1995.

In the EIA of Israel there is no mention to any specific legislation concerning the coralligenous and the maërl habitats.

Regulation in Italy

All development projects at sea in Italy must be accompanied by an environmental impact assessment study ('VIA' in the Italian language). The EIA was introduced in Italy with the Law n. 349 of 8 July 1986, which established the rules on environmental damage and the by the Ministry of the Environment. The DPCM of December 27, 1988 contains the Technical Regulation for the preparation of the Environmental Impact Studies and the formulation of the judgment of compatibility. The European Directive n. 11/1995 has been adapted in Italy in 1999 with the Decree n. 152/1999 concerning "Provisions on protection of waters against pollution". The Directive 97/11/CE (concerning the assessment of the environmental impact of certain public and private projects) was presented as a critical revision after the experience of applying the procedures of EIA in Europe. The impact study includes the elements of the European Directive plus a period during which the site is monitored after the development has been implemented. The study must always be done over a wide geographical area, depending on the preliminary project. The Directive has also expanded the number of types of projects to be subjected to EIA (listed in Annex I) and introduced the 'screening' and 'scoping' phases. The framework concerning EIA procedures in Italy was extended following the issue of the 'Target Law' (L. 443/2001) and the relative implementation decree (Legislative Decree n. 190/2002). The Legislative Decree 3 April 2006, n. 152 undertakes the reorganization of the Italian legislation on environmental matters and tries to overcome all the dissonances with the relevant European directives. Part II deals with the procedures for strategic environmental assessment, environmental impact assessment and integrated environmental authorization. In 2017, Italy implemented the Directive 2014/52/EU in the national legal system, concerning the assessment of the environmental impact of certain public and private projects, which amends the European Environmental Impact Assessment Directive 2011/92/EC.

The company wishing to carry out the development project is responsible for financing the impact study. There are many private expert evaluation agencies, which use scientists to make a successful environmental assessment. The impact study can be made by public or private bodies but these must have experience in the marine field.

In the EIA procedure regarding the marine environment, each natural and anthropogenic element of a site must be considered, as well as the interaction between these elements and the environment taken as a whole. The elements, which have to be more especially taken into account, are those set out in the Appendix II, which are:

- The air quality. It is advisable to establish the pre-existing situation, to foresee the project's impact on the water/air interface and on marine organisms, and to state the site's meteorological features;
- The hydrological environment. The marine waters must be seen as elements of the environment and as resources. An analysis of the water as an environment includes an analysis of the various physico-chemical parameters, which must be done at three depths, each month. As for water as resource, the measurements concern plankton (to grasp the biological importance of the water column and the efficiency of the first trophic levels) and nekton (to grasp its value as resource that can be removed by fishing and can renew itself). This study is done by quantitative and qualitative measurements, using synecological indices, which permit the quality, biodiversity, and functioning of the environment to be assessed;
- The soil's and subsoil's geological and geomorphological nature. The soil's character and its physico-chemical features must allow the oxido-reduction processes, substratum/organism interaction and the substratum's receptive capacity to be determined;
- Vegetation. This item represents the most important part of the impact study. Vegetation may be mapped to show the dominant species and bathymetric zoning. Rare and/or protected species must be mentioned and a floristic inventory made. If necessary, a phyto-sociological record may supplement the preceding observations;
- Ecosystems. All the above parameters must allow understanding the ecosystems state and how they function. A 1:10 000 cartographical report of the ecosystemic units must be made showing all possible anthropogenic pressures. As well as calculating the synecological indices, bio-tests may be carried out to better grasp the ecosystem functions. The site's ability to self-purify must be assessed, as well as

the degree of maturity and the quality of the ecosystem (e.g., biodiversity, presence of endemic species);

- Public health;
- Noise and vibration;
- Ionizing and non-ionizing radiation. For these three last parameters the approach is exactly the same as for impact studies on land;
- Seascape integrity. It expresses the ecosystem's aesthetic side and its structure, including topography of the seabeds, vegetation and man as observer. An appreciation of the seascape can be made with the use of acoustic images (by side scan sonar or multibeam), photographs or videos.

The Habitat Directive 92/43/CEE (European Commission, 1992) has been implemented in Italy with the D.P.R. 357/1997 and subsequent amendments. The 1995 Barcelona Convention was ratified by Italy in 1999 (Law n. 175 of 27 May 1999) and entered into force in 2004. The WFD 2000/60/EC (European Commission, 2000) has been implemented in the national system by Legislative Decree n. 152/2006. The recent MSFD 2008/56/EC (European Commission, 2008) has been implemented in Italy with the Legislative Decree n. 190/2010 and subsequent amendments, and promoted an integrated approach for the protection of marine environment through specific actions that allows the achievement by 2020 of the good environment status of marine waters.

The Italian law on EIA, however, makes no direct reference to marine habitats such as coralligenous and maërl beds. The Italian regions, however, request an EIA when the project is done in proximity of sensitive and priority marine habitats, such as seagrass meadows, coralligenous, and submerged marine caves.

Taking into account the EC regulation n. 1967/2006, concerning fisheries management measures in the Mediterranean Sea, which is well implemented in Italy, the protection of coralligenous habitat, maërl and rhodolites beds is included also through the ban of trawling fishing. A number of marine species in the Mediterranean Sea, also including some species belonging to the coralligenous and maërl habitats, are protected by international conventions, which have been all implemented in Italy because are necessary to safeguard plant and animal at high risk (Mo et al., 2010). These conventions are:

- ASPIM Protocol, 1972: include specially protected areas of Mediterranean interest
- CITES, 1973: protect species through regulation and control of their trade
- Bern, 1979: conservation of wildlife and natural environment in Europe
- Habitat Directive, 92/43: protection of flora and fauna species and their habitats
- Barcellona Convention, Protocol SPA/BIO, 1995: conservation of species and marine areas of the Mediterranean.

Regulation in Lebanon

The concept of EIA was first introduced in Lebanon in the early 90's. In the late 1999, the Ministry of Environment, with the assistance of the Mediterranean Environmental Technical Assistance Program, has initiated an aggressive program for the establishment of a comprehensive EIA system in Lebanon. A decree for environmental impact assessment was drafted by the Ministry of Environment in 2001, but was not accepted by the council of ministers (Kayal et al., 2001). In the meanwhile, resolution n. 7/1 (2003) of the Ministry of Environment defined authorized companies for the preparation of environmental impact assessments. Through the SELDAS project on strengthening the national environmental framework, a review of the draft EIA law has been carried out.

A Lebanese Environmental Code has been drafted and submitted for governmental approval several years ago. The code was finally approved in an amended form by the Lebanese Parliament in July 2002 and is known as Law 444. Within this code, provisions are proposed to conduct an EIA for developmental projects and many efforts have been done at the Ministry of Environment to pass an EIA draft decree that defines such procedures (CHUD-PMU, 2011). The EIA decree provides a list of project types that require an EIA. The objectives of the EIA are to provide a sound basis for decision-making about the design of project components that takes into account environmental considerations, including social and economic impacts.

The Lebanese Government understands the importance of effective decision-making for its seas. The Ministry of Environment in Lebanon, with the support of key stakeholders, seeks to conserve and protect marine and coastal biodiversity through policy and legal reforms, enhanced stakeholders participation and mainstreaming biodiversity priorities into national plans and programs. Accordingly, the Ministry of Environment and the IUCN implemented the project “Supporting Management of Important Marine Habitats and Species in Lebanon” (2010-2012) to support the development of a network of MPAs and an associated monitoring program to evaluate their management effectiveness (El Shaer et al., 2012). This project aimed to achieve a healthy, productive, and biologically diverse marine environment through the MPAs strategy, which has been developed for increasing the percentage of marine protected areas of particular importance for biodiversity in Lebanon.

Other laws or decrees concerning the marine environment implemented in Lebanon are:

- Law issued as Decision n. 2775 of 28/9/1929 to control and regulate fishing
- Decree 4810 of 24/6/1966 for the regulation of the maritime public domain
- Decree 4869 of 2/9/2010 for the sustainable management of marine and coastal biodiversity and habitats through policy and legislative development for mainstreaming in Lebanon.

An important law concerning the species protection is the Animal Protection and Welfare Law, which ensures the protection and welfare of live animals and regulates establishments that handle or use such animals, in compliance with the related international conventions and regulations, especially CITES.

Specific references to environmental impact studies on coralligenous and maërl habitats do not appear in the EIA regulations of Lebanon.

Regulation in Libya

The EIA follows the Law n. 15 of 2003 on Protecting and Improving the Environment (Faraj, 2010). In this Law, Chapter 3 contains 21 articles, comprehensively covering marine fisheries and marine wealth conservation, identifying the means and procedures necessary for the protection of fish stock, and banning the dumping of oils and other pollutants from vessels into the sea and the discharge of land-based sewage and industrial water into the marine environment. It also prohibits the use of explosives, radioactive and other poisonous substances for fishing, and bans dredging for sponges. It also provides guidelines for the zonation of MAs for the preservation of threatened marine organisms (Hamza et al., 2011).

The law specifies public duties and the other related parts towards preserving the environment in the following fields:

- Air Pollution (Articles 10-17)
- Protection of sea and marine wealth (Articles 18-38)

- Protection of water sources (Articles 39-47)
- Protection from common animal diseases (Article 52)
- Protection of soil and plants (Articles 53-55)
- Protection of wildlife (Articles 56-57)
- Biological safety (Articles 58-63).

The EIA must be prepared by specialized institutions or engineering firms, affiliated with the Environment General Authority. The Department or the competent authority is in charge of the evaluation of the EIA and can request all further necessary information in order to authorize (or not) the project or to rectify the study. The EIA in Libya includes the following stages:

- A summary of the different components of the project in a simple and non-technical language, with a copy in Arabic language
- An introduction with general project information (type of activity and list of institutions which have contributed to the EIA)
- A list of the current laws related to the project
- A detailed project description with the project objectives (steps of the project, implementation schedule, etc.), the site (map, surface area, land use map, water resources, environment) and the existing infrastructures
- A description of the initial environmental state with all the environmental data (natural and climatic conditions, water quality and resources, air quality, noise pollution, etc.)
- A description of the possible project impacts
- An EIA description with the identification of the direct and indirect impacts (a table may recapitulate the description of the major impacts of each action)
- The measures to reduce the environmental threats
- The alternative measures related to the project and to the measures in order to reduce the environmental threats, justifying the choice criteria of each alternative
- The environmental management plan, describing the environmental actions to implement in order to respect the commitments and to insure the right evolution of the control and monitoring processes of the different project phases
- The annexes with a list of the persons who have prepared the EIA and their professional qualification, the references, the registration of the executive institutions, the opinion and the comments of the stakeholders and the non-governmental local authorities and finally the measures relative to the project
- Notification to Environment General Authority
- Reviewing and evaluation of the environmental studies
- Consultation with the EIA manager, staff, public, other parties, etc.
- The final decision.

Furthermore, the Law n. 14 of 1989 is the basic legislation concerning the regulation of the use and conservation of marine wealth. It deals with the type of equipment, both local and imported, allowed

for marine fishing, the sizes of fish/species and other marine organisms allowed to be caught, and issues relating to the supervision and control of the industry regarding safety issues.

Libya has been a party to the Convention on Biological Diversity since its declaration in Rio de Janeiro in 1992. However, the development of implementation of this crucial convention has been slow. In Libya CITES comes into force in 2003.

There is no specific reference to coralligenous and maërl habitats in the EIA of Libya.

Regulation in Malta

The EIA Directive of 1985 and its three subsequent amendments have been codified by the Directive 2011/92/EU of 13 December 2011, which has been modified in 2014 through Directive 2014/52/EU. Currently, Malta is in the process of transposing into its legislation the revisions required through Directive 2014/52/EU.

Council Regulation EC n. 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, also related to the conservation, management and exploitation of living aquatic resources in the Mediterranean, constitutes a number of provisions related to the conservation of marine resources including the regulation or prohibition of specific fishing activities on protected or sensitive habitats, in particular *Posidonia oceanica*, coralligenous and maërl habitats and corals. This regulation also calls for the establishment of Fishing Protected Areas in which fishing activities may be banned or restricted in order to conserve and manage living aquatic resources or maintain or improve the conservation status of marine ecosystems, and for the adoption of management plans for specific Mediterranean fisheries. The regulation adopts a 25-mile Fisheries Management Zone around the Maltese Islands and stipulates provisions regulating fishing within this zone.

Malta has designated five Special Areas of Conservation in the marine environment within the framework of the Habitats Directive (92/43/EEC), published as per Government Notice n. 851 of 2010.

Regulation in Monaco

The Law n. 1.456 establishes an Environmental Code for Monaco in order to sustainably manage and protect the environment against all forms of pollution, contribute to climate change mitigation efforts and energy transition, and other environmental and health related purposes. The Code stipulates that the State can legally order an EIA, including when there are possible impacts on the climate.

The Principality is a country that is deeply linked to the Mediterranean, especially through the protection of its marine environment. All of its territorial waters are also part of the Pelagos Marine Sanctuary. Since the 1970s, the Principality has been committed to protecting its marine environment, through the creation of a marine reserve in Larvotto, which is 50 ha in size. The coralligenous ‘drop-off’ reef wall reserve, created in 1986, is one of the rare special protected areas in an urban environment hosting red coral.

Monaco is also a historic member of the CITES, the provisions of which are implemented via the introduction of a permit system.

Lastly, the Principality of Monaco takes an active part in preserving the Mediterranean through the RAMOGE Agreement and the Barcelona Convention, among others, and the Principality is also the headquarters of international entities studying and preserving the marine environment (ACCOBAMS, IAEA, etc.).

The Department of the Environment regularly runs inventory and monitoring programs for marine and land-based species, not only enabling the assessment of the quality of the environment, but also to monitor the relevance of the measures undertaken.

Monaco also hosts several MPAs, which not only preserve the marine ecosystem and conserve its biodiversity, but they also contribute to their valorisation by assuring the sustainable economic development of local communities.

Regulation in Morocco

The EIA system has been implemented in Morocco in a progressive way through several stages (Benfadil, 2016):

- Between 1994 and 2003, EIA studies were carried out on a voluntary basis by the promoters of projects, requested by international donors, or because of the particular sensitivity of the receiving environment of a project;
- The second stage, between 2003 and 2008, began with the adoption of the Act n. 12.03 on the EIA, and became the principal legislative reference of the impact study. Even in the miss of application text of this Act, an EIA review procedure has been established at national level;
- With the ratification in 2008 of the implementing decrees of Act n. 12.03 on the EIA, the EIA system has entered a new milestone marked by the deconcentrating of the EIA review process and the consideration in the opinion of the population of the environmental assessment of projects. This required great efforts in organization, adopting a structured approach of the EIA review process and sustained support for strengthening capacities of stakeholders in this process.

The Moroccan legislature unanimously voted to adopt the Law n. 81-12 relating to the Coast on June 23, 2015. This new law balances the need to protect and promote the natural assets of the coastal zone, with the requirements of the country's economic, social and cultural development. The law establishes that scientific data are the basis for the integrated management of the coastal environment, taking the impact of climate change on the coastal zone into consideration. The law aims to:

- Preserve the coast's biological and ecological balance, natural and cultural heritage, while combating coastal erosion
- Prevent and reduce pollution and the coast's degradation, while rehabilitating polluted and damaged areas
- Improve planning, by means of a national plan for the coast and compatible regional spatial planning documents
- Guaranty free and unpaid access to the seashore
- Enable the involvement of organizations, the private sector, and affected local and regional authorities in decisions pertaining to coastal zone management
- Advance research and innovation promoting the coast and its resources.

Importantly, the law establishes a national commission and various regional commissions for coastal management, bringing together and mobilizing stakeholders, and provides a legal definition of the coastal zone, incorporating marine and land components.

Coralligenous and maërl habitats are not mentioned in the EIA regulations.

Regulation in Montenegro

Montenegro has achieved a high level of transposition of the European Environmental Impact Assessment Directive 85/337/EC, the SEA Directive (2001/42/EC) and the Environmental Information Directive (2003/4/EC). Since 2005, the Law on Environmental Impact Assessment (OG 80/05) prescribes procedures for carrying out an EIA for projects that may have significant impact on the environment, while the Law on Strategic Environmental Assessment (OG 80/05) prescribes the procedures – from screening to approval stage – for assessment of impacts of certain plans and programs on the environment. In 2008 a further implementation of these two laws has been done.

The Law on EIA shall also regulates the impact assessment procedure about the contents of the EIA study, participation of authorities, organisations, and the public concerned, evaluation and procedure of approval issuing, exchange of information on projects that may have significant impact on the environment in another state, supervision and other issues of relevance for the EIA. The Regulation prescribes 79 categories activities requiring an EIA (such as activities in protected areas, ports, marinas, and activities that may cause changes to biodiversity). The categories are very general with few specifications as size, impact or clear distinction in the type of firm. The Ministry of Tourism and Environmental Protection has tree staff members working on EIA. Public participation is not mandatory for an EIA. It is left to the discretion of the Ministry to organize public hearing for major projects and to define its appropriate procedure. On the basis of an approved EIA, the Ministry issues an ‘ecological permit’ containing a prevention and mitigation measures identified in the EIA. Approximately, the Ministry issues 190 permits per year based on EIA studies. Since the competences of Ministry of Tourism and Environmental Protection cover only biodiversity and air, the content of EIA is also limited to these areas. No preventive or mitigation measures are given for protection of water or soil.

Regarding the marine environment, there are no specific laws or policies dealing solely with MPAs in Montenegro. Instead, the main laws and strategic documents that apply for Protected Areas in general also apply for MPAs. Coastal ecosystems are protected by a set of regulations, such as the Law on Nature Protection (OG n. 51/08, 21/09, 40/11, 62/13).

The Law on Marine Fisheries and Aquaculture (OG 55/03, 56/09) states that trawling is forbidden above the depth of 50 m and in less than two nautical miles from the coast and the four Rule Books issued in 2004 provide for restriction, control and monitoring of different categories of marine fisheries in Montenegro. This law states that: “Fish and other marine organisms, as well as marine biodiversity, shall be protected from threat to their vital environment and overexploitation” (Article 6).

Montenegro follows the Habitat Directive protecting habitats listed in the Annex I, i.e., *Posidonia oceanica* beds, rocky reefs, submerged or partially submerged caves, and coralligenous habitat.

In the Annex II of the SPAMI Protocol of the protected species observed in Montenegro, several protected species that may be found in the coralligenous habitat are mentioned, such as *Axinella cannabina* and *Axinella polypoides*.

UNEP/MAP recently supported the implementation of field surveys on marine biodiversity (benthic and fish communities) in order to identify new potential MPAs in Montenegro (RAC/SPA - UNEP/MAP, 2014b). Surveys were completed in 2011 and covered more than 20 locations along the entire coast. Among the recommendations made there is one concerning the protection of rocky reefs and sponges communities (RAC/SPA-IUCN-Med, 2014b).

Regulation in Slovenia

Slovenia has special laws on impact studies (Off. Bull. n. 66/1996 and n. 12/2000, Ministry of the Environment). Slovenia has transposed the EU Directives governing environmental impact assessment (Directive 85/337/EEC, Directive 97/11/EEC, and Directive 2003/35/EEC providing for public participation in respect of the drawing up of certain plans and programs relating to the environment, amending with regard to public participation and access to justice the Directives 85/337/EEC and 96/61/EC). EIA was introduced in Slovenia as a specific procedure in which it must be determined whether the planned activity in the environment presents a potential risk to the environment or whether this activity is actually possible to develop. It is obligatory that the impact study contains a description of the original condition, projected development, the impacts and harm expected and measures suggested to reduce this damage. The Ministry of the Environment then sets out case by case the criteria which must be taken in mind. The study is made by bodies empowered by the Ministry of the Environment, but financed by the firm, which wishes to carry out the development. The EIA is based on the environmental impact report, which must be drawn up in accordance with the instruction on the methodology of preparing reports on environmental impact (OG Republic of Slovenia, n. 70/96).

The cases when an EIA needs to be carried out are specified in the Decree on categories of activities for which an environmental impact assessment is mandatory (OG Republic of Slovenia, n. 66/96, 12/00, 83/02). In the regulatory text of the EIA no reference is made to coralligenous and maërl habitats. It is obligatory to carry out an impact study for any aquaculture structure that is bigger than 0.5 ha, for building ports or marinas of over 100 mooring rings and for 'reclamation', i.e. land reclaimed from the sea by filling-in.

As in other European countries, the water management in Slovenia is linked to the WFD. In the field of water, the Environmental Agency of the Republic of Slovenia performs activities like a program for monitoring the quality of waters and analyses of water pollution.

Furthermore, Slovenia signed the Convention on Biological Diversity, and so the country adopted the 2012/2020 target for MPAs, that invites countries to achieve (by 2020) a global network of comprehensive and effectively managed national and regional protected area system (Vidmar and Turk, 2011).

Several marine species are legally protected in Slovenia (Decree 112/2003), such as *Cystoseira* algal beds, but rocky reefs (and thus coralligenous habitat) are not included in this protection decree.

Regulation in Spain

EIA in Spain follows the Article 7 of the European Environmental Impact Assessment Directive (85/337/EEC) and its most recent version (2014/52/EC), and is based on the Article 11 of the Royal Legislative Decree 1/2008 and the National Law of Environmental Impact Assessment of Projects 9/2006. Strategic environmental assessment is based on the European Directive 2001/42/EC, the Law 9/2006 and the regional legislation.

Other related laws on environmental protection exist: the Royal Decree 1302/1986, which has been modified by the National Law 9/2006 on strategic environmental assessment (BOE in date 29/04/2006) that is an adaptation in special intern law of the European Directive 2001/42/CEE; the BOE 155, 239, 261, the Decree 1131/1988, and the regional Catalan Decree 114/1988, DOGC 1000 (Garcinuño, 2010).

Other more general regulations on the environment working in Spain are:

- ✓ Article 4.3 of the Barcelona Convention for the protection of marine environment and the coastal region of the Mediterranean adopted in 1995 (and entry into force of amendments in BOE 173 of 19/7/2004), which regards the protection of the Mediterranean marine environment;

- ✓ Spanish-Portuguese Albufeira Convention, a transboundary cooperation that seeks to maintain the friendship between the Nations to balance environmental protection with sustainable use of the water resources within the framework of international and EU laws, whilst at the same time respecting the provisions of previous water treaties (BOE 37, 12/02/2000);
- ✓ Action Protocol between the Spanish and the Portuguese Governments, for the application in environmental impact assessment of plans, programs and projects with transboundary effects (made in Madrid on the 19th January 2008).

Interventions in the environment that imperatively require impact studies are clearly identified. They concern projects defined in the Appendix I of the EEC Directives 85/337 and 2001/42/EC, which are all interventions likely to damage the value of natural areas, as defined by the Spanish law, and that could have a direct or indirect effect on the Natura 2000 sites. The 1/2008 Royal Decree defines and standardises impact study procedure. The Decree states that any development imperatively requiring an impact study and carried out without this being done will be suspended. Similarly, any omission or falsification of data in the impact procedure or any infringement of the conditions imposed for putting the project into effect may bring about the stoppage of the work. Similarly, when, after an illegal intervention, the environment is seen to be disturbed, the person/s responsible for the work must repair the state of the environment in the form requested by the administration.

The environmental competencies depend by the State (basic legislation on environmental protection, exclusive competencies on river basin management and coastal public domain protection), the autonomous Regions (environmental management, additional provisions on environment protection, land use planning, etc.), and local authorities. Responsibilities in EIA rely on the Administration responsible for the approval of the project (development consent) and for its environmental assessment, and on infrastructure projects developed by the Central State Administration. The EIA processes include:

- Initiative (Developer)
- Screening (EIA Law annexes, Ministry of Environment)
- Scoping (Ministry of Environment)
- Environmental impact report (Developer)
- Information to the public (Competent Authority)
- Environmental review (Ministry of Environment)
- Project approval (Competent Authority)
- Monitoring (Competent Authority).

Declaration of MPAs and the launch of the Spanish Inventory of Marine Habitats and Species contribute to conservation issues on the marine environment. Both tools are based on the provisions of Law 41/2010, of 29 December 2010, on the Protection of the Marine Environment and Law 42/2007, of 13 December 2007, and on the Natural Heritage and Biodiversity.

The coralligenous habitat is mentioned in the Royal Decree of 12 December 1984 and Order of 15 March 1985, which places its protection under Spanish jurisdictions. Regional legislations (e.g., Catalonia) state clearly that an analysis of the ecological systems of the area must include a study of the benthic communities and the organic elements in the sediments, on the same scale as the general bathymetry. Quantitative studies of the populations of the most representative species must also be included. Lastly, the methodology used must be meticulously described to make possible future comparisons with similar studies, which will help to establish the evolution over time, after the development. The impact studies require a description of the area present biological state (zero state), on the basis of which a forecast is made on the evolution of the biological systems according to the expected impacts.

Regulation in Syria

The EIA in Syria follows the Environmental Protection Law n. 50 of 2002 (Ahmad, 1996). The Ministry of Environment has two executive agencies: the General Commission for Environmental Affairs that is the technical arm and the Scientific and Environmental Research Centre, which is the research arm. EIA is the responsibility of the General Commission for Environmental Affairs, which contains the EIA Unit. The General Commission for Environmental Affairs has no enforcement powers, as the Environmental Protection Act and the EIA Decree are not yet in force. Currently EIAs are carried out by the EIA Unit itself as Syria lacks environmental consultancies and the EIA related law is not endorsed (Ennabli and Whitford, 2005).

Strategic Environmental Assessment should play a major role by steering and controlling high level planning to promote sustainable development. Indeed implementing effective EIA and Strategic Environmental Assessment would be a major element and potentially powerful tool that supports the national environmental strategy outlined in the National Environmental Action Plan.

Syria signed the Convention on Biological Diversity on May 3rd, 1993 and ratified it on December 10th, 1995 and became a full member that should adopt and take integrated measures in all sectors.

Syria also joined the CITES and began executing it, and has prepared the national law draft for execution of CITES.

There is no mention concerning coralligenous and maërl habitats in the EIA regulations.

Regulation in Tunisia

The EIA in Tunisia was established in August 1988 and was applied in 1991 with the Decree n. 91-362 (OG 13 March 1991). It is defined as a study which aims at getting information about the environment and assessing the impact, direct or indirect, on environment of a planned development before it is put into effect, so that it can be decided in the light of the knowledge available whether this project should really be carried out. EIA is a preventive way to assess the reliability of development project in order to assure sustainability. In Tunisia the main administrative body and the competent authority for EIA is the National Agency for the Protection of the Environment, created in 1988 (Ennabli and Whitford, 2005). In the framework of an integrated municipal waste management project, the National Agency for the Protection of the Environment and the World Bank have studied the use of the national Tunisian system in the environmental assessment for projects funded by the World Bank. This study concluded that Tunisian experience in terms of EIA is an important achievement for pollution prevention and environmental damage. Many positive results were noticed and the difference with the World Bank system, in the considered waste field, is limited.

EIA procedures follow the 2 phases of screening and scoping. Content of an EIA study are:

- Project description
- Baseline data
- Analysis of impacts
- Justification for the project
- Mitigation measures.

The decree n. 1991 in date of 11 July 2005 improves the consideration for the other sectors concerned by EIA:

- Impact assessment studies are made by engineering companies and qualified experts in the field of environment management
- Approval deadlines are reviewed depending on projects
- The conditions of contract are set up for some projects.

Since independence, a number of codes and laws relating to the protection of the environment emerged in Tunisia, including the Forest Code (1966 and revised in 1988) and the Water Code (1975). During the following two decades, several public institutions operating in the environmental field have been successfully implemented, such as the Agency for Protection and Development of the Coastline created by Law n. 95-72 of 24 July 1995.

Similarly, a set of texts has strengthened the legislative and regulatory framework related to environmental protection and the fight against pollution, including the Law n. 95-73 of 24 July 1995, relating to the maritime public domain, the Law n. 95-70 of 17 July 1995 on the conservation of water and soil, the Law n. 96 of 3 April 1996 establishing a national plan of urgent action to fight against marine pollution incidents, the law n. 96-41 of 10 June 1996 on waste control, management and disposal and its implementing regulations, and the Law n. 2007-34 of 4 June 2007 on air quality.

Regarding the marine species protection, there are several fishing restrictions (Cacaud, 2003). Coral fishing is strictly prohibited in the Bay of Bizerta within a line drawn between Cape Zebib and Cape Blanc. It is also forbidden off the Cani Islands at depths of less than 50 m (Article 4 of Order of 26 February 1982). Elsewhere, coral fishing is subject to special authorization (Article 1 of Order of 26 February 1982).

There is no reference to coralligenous and maërl habitats in the EIA regulations of Tunisia.

Regulation in Turkey

The first idea on regulation of impact studies appeared in the Law on the Environment (Law n. 9.8.1983). This very general law indicates that organizations and establishments, which may create environmental problems through some planned activities, must draft a report on these expected impacts. The text sets out a list of projects, which may give rise to an impact study and the elements, which must appear in it, and describes the procedures and the authorities responsible for the decision. The EIA was then promulgated by Law on 7 February 1993 (OG n. 21489), and later four revisions were made by the Ministry of Environment and Forestry, the last one that is still in force is that of 17 July 2008 (OG n. 26939) (Ozsayin, 2010).

Phases of an EIA project are:

- Screening
- Scoping
- EIA report
- Consultations with public and relevant authority
- Final decision
- Monitoring and control.

Projects, which require an impact study, are the building of thermal power and nuclear power stations, refineries, ports (for handling boats of over 1350 tons), pipelines, storing facilities, and industrial or naval repair units. It is advisable to add offshore rigs and dredging and filling-in activities over large areas. For smaller developments, such as building reservoirs used as ballast

tanks, fishing ports, marinas or breakwaters, only a (smaller) preliminary study is needed. If this preliminary note concludes that there is sizeable damage, the full procedure of an impact study must be gone through. The full procedure is also necessary in all 'sensitive' areas (e.g., national parks, protected areas, marine resource production sectors).

The Ministry of Environment and Urbanization recently amended the EIA regulation to introduce the concept of capacity increase assessment, new standards for the revision of EIA reports, and certain new thresholds. The amendments were published on the Official Gazette and entered into force on 26 May 2017.

In the MPAs of Turkey, it can be found a highly significant biodiversity. Currently, about 4% of the Turkey's territorial waters are protected. The proposed long-term aim for marine biodiversity conservation in Turkey's territorial sea is a reconfigured Marine and Coastal Protected Area network designed to protect biodiversity while optimizing its ecological service functions.

During the 2013 meeting of the Barcelona Convention, the parties agreed to develop a representative network of coastal and marine protected areas, to protect the Mediterranean Sea habitats and to increase the number and visibility of the SPAMI. Strengthening the system of Marine and Coastal Protected Areas of Turkey is a joint cooperation between the Global Environment Facility, the Government of Turkey and the United Nations Development Programme. The project aims to strengthen Turkey's national marine and coastal protection system and to ensure its effective management. Some of the project's achievements include: increase in the percentage of Turkey's territorial waters that are protected, creation of 10 no-fishing zones in Gökova and Datça-Bozburun Special Environmental Protection Areas (a total of 4000 ha area is now protected), and the draft of the Turkey's National Marine and Coastal Protected Areas Strategy and Action Plan.

Coralligenous and maërl habitats are not specifically concerned by the Turkish regulations on EIA. Nevertheless, there are some regulations concerning fishing, such as Fisheries Law n. 1380 of 1971, which arranges the principle of the aquaculture activities and penalty of illegal fish farms, the Environment Law n. 2872 of 1983, which states that the areas where fish farms should not be constructed are decided and inappropriate farms are closed after one year (Okumus et al., 2003).

Synthesis

The analysis of EIA regulations related to coralligenous and other calcareous concretions in the Mediterranean countries indicates that most of them do not specifically refer to these habitats when setting protocols and procedures for impact assessment. All the countries have, nevertheless, laws on impact studies and these procedures are on the whole effective. The European Environmental Impact Assessment Directive 85/337/EEC and its most recent amendments (the last Directive 2014/52/EC) aim at improving the existing environmental impact assessment system. When EIA is defined in the national legislation, the specific implementation regulations are sometimes not published, thus leading to the not applicability of the legislation.

All the Mediterranean countries must somehow implement the EIA Directive in their national legal system, concerning the assessment of the environmental impact of certain public and private projects. Impact studies, however, concern mainly the protection of land rather than of marine environment, and often the text of the laws does not specifically mention the coastal environment. Development projects on sea concern essentially in port infrastructure, beach replenishments, structures to protect the coastline from the sea, dredging for sand extraction, aquaculture installations, and sea discharge pipes.

The Action Plan (UNEP/MAP-SPA/RAC, 2017) indicates the actions that must be taken to protect and conserve coralligenous and other bioconstructions, but it is not a legally binding instrument. The legislation aimed at conserving coralligenous and other bioconstructions is today not yet available. There are only some conventions and directives that indirectly provide protection to coralligenous and maërl habitats, i.e. the Council Regulation n. 1967/2006 (amended with Regulation n. 2847/93 and Regulation n. 1626/94), concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, which prohibit fishing trawl nets, dredges, shore seines or similar nets above coralligenous habitats and maërl beds, and which apply to all Natura 2000 sites.

Absence of specific mentions to coralligenous and other calcareous concretions in impact study procedures may be partially compensated by the legal protection status that some of the species developing in these habitats have nowadays in the Mediterranean. This protection can be direct (national or regional laws) or indirect (international conventions or Directives). Effectiveness in terms of conservation of coralligenous and other calcareous formations is not therefore ensured through the impact studies but rather through the protection of important species or habitats.

Impact studies represent today an important tool for conserving marine environment that interest and involve not only the scientific sphere, but also local people, stake-holders and economic-politic parties. In the Mediterranean the impact study procedure is today the rule for developments, and the lack of clear and standardised procedures is the exception. The recently updated guidelines for monitoring coralligenous and other calcareous bioconstructions (UNEP/MAP-SPA/RAC, 2019a) define standard procedures to be used in monitoring programs on both shallow water (up to 40 m depth) and mesophotic (around 40-160 m depth) coralligenous and rhodoliths habitats, which can thus be used not only for increase our knowledge on these habitats and for monitoring purposes as requested by the European Directives and Conventions (e.g., WFD, MSFD, EcAp of the Barcelona Convention), but also for the EIA studies requested during all development phases of any project involving marine environment, to reduce the impacts and conserve priority habitats.

Major constrains for a well conducted EIA on the marine environment are often due to little budget availability for impact studies, which therefore are generally carried out only superficially or by inexperienced people. This can give rise to various results (in terms of quality and competence), in particular when the guidelines of the procedure are not detailed and when the elements to be taken into account are not explicitly stated. This way of approaching can also lead to a systematic underestimation of the developments potential damage for the environment, and then to the conclusion that a development project as proposed is feasible (Pergent-Martini and Le Ravallec, 2007).

Even when a regulatory text exists for EIAs, it is not always accompanied by precise directives on how the study should be carried out. This often leads to rather superficial studies being made, or made by teams whose competence is not adequate for this task. The absence of a standardised protocol for EIAs on coralligenous and other calcareous bioconstructions makes all follow-up of the developments real impact difficult to be assessed, and does not permit the comparison of the results at national and EC level. The

guidelines for environmental impact assessment on coralligenous and other calcareous bioconstructions here presented are, thus, a fundamental tool to overcome the problem of the lack of standardisation, to be jointly used with the most effective and recent methodologies for monitoring coralligenous and maërl habitats in the Mediterranean Sea, as described in detail in UNEP/MAP-SPA/RAC (2019a).

Standardised protocol for environmental impact assessment on coralligenous and maërl habitats

Any development in the maritime domain may justify an impact study procedure. A development project may imply, both during the project and afterwards, a modification of the sea currents that results in enhanced water turbidity and/or sedimentary phenomena (Nepote et al., 2017). Benthic habitats may be affected, either directly (e.g., filling-in, burial) or indirectly due to alterations in environmental conditions (e.g., rise in temperature and salinity changes, localised increase of nutrients, increase of various chemical substances) and to changes in the topography of the seafloor. Coralligenous and maërl habitats can be intensively affected by any development project that causes alterations in the water quality and change in the hydrodynamic and sedimentary regimes. Impact study procedures are thus expected to be able to limit all the consequences caused by such developments. It becomes imperative, during each EIA study, to get as soon as possible information on:

- local coastal currents in order to understand the impact of possible sediments and pollutants from the envisaged development;
- possible increase in water turbidity, which has negative impact on both autotroph organisms (i.e. algae) and filter feeders, the latter being the main component of coralligenous assemblages;
- possible change in water temperature, as many species are sensitive to thermal anomalies;
- possible addition of nutrients;
- possible addition of sediment, as medium- or long-term change in the amount of sediment on the bottom causes benthic species be buried, which can in the long run cause the death of organisms.

European legislation requires monitoring plans for the evaluation of ecological status of coralligenous and maërl habitats based on standardised methods, in order to facilitate the comparability of results on a large spatial-time scale. Plans must also be based on the best available scientific knowledge; therefore, the legislation requires for the periodic updating of strategies for monitoring the marine environment based on the evolution of technical and scientific knowledge. In this frame, the recently updated guidelines for monitoring coralligenous and other calcareous bioconstructions (UNEP/MAP-SPA/RAC, 2019a) represent the proper tool to guarantee standard and harmonised monitoring plans on these habitats. Effective EIAs require availability of survey tools that enable quick, reliable understanding of the general condition of the environment and then follow-up of its evolution over long periods of time. Evaluate and quantify the impacts of a specific development project on the environment is often difficult because disentangling between natural variation and human influence in time and space is usually a complex task for ecologists. A multi-disciplinary approach (ecological risk assessment), coupled with medium-term monitoring programs, can enable detecting and preventing the damage before it happens (Pergent-Martini and Le Ravallec, 2007).

Any impact study concerning coralligenous and maërl habitats must allow understanding the overall functioning of these formations. In the frame of the EcAp to manage human activities that may affect the Mediterranean marine and coastal environment for the promotion of sustainable development (UNEP/MAP, 2008), monitoring programs have been implemented to address the two Common Indicators that specifically relate to habitats:

1. Common Indicator 1: Habitat distributional range, to also consider habitat extent as a relevant attribute. This indicator is aimed at providing information about the geographical area in which the benthic habitat occurs. The main outputs of the monitoring for this indicator are maps with habitat presence and distributional range. Availability of series of updated and complete maps will allow detecting any important change in the habitat distributional patterns, useful to understand its

evolution over time, also as a consequence of environmental impacts due to development projects, and measuring its distance from the original status (i.e., drawing trajectories of change);

2. Common Indicator 2: Condition of the habitat's typical species and communities. This indicator is aimed at providing information about the ecological status of the benthic habitat. Assessments should be focused in collecting data on the status of habitats using typical/target species as indicators and/or considering the community composition. Thanks to this indicator any important change in the status of the habitat can be detected, and again availability of long-term data series will allow understanding the trajectories of change experienced by those habitats through time.

All details on the standardised programs proposed for monitoring coralligenous and rhodoliths habitats can be found in UNEP/MAP-SPA/RAC (2019a). In the following paragraphs, a synthesis of the main methods and descriptors for monitoring is reported. For EIA, short term monitoring (generally 1-2 years) is recommended and should be initiated before the interventions (namely "zero" time), and possibly continued during, or just after the conclusion of the works. A further survey can be made one year after the conclusion of the project. The interval of surveys could be annual, as most of the typical species belonging to coralligenous assemblages and to rhodoliths beds display slow grow rates and long generation times. The detection of human impacts requires appropriate rigorous sampling designs and powerful statistical tests (Benedetti-Cecchi, 2001). A symmetrical BACI design (Underwood, 1992, 1993) is often adopted in impact studies, where multiple disturbed sites are contrasted with multiple controls in two distinct time periods, i.e. in an early (before the intervention) and in a late (after the end of the project) phase of the impact. The ecological status of the site subjected to coastal interventions (namely the "impact" site) must be contrasted with the status of at least two "reference" or "control" sites, displaying similar environmental characteristics. This sampling design must be always repeated in all the survey phases requested to tackle for the effects of a project.

Habitat distributional range and extent (Common Indicator 1)

Inventories on the distributional range of coralligenous and rhodoliths beds raise several problems, due to their large bathymetric distribution and the consequent sampling constraints and often limited accessibility, and their high spatial heterogeneity. Field surveys must be sufficiently numerous and distributed appropriately to obtain the necessary precision and coverage of the area investigated, according to the expected range of diffusion of predicted impacts consequent to the development project and considering connectivity patterns among adjacent habitats. The choice of the survey method mostly depends on the scale of the EIA study and on the spatial resolution requested. Acoustic techniques (e.g., side scan sonar, multibeam echosounder) and underwater video recordings (ROVs, towed cameras) are usually integrated for characterising spatial patterns of coralligenous and rhodoliths habitats over large areas. From maps obtained through remote sensing surveys, the presence/absence of the habitat, its distributional range, the geomorphology of the formations and the total habitat extent (expressed in square meters or hectares) can be easily obtained. To facilitate the comparison among maps, the standardised red colour is generally used for the graphic representation of coralligenous and rhodoliths habitats. Using the overlay vector methods on a Geographical Information System platform, a diachronic analysis can be done to evaluate temporal changes of the habitat during the period of the EIA procedure, in term of percentage gain or loss of the habitat extension, through the creation of concordance and discordance maps (Canessa et al., 2017).

Acoustic methods are presently the most convenient technique for mapping rhodoliths beds and monitoring change in their extent over time, but they must always be associated with ground-truthing activities carried out by either ROV, or box-coring, or scuba diving (Bonacorsi et al., 2010). The percentage cover of live thalli over a wide area can also be assessed from a ROV survey. The operational restrictions imposed by scuba diving (Gatti et al., 2012 and references therein) reduce the amount of collected data during each dive and increase the sampling effort. However, direct observations by scuba diving provide discrete punctual data that are vital for ground-truthing the instrumental surveys. Scuba diving is also suggested as a safe and cost-effective tool to obtain a visual description and sampling of shallow rhodoliths beds up to 30-40 m depth. Underwater observations are effective for a first characterisation of the aboveground facies of this habitat, i.e. thickness of live layer, mean percentage cover of live thalli, live/dead rhodoliths ratio, dominant morphologies of rhodoliths, and identification of the most common and volumetrically important

species of calcareous algae (Basso et al., 2016). To describe the belowground community or to survey deep rhodoliths beds (down to 30-40 m), samples from vessels involving blind grabs, dredges and box corers in a number of randomly selected points on the bottom become necessary. The use of destructive sampling methods from vessels for characterising rhodoliths beds should be, however, as much as possible discouraged, in order to minimize the impact of the investigation.

Condition of the habitat's typical species and communities (Common Indicator 2)

Following the preliminary definition of the distributional range and extent of coralligenous and rhodoliths habitats (the previous CII), the assessment of the condition of the two habitats starts with a quali-quantitative characterisation of the typical species and assemblages occurring within each habitat. Monitoring the condition of the two habitats basically relies on underwater diving, when possible, within a limited range of depths (from the surface down to maximum depths of 30-40 m, according to local rules on scientific diving), and over a limited underwater time (Bianchi et al., 2004). Divers annotate on their slates the list of the main conspicuous species/taxa or morphological groups recognisable underwater that characterise the assemblages. Given the complexity of the coralligenous habitat (3-D structure and high biodiversity), divers must be specialists in taxonomy of the main coralligenous species to ensure the validity of the information recorded underwater. Photographs or video collected with underwater cameras can be usefully integrated to visual survey to speed the work (Gatti et al., 2015b). The use of operational taxonomical units (OTUs), or taxonomic surrogates such as morphological groups (lumping species, genera or higher taxa displaying similar morphological features; Parravicini et al., 2010), may represent a useful compromise when a consistent species distinction is not possible (either underwater or on photographs) or to reduce the surveying/analysis time. Assessing vitality (signs of necrosis), presence of broken individuals of target species (e.g., gorgonians, bryozoans, erect sponges), and the amount of sediment deposited over organisms are important elements to be taken into consideration in EIAs (Garrabou et al., 1998; Gatti et al., 2012). A decrease in rhodoliths beds extent, live/dead rhodoliths ratio, live rhodoliths percentage cover, associated with change in the composition of the macrobenthic community (calcareous algal engineers and associated taxa) may reveal potential negative impacts acting on rhodoliths beds during an EIA procedure.

Adoption of instrumental tools (e.g., ROVs, towed camera video recordings, or sampling methods from vessels with dredges, grabs or box corers in the case of rhodoliths beds) allows for a less precise assessment but covers larger spatial scales. Acoustic methods are totally inoperative for detailed quantitative characterisations, especially for coralligenous. The use of ROVs or towed camera can be useful to optimise information obtained and sampling effort (in term of working time) and become essential for monitoring deep coralligenous assemblages and rhodoliths beds developing in the upper mesophotic zone (down to 40 m depth), where scuba diving procedures are usually not recommended. High quality videos and photographs recorded by ROV or towed camera will be analysed in laboratory (also with the help of taxonomists) to list the main conspicuous species/taxa or morphological groups recognisable on images and to evaluate their abundance (coverage or surface area in cm²). Videos and photographs can then be archived to create temporal datasets.

Protocol for monitoring shallow (up to 40 m depth) coralligenous habitat

An integrated and standardised procedure namely STAR (STAndaRdized coralligenous evaluation procedure) for monitoring the condition of coralligenous reefs by scuba diving has recently been proposed (Piazzi et al., 2019), which allows obtaining information about most of the descriptors used by the different ecological indices adopted up to date on coralligenous reefs, through a single sampling effort and data analysis. The protocol can be synthesised as follow:

1. Seasonal dynamics of native and invasive macroalgae suggest planning monitoring activities between April and June, and no more than once per year;
2. A depth of about 35 m on a vertical substrate (i.e., slope 85-90°) can be considered as optimal to ensure the presence of coralligenous assemblages in most of the Mediterranean Sea, including the southern areas in oligotrophic waters. Vertical rocky substrates at about 35 m depth can also be easily found near the coast, which is in the zone where most of the EIA procedures are realised;
3. Sampling designs must be planned with high replication at small scales (i.e., tens of metres), whereas intermediate or large scales (i.e., hundreds of metres to kilometres respectively) will require fewer replicates;
4. Areas of 4 m² located tens of metres apart should be sampled, and a minimum of 10 replicated photographic samples of 0.2 m² each should be collected in each area by scientific divers, for a total sampling surface area of 6 m². This design can be repeated depending on the size of the study site and allows analysis of the data through both seascape and biocenotic approaches usually adopted to elaborate ecological indices on coralligenous;
5. A combination of photographic and visual approaches is suggested as effective sampling method, using photographic sampling to assess the structure of assemblages and integrating information by collecting a reduced amount of data with the Rapid Visual Assessment (RVA) method (Gatti et al., 2012, 2015b), i.e. the size of colonies of erect species and the thickness and consistency of the calcareous accretion;
6. The analysis of photographic samples can be performed by different methods (Piazzini et al., 2019 and reference therein): the use of a very dense grid (e.g., 400 cells) or manual contouring techniques through appropriate software may be useful in order to reduce the subjectivity of the operator's estimate;
7. The descriptors that must be assessed underwater or on photographs are the following:
 - *Sediment load*: the amount of sediment may be indirectly evaluated as percentage cover on photographic samples;
 - *Calcareous accretion*: thickness and consistency of the calcareous deposit can be measured underwater through a hand-held penetrometer, with six replicated measures in each of the three areas of about 4 m² and located tens of metres apart. For each measure, the hand-held penetrometer marked with a millimetric scale must be pushed into the carbonate layer, allowing the direct measurement of the calcareous thickness;
 - *Erect anthozoans*: the size (mean height) and the percentage of necrosis and epibiosis of erect anthozoans should be assessed through the RVA visual approach, measuring the height of the tallest colony for each erect species and estimating the percentage cover of the colonies showing necrosis and epibiosis signs in each of the three areas of about 4 m² and located tens of metres apart;
 - *Structure of assemblages*: the percentage cover of the conspicuous taxa/morphological groups must be evaluated on each photographic sample. The cover values (in %) of each taxon/morphological group are then classified in eight classes of abundance: (1) 0 to ≤0.01%; (2) 0.01 to ≤0.1%; (3) 0.1 to ≤1%; (4) 1 to ≤5%; (5) 5 to ≤25%; (6) 25 to ≤50%; (7) 50 to ≤75%; (8) 75 to ≤100%. A value of sensitivity level (SL) is assigned to each taxon/morphological group (Piazzini et al., 2017). The overall SL of a sample is then calculated by multiplying the value of the SL of each taxon/group for its class of abundance and then summing up all the final values. Then, the richness (α -diversity, i.e. the mean number of the taxa/groups per photographic sample) should be computed;

- *Spatial heterogeneity*: variability of species composition among sampling units is measured in terms of multivariate dispersion calculated on the basis of distance from centroids through permutational analysis of multivariate dispersion (PERMDISP);
8. From the descriptors obtained through the STAR procedure, it is possible to elaborate most of the ecological indices proposed up to date for evaluating the ecological quality of coralligenous reefs. In particular: ESCA (Ecological Status of Coralligenous Assemblages; Piazzì et al., 2017), ISLA (Integrated Sensitivity Level of coralligenous Assemblages; Montefalcone et al., 2017), CAI (Coralligenous Assessment Index; Deter et al., 2012), COARSE (COralligenous Assessment by ReefScape Estimate; Gatti et al., 2012, 2015b), and INDEX-COR (Sartoretto et al., 2017).

Protocol for monitoring mesophotic (down to 40 m depth) coralligenous habitat

1. The use of unmanned vehicles, such as ROVs, may be considered suitable to survey the condition of deep coralligenous reefs in mesophotic environments, down to 40 m depth (Cánovas-Molina et al., 2016; UNEP/MAP-SPA/RAC, 2017).
2. Three replicated video-transects, each at least 200 m long, should be collected in each area investigated (Enrichetti et al., 2019). ROV must be equipped with a high definition digital camera, a strobe, a high definition video camera, lights, and a 3-jaw grabber. The ROV should also host an underwater acoustic positioning system, a depth sensor, and a compass to obtain georeferenced tracks to be overlapped to multi-beam maps when available. Two parallel laser beams (90° angle) can provide a scale for size reference. In order to guarantee the best quality of video footages, ROV is expected to move along linear tracks, in continuous recording mode, at constant slow speed ($< 0.3 \text{ ms}^{-1}$) and at a constant height from the bottom ($< 1.5 \text{ m}$), thus allowing for adequate illumination and facilitating the taxonomic identification of the megafauna. Transects are then positioned along dive tracks by means of a Geographical Information System software editing. Each video transect is analysed through any of the ROV-imaging techniques, using starting and end time of the transect track as reference. Visual census of megabenthic species is carried out along the complete extent of each 200 m-long transect and within a 50 cm-wide visual field, for a total of 100 m² of bottom surface covered per transect;
3. From each transect the following descriptors are measured on videos:
 - Extent of hard bottom, calculated as percentage of total video time showing this type of substratum (rocky reefs and biogenic reefs) and subsequently expressed in m²;
 - Species richness, considering only the conspicuous megabenthic sessile and sedentary species of hard bottom in the intermediate and canopy layers (*sensu* Gatti et al., 2015b). Organisms are identified to the lowest taxonomic level and counted. Fishes and encrusting organisms are not considered, as well as typical soft bottom species. Some hard-bottom species, especially cnidarians, can occasionally invade soft bottoms by settling on small hard debris dispersed in the sedimentary environment. For this reason, typical hard bottom species (e.g., *Eunicella verrucosa*) encountered on highly silted environments have to be considered in the analysis;
 - Structuring species are counted, measured (height expressed in cm) and the density of each structuring species is computed and referred to the hard-bottom surface (as n° of colonies or individuals m⁻²);
 - The percentage of colonies with signs of epibiosis, necrosis and directly entangled in lost fishing gears are calculated individually for all structuring anthozoans;
 - Marine litter is identified and counted. The final density (as n° of items m⁻²) is computed considering the entire transect (100 m²).

4. Within each transect, 20 random high definition photographs targeting hard bottom must be obtained, and for each of them four parameters are estimated, following an ordinal scale. Modal values for each transect are calculated. Evaluated descriptors on photos include:
 - Slope of the substratum: 0°, <30° (low), 30°-80° (medium), >80°(high);
 - Basal living cover, estimated considering the percentage of hard bottom covered by organisms of the basal (encrusting species) and intermediate (erect species but smaller than 10 cm in height) layers: 0, 1 (<30%), 2 (30-60%), 3 (>60%);
 - Coralline algae cover (indirect indicator of biogenic reef), estimated considering the percentage of basal living cover represented by encrusting coralline algae: 0, 1 (sparse), 2 (abundant), 3 (very abundant);
 - Sedimentation level, estimated considering the percentage of hard bottom covered by sediment: 0%, <30% (low), 30-60% (medium), >60% (high).
5. Three seascape indices have been defined for mesophotic environments based on ROV footages, namely MAES (Mesophotic Assemblages Ecological Status; Cánovas-Molina et al., 2016), CBQI (Coralligenous Bioconstructions Quality Index; Ferrigno et al., 2017), and MACS (Mesophotic Assemblages Conservation Status; Enrichetti et al., 2019). MACS is a recent multi-parametric index that is composed by two independent units, the Index of Status (*Is*) and the Index of Impact (*Ii*), thus following a DPSIR (Driving forces – Pressures – Status – Impacts – Response) approach. The index integrates three descriptors included in the MSFD and listed by the Barcelona Convention to define the environmental status of seas, namely biological diversity, seafloor integrity, and marine litter.

Protocol for monitoring maërl/rhodoliths habitat

A recent proposal of monitoring plan for rhodoliths beds can be found in Basso et al. (2016). When allowed, monitoring the rhodoliths habitat can be done by underwater diving and direct visual observation, with sample sorting and following taxa identification in laboratory. However, surveys using ROVs and towed cameras are often favoured because of the greater homogeneity of this habitat, and when sampling from vessels using blind grabs, dredges or box corers can be performed. Monitoring should address all the variables previously described for the first descriptive characterisation of the habitat, with the addition of the full quantitative description of the rhodoliths community composition, including number of typical or indicator species.

Three major categories of growth form and shape can be recognised for rhodoliths: compact and nodular pralines, larger and vacuolar box-work rhodoliths, and unattached branches. Each of the three end-members within rhodoliths morphological variability corresponds to a typical (but not exclusive) group of composing coralline species and associated biota and is possibly correlated with environmental variables, among which substratum instability (mainly due to hydrodynamics) and sedimentation rate are the most obvious. Thus, the indication of the percentage cover by the three live rhodoliths categories at the surface of each rhodoliths beds is a proxy of rhodoliths habitat structural and ecological complexity. The high species diversity hosted by rhodoliths beds requires time-consuming and expensive laboratory analyses for species identification. Videos and photos provide little information on rhodoliths community composition owing to the absence of conspicuous, easy-to-detect species. Moreover, since most coralline species belong to a few genera only, the use of taxonomic ranks higher than species is not useful.

When necessary for a detailed characterization of rhodoliths communities, a minimum of three box-cores with opening $\geq 0.16 \text{ m}^2$ should be collected in each rhodoliths bed at the same depth, and penetrating the substrate for a width of about 20 cm. In those extreme cases of very coarse material preventing box-core penetration and closure, a grab could be used instead, although it cannot preserve stratification. Once the box-core is recovered a colour photograph of the whole surface of

the box-core, at a high enough resolution to recognise the morphology of single live rhodoliths and other conspicuous organisms, must be collected. In addition, the possible occurrence of heavy overgrowths of fleshy algae that may affect rhodoliths growth rate must be reported. The following descriptors must then be assessed:

- 1) visual estimation of the percentage cover of live red calcareous algae;
- 2) visual estimation of the live/dead rhodoliths ratio calculated for the surface of the box-core;
- 3) visual assessment of the rhodoliths morphologies characterising the sample;
- 4) measurement of the thickness of the live rhodoliths layer. The sediment sample is then washed through a sieve (e.g., 0.5 mm mesh) and the sample treated with Rose Bengal to stain living material before being preserved for sorting under a microscope for taxa identification. All live calcareous algae and accompanying phytobenthos and zoobenthos should be identified and quantified, in order to allow for the detection of variability in space and time, and for any changes after possible impacts. Algal species must be evaluated using a semi-quantitative approach (classes of abundance of algal coverage: absent, 1-20%, 21-40%, 41-60%, 61-80%, >81%). For molecular investigations, samples from voucher rhodoliths morphotypes should be air-dried, and preserved in silica gel. The sediment sample should be analysed for grain-size (mandatory), and carbonate content.

Practical measures to mitigate impacts on coralligenous and maërl habitats

When impacts on coralligenous and maërl habitats are envisaged as consequences of development projects following an EIA procedure, only the pure and simple banning of the development can constitute the proper solution. Considering the low generation time of many species belonging to the coralligenous habitat (e.g., gorgonians, scleractinia, massive and erect sponges), resilience of coralligenous, as well as of rhodoliths, can be very low thus requiring long times to recover after a perturbation. Nevertheless, in many cases this kind of solution is ruled out, and the development has to be carried out in the light of its interest for the local people (e.g., laying down telecommunication cables, building discharge pipes out to sea). In these cases, availability of detailed maps showing distribution of the benthic habitats may constitute an effective way for reducing the impacts on these calcareous formations, by optimizing the chosen layout in order to place interventions as far as possible from priority habitats, and possibly avoiding the passage of the cables/structures directly over or in the immediate vicinity of the habitats.

It is desirable to bear in mind that no solutions can compensate for the loss of calcareous formations; this notwithstanding, several operational techniques may be used to reduce impacts on coralligenous and rhodoliths habitats during the execution of a development project (i.e., compensatory measures). Procedures or precautions needed to minimise, as much as possible, impacts on these habitats may include interventions for reducing water turbidity and/or addition of fine particles, as for instance in the case of beach replenishments or coastal constructions. These threats can be minimised by using materials that have previously been washed to reduce the increase of fine particles in the water column. This is an effective way of reducing the deposition of fine particles over benthic habitats. Similarly, the use of geotextile nets enables the impact to be confined to the development area alone, by preventing the fine particles being dispersed by currents. As regard to other indirect threats (e.g., addition of nutrients, sedimentary deficit), these must be at firstly identified and then quantified. No compensatory measures are specified in these cases (Pergent-Martini and Le Ravallec, 2007). Of course, all threats linked to the direct destruction of biogenic bottoms must be completely avoided and banned. For instance, the improper use of bottom trawls or dragnets, which represent a significant source of degradation of both coralligenous formations and rhodoliths beds, is banned by the existing laws that must be respected. Recourse to anti-trawl artificial reefs may be an additional means to facilitate the implementing of bans on fishing in certain areas, although these solutions appear to be more effective in shallow waters (Boudouresque, 1996).

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