Addressing the drivers of the **Mediterranean ecosystem degradation**

The **SCP approach** in the application of the Ecosystem Approach to the management of **human activities in the mediterranean**

Regional Activity Centre for Cleaner Production (CP/RAC)
Mediterranean Action Plan

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UNEP

MAP

STOCKHOLM CONVENTION

GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIOAMBIENTE

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If there is any study point which can be improved or if there is any inaccuracy, please let us know.

The CP/RAC, based in Barcelona-Spain, was established in 1996. Its mission is to promote sustainable consumption and production in Mediterranean countries. The CP/RAC activities are approved by the Contracting Parties to the Barcelona Convention and by the Bilateral Monitoring Commission made up of representatives from the Spanish and Catalan Governments.

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HOW TO READ THIS DOCUMENT

This report, entitled "Addressing the drivers of Mediterranean ecosystem degradation: the SCP Approach in the application of the Ecosystem Approach to the management of human activities in the Mediterranean" consists of six main chapters, an introductory chapter, a bibliography and two annexes. Moreover, the principal contents and outstanding conclusions are summarised in the Executive Summary.

The scope and the specific objectives of the report are set up in the introductory chapter. Moreover, in order to position the Ecosystem Approach and the Sustainable Consumption and Production (SCP) Approach in the Mediterranean context, the introductory chapter gives a detailed description of both approaches and their implementation framework. Thus, this chapter describes what the Ecosystem Approach is, as well as the implementation framework at international, European (through the Marine Strategy Framework Directive [MSFD]) and regional levels in the Mediterranean Action Plan (MAP). The roadmap established by the MAP for the gradual application of the Ecosystem Approach in the Mediterranean, the current situation and the steps planned for the next years for its implementation are also presented. Furthermore, an overview of the current status of SCP in the international and European agenda is given, with specific reference to the Mediterranean.

Chapter 1 includes the main environmental issues of concern in the Mediterranean Sea and an assessment of the environmental status of Mediterranean marine ecosystems based on 11 descriptors, in line with the 11 EU MSFD Descriptors for determining Good Environmental Status (GES). For these descriptors, the MAP has established ecological objectives and their corresponding operational objectives to be achieved in the Mediterranean within the framework of the implementation of the Ecosystem Approach in the MAP (the set of ecological objectives, operational objectives and indicators proposed by the MAP is provided in Annex 1).

Chapter 2 describes the Drivers-Pressures-State-Impact-Response (DPSIR) framework, which is the tool applied in the report to formulate the relations between the environmental status of Mediterranean marine ecosystems and the consumption and production patterns. After clarifying the definitions adopted for the different elements of the framework (Drivers-Pressures-State-Impact-Response), the authors indicate what choices in interpretation have been made for Pressures and State in order to ensure they correspond to the MAP Ecological Objectives. In this respect, while some of the ecological objectives of the Ecosystem Approach have been interpreted directly as States within the DPSIR framework, others environmental objectives have been identified as Pressures or Pressure/State pairs.

Thus, in a first step the key relations between the human activities (Drivers), the Pressures and the States have been mapped in detail in the context of the Mediterranean ecosystem (Chapter 3). The human activities considered are those identified as key drivers of environmental impacts in the Mediterranean.

Chapter 4 presents in detail the concepts of SCP Approach, its main principles, scope and set of tools in order to explain to the reader what this approach is about and what it can bring to the implementation of the Ecosystem Approach in the Mediterranean. In particular, two contributions are proposed: using the management tools in order to act on the above mentioned drivers and better the state of environment in a more sustainable way; and using the evaluation tools in order to monitor the relationship between the state of the marine environment and the patterns of consumption and production. This last proposal is further detailed in Annex 2 through the example of the application of Environmentally Extended Input-Output Analysis (EE-IOA) methodology in the calculation of Spain's carbon footprint.

Following the application of the DPSIR framework started in Chapter 3, and taking into account the tools exposed in Chapter 4, as a second step, various SCP Approach management tools have been identified as a Response (Chapter 5) to apply to the key Drivers (human activities considered before) in order to change them and thus achieve the ecological objectives established by MAP. Furthermore, in order to obtain a practical overview of the process described in Chapters 3, 4 and 5, an example of the application of SCP measures in Fisheries is given in the latter part of the Chapter 5.

Finally, as conclusions to the report, Chapter 6 refers to the challenges and opportunities as well as the proposed next steps in the application of the SCP within the framework of the MAP Ecosystem Approach roadmap. In this respect, the human activities in the Mediterranean where the application of SCP Approach is relevant are identified and compared to the traditional responses. Monitoring and management measures and public awareness in sustainable consumption are proposed as the next steps to take in the application of the SCP in the MAP Ecosystem Approach roadmap.

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EXECUTIVE SUMMARY

In 2008, the 15th Meeting of the Contracting Parties to the Barcelona Convention decided to apply the Ecosystem Approach progressively to the management of human activities that may affect the Mediterranean marine and coastal environment in order to promote sustainable development (Decision IG 17/6). A seven-step roadmap was developed for the gradual application of the Ecosystem Approach (EcAp) in the Mediterranean. The derivation of environmental targets (last part of step 5) is currently being undertaken.

Introduction: the Ecosystem Approach in the Mediterranean Action Plan

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Key environmental concerns in the Mediterranean and description the ecological objectives

↓

The concept: linking the Ecosystem Approach to consumption and production models

↓

Mapping links between human activities and the ecological objectives

↓

Concepts and tools for the Sustainable Consumption and Production (SCP) approach

↓

Identifying SCP tools for achieving ecological objectives

↓

Conclusions: challenges in applying the SCP approach and the next step to be taken

The achievement of the targets to be established for each ecological objective will require the implementation of a wide and diverse range of policies by the different stakeholders in the Mediterranean countries. The definition of these policies is considered in the last step of the roadmap: Step 7-Development and review of the relevant action plans and programmes. Within this framework, the Regional Activity Centre for Cleaner Production (CP/RAC) has elaborated a preliminary assessment of the potential contribution of the Sustainable Consumption and Production (SCP) tools in the application of the Ecosystem Approach to the management of human activities in the Mediterranean.

The state of the marine and coastal Mediterranean ecosystems depends on the level of pressures caused by the human activities, and therefore, is linked to the models of production and consumption. Thus, an improvement in the production and consumption models can contribute to the achievement of the ecological objectives established by MAP.

In this respect, the human demands function as the Drivers that create Pressures on the environment. These socioeconomic drivers may consist of the need for food, recreation, space for living and other basic human needs that are delivered through fisheries, recreational sites, urbanised areas, industrial activities, agriculture and livestock, bioremediation of waste, and so forth.

Therefore, the consumption activities carried out by members of human

societies, in accordance with their lifestyle and consumption choices, and within the constraints of their wealth, available technology and legal systems, constitute the first point in the chain. The consumers' demand is satisfied by production activities (e.g. agriculture, industry, tourism, etc.) that cause environmental pressures (e.g. pollution loading). In some cases, consumption activities can generate environmental pressures directly (e.g. an excessive number of people in natural habitats or recreational fishing).

The pressures on the ecosystem result in a change of State of the Ecosystem, which is described by the ecological objectives established in the framework of the MAP Ecosystem Approach roadmap.

The various responses by human societies include those that tackle the origin of the chain: the consumption and production models. The SCP tools focus specifically on this.

The SCP approach focuses on minimising the use of natural resources and toxic materials, as well as the emissions of waste and pollutants, over the life cycle of the services and products. Therefore, the evolution of SCP expands the traditional focus on the production site and manufacturing processes and incorporates various aspects over a product's entire life cycle from cradle to cradle (i.e. from the extraction of resources, through the manufacture and use of the product, to the final processing of the disposed product).

Besides widening the scope of the production, the SCP allows the scope of the consumption to be included progressively, evaluating the environmental impact of the different consumption options and introducing policies, initiatives and tools to reduce those impacts.

The SCP approach includes a set of tools for the assessment of the complex interactions between, on one hand, the consumption demand and production activities and, on the other hand, the final Pressures produced by the patterns of consumption and production on the ecosystems. The knowledge of these interactions can help define more accurate and effective policies to facilitate the achievement of ecological objectives and therefore, the Good Environmental Status (GES). SCP tools for evaluating the relationships between consumption, production and environmental pressures include the Environmental Extended Input-Output Analysis (EE-IOA) and the Life Cycle Analysis.

The SCP approach also incorporates a large number of management tools aimed at alleviating the Pressure on the ecosystems, at both consumption and production levels, and thereby helping to maintain the desired environmental conditions.

Therefore, in conjunction with other assessment and management tools, the SCP approach can contribute to the achievement of conservation goals for the Mediterranean established in the framework of the Barcelona Convention, and for the European Union as a whole, the GES of the Marine Strategy Framework Directive.

The results of the assessment carried out reveal that in some of the main human activities carried out in the Mediterranean, SCP intervention can be highly relevant with regard to discharges from land-based sources and activities, the extraction of non-living resources, as well as fisheries and mariculture. Consequently, SCP could constitute a valuable contribution to the achievement of the ecological objectives linked firstly to eutrophication and contaminants, and secondly to the sea-floor integrity, biological diversity and marine food webs.

0. INTRODUCTION AND FRAMEWORK

0.1 Scope and objectives

The **specific objectives** of the report are to:

- Formulate at a conceptual level the relation between the Sustainable Consumption and Production (SCP) approach and the Ecosystem Approach within the framework of MAP.
- Identify the main potential contributions of the SCP approach to the Ecosystem roadmap of MAP and the ways to insert SCP into this process.
- Identify current challenges when applying the SCP approach within the framework of the Ecosystem roadmap of MAP.

The report's outline is based on the following steps:

Introduction: the Ecosystem Approach in the Mediterranean Action Plan

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Key environmental concerns in the Mediterranean and the ecological objectives

↓

The concept: linking the Ecosystem Approach to consumption and production models

↓

Mapping links between human activities and the ecological objectives

↓

Concepts and tools of the Sustainable Consumption and Production (SCP) approach

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Identifying SCP tools for achieving ecological objectives

↓

Conclusions: challenges in applying the SCP approach and the next step to be taken

0.2 MAP Ecosystem Approach roadmap framework

The Ecosystem Approach was defined in 2000 by the Convention on Biological Diversity as "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the Ecosystem Approach will help to reach a balance of the three objectives of the Convention"[1]. "The Ecosystem Approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems"[2].

As described by the Conference of the Parties to the Convention on Biological Diversity, the Ecosystem Approach is the primary framework for action under the Convention. The Conference of the Parties, at its Fifth Meeting in 2000, endorsed the description of the Ecosystem Approach and operational guidance and recommended the application of the principles and other guidance on the Ecosystem Approach (Decision V/6).

The Johannesburg Plan of Implementation (2002) encouraged the application of the Ecosystem Approach by 2010 in oceans, seas, islands and coastal areas since they "*form an integrated and essential component of the Earth's ecosystem and are critical for global food security and for sustaining economic prosperity and the well-being of many national economies, particularly in developing countries*".

The principal framework for expressing the "usefulness" of biodiversity is through the concept of ecosystem services. They illustrate the link between, on the one hand, the interactions of species with each other and with the physical environment; and on the other, the well-being of people, whether in terms of wealth, nutrition or security.

The Millennium Ecosystem Assessment published in 2005, divided ecosystem services into four categories:

- **Provisioning services,** or the supply of goods of direct benefit to people, and often with a clear monetary value, such as timber from forests, medicinal plants, and fish from the oceans, rivers and lakes;

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[1] Article 1 of the Convention on Biological Diversity
The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

[2] "Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Article 2 of the Convention on Biological Diversity).

- **Regulating services,** the range of functions carried out by ecosystems, which are often of great value but generally not given a monetary value in conventional markets. They include regulation of climate through the storing of carbon and control of local rainfall, the removal of pollutants by filtering the air and water, and protection from disasters such as landslides and coastal storms;

- **Cultural services,** not providing direct material benefits, but contributing to wider needs and desires of society, and therefore to people's willingness to pay for conservation. They include the spiritual value attached to particular ecosystems such as sacred groves, and the aesthetic beauty of landscapes or coastal formations that attract tourists;

- **Supporting services,** not of direct benefit to people but essential to the functioning of ecosystems and therefore indirectly responsible for all other services. Examples are the formation of soils and the processes of plant growth.

A fifth category has been introduced by some authors for defining goods and services provided by marine biodiversity, "Option use values", which are associated with safeguarding the option to use the ecosystem in an uncertain future.

Thus, for the marine environment, specific ecosystem services and societal benefits for the five categories exposed above are presented in Table 1. At the Mediterranean level, Blue Plan -one of MAP's regional activity centres- has undertaken an exploratory study aimed at providing an economic evaluation of the sustainable benefits rendered by Mediterranean marine ecosystems[3].

[3] Mangos, A., Bassino, J-P., Sauzade, D. (2010). *The economic value of sustainable benefits rendered by the Mediterranean marine ecosystems*. Plan Bleu, Valbonne. (Blue Plan Papers 8).

CATEGORY	MARINE ECOSYSTEM SERVICES
Provisioning services	Food provision – extraction of marine organisms for human consumption Raw materials – extraction of minerals and organisms not for human consumption Transport and navigation – use of waterways for shipping Energy – non-consumptive use of the marine environment for energy generation e.g. wave and tidal power Residential and industrial water supply – abstraction of water for residential and industrial purposes
Regulating services	Gas and climate regulation – balance and maintenance of the atmosphere Disturbance prevention – flood and storm protection of biogenic structures Bioremediation of waste – removal of pollutants by storage, burial and recycling
Cultural services	Cultural heritage and identity – values associated with the marine environment itself Cognitive values – education and research resulting from the marine environment Leisure and recreation – refreshment and stimulation of the human body and mind through the perusal and study of, and engagement with the marine environment Feel good or warm glow – value derived from the marine environment without using it
Option use values	Future unknown or speculative benefits – currently unknown future uses of the marine environment values
Over-arching support services	Resilience and resistance- life support by the marine environment and its response to pressures Biologically mediated habitat – habitat provided by living marine organisms Physical habitat – habitat provided by the physical (non-living) environment Nutrient cycling – the storage, cycling and maintenance of nutrients by the marine environment

Table 1 Ecosystem services and societal benefits provided by the marine environment

Along these lines, in 2008 the European Parliament and the Council of the European Union adopted the Marine Strategy Framework Directive (MSFD). This Directive establishes a framework within which Member States shall take the necessary measures to achieve or maintain Good Environmental Status (GES) in the marine environment by the year 2020 at the latest. For that purpose, marine strategies shall be developed and implemented. Article 1.3 establishes that "*Marine strategies shall apply an ecosystem-based approach to the management of human activities, ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while enabling the sustainable use of marine goods and services by present and future generations*".

Within the framework of the Mediterranean Action Plan (MAP), the 14th Meeting of the Contracting Parties to the Barcelona Convention held in Portoroz (Slovenia) in 2005

adopted to follow the initiative of the European Commission relating to a project on the Ecosystem Approach to the management of human activities, with a view to the possible application of the Ecosystem Approach by the whole MAP system.

Then, taking into account this background, in 2008 the 15th Meeting of the Contracting Parties to the Barcelona Convention held in Almería (Spain) decided to apply the Ecosystem Approach progressively to the management of human activities that may affect the Mediterranean marine and coastal environment for the promotion of sustainable development (*Decision IG 17/6: Implementation of the Ecosystem Approach to the management of human activities that may affect the Mediterranean marine and coastal environment*).

Moreover, for the gradual application of the Ecosystem Approach, a process or roadmap was decided on, which contains the following seven steps:

i) Definition of an ecological Vision for the Mediterranean

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ii) Setting of common Mediterranean strategic goals

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iii) Identification of important ecosystem properties and assessment of ecological status and pressures

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iv) Development of a set of ecological objectives corresponding to the Vision and strategic goals

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v) Derivation of operational objectives with indicators and target levels

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vi) Revision of existing monitoring programmes for on-going assessment and regular updating of targets

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vii) Development and review of relevant action plans and programmes

The **ecological vision for the Mediterranean** (step i) was adopted as:

"A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations"

and the **strategic goals for marine and coastal areas** (step ii) were established as parts of the same decision, corresponding the first two steps of a seven-step roadmap. The above strategic goals are as follows:

a) To protect, allow recovery and, where practicable, restore the structure and function of marine and coastal ecosystems thus also protecting biodiversity, in order to achieve and maintain good ecological status and allow for their sustainable use.

b) To reduce pollution in the marine and coastal environment so as to minimize impacts on and risks to human and/or ecosystem health and/or uses of the sea and the coasts.

c) To prevent, reduce and manage the vulnerability of the sea and the coasts to risks induced by human activities and natural events.

The work for the implementation of decision IG 17/6 has since been guided by the Government designated expert (GDE) group supported by the meetings of the technical expert group, the MAP Coordinating Unit and MAP components (in particular the Programme for the Assessment and Control of Pollution in the Mediterranean Region -MED POL-, Regional Activity Centre for Specially Protected Areas -SPA/RAC- and the Plan Bleu Regional Activity Centre -BP/RAC).

In order to prepare the implementation of step iii) and to plan steps iv) and v) of the roadmap adopted in Almería, a Meeting of GDE was held in Athens in July 2008. Then, for the purpose of **implementing step iii)** of the roadmap for the application of the Ecosystem Approach relevant to the assessment of the ecological status, four areas were tentatively identified in the Mediterranean: Area 1: Western Mediterranean Sea; Area 2: Adriatic Sea; Area 3: Ionian Sea and Central Mediterranean; and Area 4: Aegean-Levantine sea. For the fulfilment of step iii) of the roadmap, an assessment document has been prepared for each of the four areas by a group of experts with the support of the MAP components. This document covers physical and chemical characteristics, hydrogeological and oceanographic parameters and focuses on pollution and biodiversity, as well as a study on the economic value of the Mediterranean marine ecosystems.

A set of 11 **ecological objectives** (step iv) of the roadmap) was determined in harmony with the 11 EU MSFD Descriptors for determining GES, but tailored to suit the Mediterranean region. Each ecological objective is classified according to the related descriptor (see Annex 1). A methodology for the determination of the ecological objectives including the corresponding suites of operational objectives and indicators (step v of the roadmap) was approved by the Contracting Parties to the Barcelona Convention during the COP 17 in February 2012.

In this context, ecological objectives are statements on the desired condition of the different components of, and pressures and impacts on, Mediterranean marine and coastal waters. Thus, ecological objectives are related to ecosystem health, structure and/or function and take into consideration the analysis of ecosystem properties and pressures. On the other hand, operational objectives are derived from the ecological objectives with a view to making them measurable and facilitating the choice of indicators, which are measures of environmental conditions.

Therefore, the following ecological objectives for the Mediterranean were defined and agreed following a methodology, developed by the Secretariat and approved at the technical meetings. The resulting ecological objectives take into account the geographical scope of the application of the Barcelona Convention and its Protocols, the issues emerging from the finalized Integrated Assessment Report, socio-economic considerations, Integrated Coastal Zone Management (ICZM) and cumulative impacts.

1. **Biological diversity** is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
2. **Non-indigenous species** introduced by human activities are at levels that do not adversely alter the ecosystem.
3. **Populations** of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4. Alterations to components of **marine food webs** caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability.
5. Human-induced **eutrophication** is prevented, especially adverse effects thereof, such as loss in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.
6. **Sea-floor integrity** is maintained, especially in priority benthic habitats.
7. Alteration of **hydrographic conditions** does not adversely affect coastal and marine ecosystems.
8. The **natural dynamics of coastal areas** are maintained and **coastal ecosystems and landscapes are preserved.**
9. **Contaminants** cause no significant impact on coastal and marine ecosystems or human health.
10. **Marine and coastal litter** do not adversely affect the coastal and marine environment.
11. **Noise** from human activities causes no significant impact on marine and coastal ecosystems.

The set of **operational objectives, and their corresponding indicators, for each of these proposed ecological objectives (step v)** was also developed in accordance with the methodology that included consideration of the pertinence of the operational objective as it relates to the ecological objective, of the feasibility of collecting information across the region, and of the potential importance of the management response that could flow from the adoption of operational objectives and targets. The overall structure of the process for defining objectives and indicators for the achievement of the GES is showed in Fig. 1, while in Fig. 2 the process for this definition in the case of the biological diversity descriptor is presented. This last process has been developed by MAP for the 11 descriptors for determining GES.

The structure of the process presented in Fig. 1 can be summarised as follows: on the basis of the initial assessment made, a comprehensive set of environmental targets (ecological objectives and their derived operational objectives) and associated indicators are set with the aim to guide progress towards achieving GES in the marine and coastal environment. A target level is a specific value of an indicator associated with a particular objective. This value can be set as an objective that must be achieved for the GES.

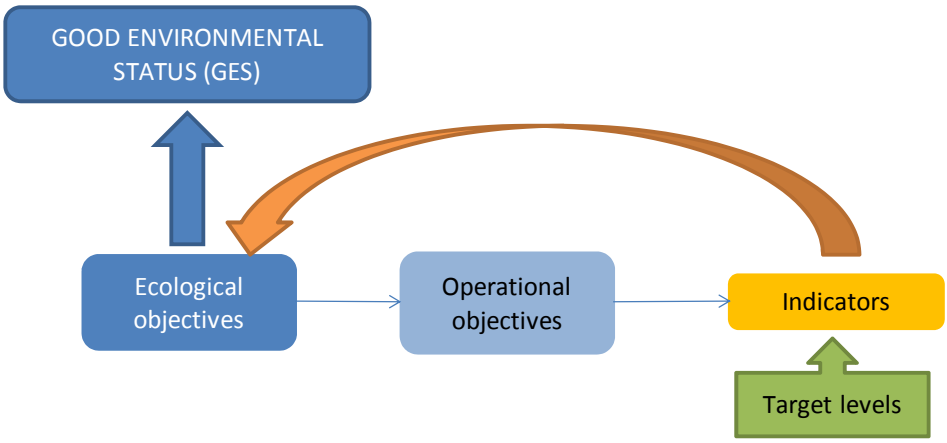

Fig. 1 Summary of the overall structure of the process for defining objectives and indicators for achieving good environmental status

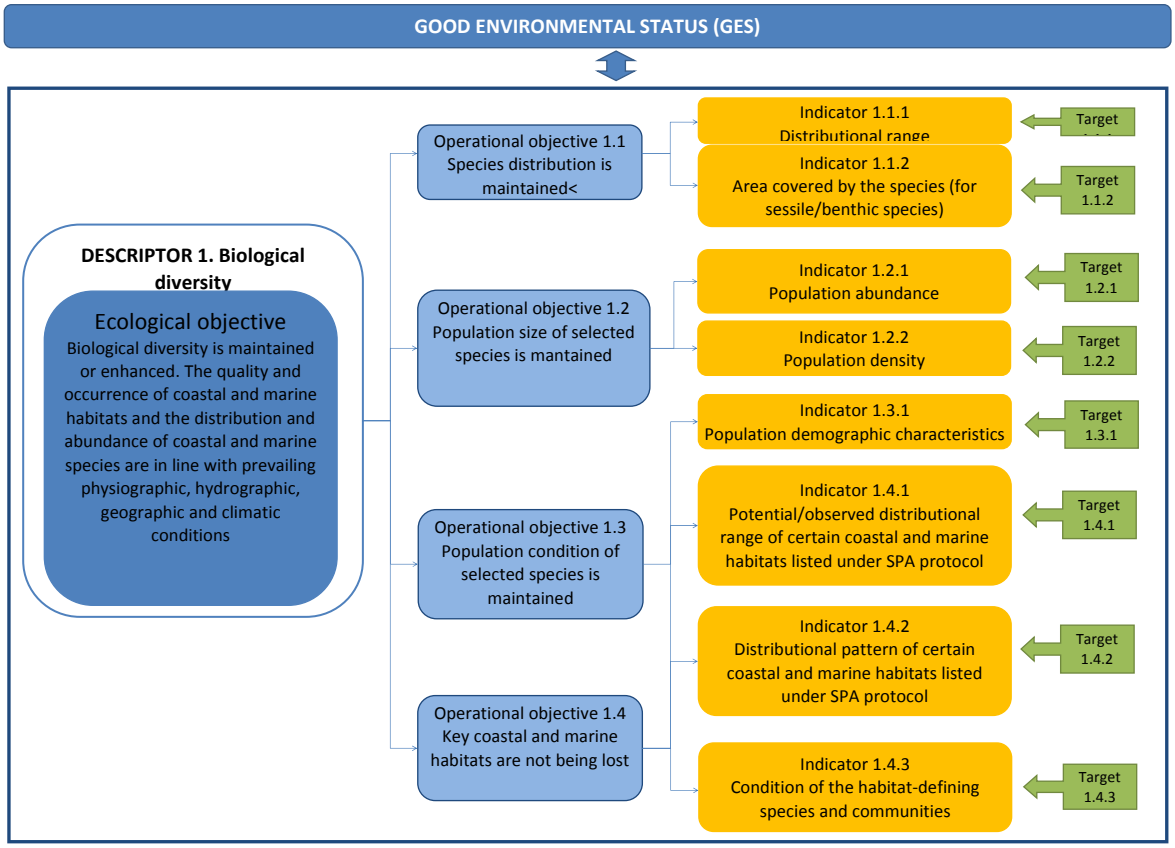

Fig. 2 Process for defining objectives and indicators for achieving good environmental status in the Mediterranean for the biological diversity descriptor

The set of ecological objectives, operational objectives and indicators (see Annex 1) will guide the work of the Contracting Parties during the first cycle of the application of the Ecosystem Approach and could be reviewed and amended as necessary towards subsequent cycles[4].

The work needed for the **derivation of targets** (last part of step v) will be undertaken at a later stage, since it involves the availability of the finalised Initial Integrated Assessment report and a dedicated participative and inclusive process for discussing firstly the concept of Good Environmental Status and secondly the methods for deriving targets for each of the previously agreed indicators.

A pilot study has been formulated in order to test the utility of the proposed ecological objectives in suggesting management responses with the specific objectives, for its first

[4] The cyclical character of the Ecosystem Approach will make it possible for, after iterations, the information gathered for the different indicators to constitute trends that will illustrate at what rate ecosystems are approaching thresholds, or moving closer or away from the (later) agreed-upon target levels. In addition to the iterative character of the compilation of data for the indicators, it is important to mention that the spatial monitoring strategy should be adapted to each of the indicators so as to optimise monitoring efforts.

phase, of verifying at an actual site on a small scale (i) the data availability and accessibility; (ii) the data geographical coverage and georeferentiation to allow for its spatial analysis and the integration of information across ecological objectives, operational objectives and indicators; (iii) the overall potential of the compiled data set and its analysis for suggesting management options for indicative purposes; and (iv) the additional needs for data collection both in terms of gaps in data coverage and of monitoring programmes, infrastructure and the technical capacity for data collection.

Finally, at the third meeting of Technical Experts on the Application of the Ecosystem Approach by UNEP/MAP held in Istanbul in March 2011, the Secretariat presented a draft timeline and projected outputs for the progressive application of the Ecosystem Approach in comparison with the timeline for the implementation of the EU Marine Strategy Framework Directive in order to allow for better identification of the potential synergies between both processes. The timeline and projected outputs on the Ecosystem Approach were agreed on during the third meeting of Government-designated Experts on the Application of the Ecosystem Approach by MAP held in Durres (Albania) in June 2011, as well as the elements for the draft decision of the 17th Contracting Parties meeting regarding the Ecosystem Approach.

The timeline and projected outputs of the Ecosystem Approach roadmap implementation for the next few years, with indications of its corresponding roadmap steps, are presented in the document entitled, *Draft decision on implementing MAP Ecosystem Approach roadmap: Mediterranean Ecological and Operational Objectives, Indicators and Timetable for implementing the Ecosystem Approach roadmap* (UNEP(DEPI)/MED WG 363/7, 9 November 2011). A summary is presented below.

Steps	To December 2011	From July 2011 to December 2013	From January 2014 to December 2015	From January 2016 to December 2017	From January 2018 to December 2019
iii)	Preparing a Mediterranean regional study on ecosystem services				
iv) and v)	Testing the ecological objectives, operational objectives and indicators				
v)		Determination of Good Ecological Status (GES) and Targets			
vi)		Integrated Monitoring Programme	Integrated Monitoring Programme	Integrated Monitoring Programme	Integrated Monitoring Programme
vii)		➢ Development of MAP assessment policy ➢ UNEP/MAP policies under development to incorporate EcAp application progress ➢ Public awareness raising on the Ecosystem Approach	➢ Review and development of Action Plans and Programmes of measures to take into account the EcAp application progress ➢ Public awareness raising on the Ecosystem Approach	➢ Review and development of Action Plans and Programmes of measures to take into account the EcAp application progress ➢ Public awareness raising on the Ecosystem Approach	➢ Development and implementation of Action Plans and Programmes of measures to take into account the EcAp application progress ➢ Public awareness raising on the Ecosystem Approach
-	State of Environment Report (SOER 2011) based on Initial Assessment			SoE report finalised in the form of quality status report and submitted to the CPs meeting	
-				Review process and implementation of its outcome	Review process and implementation of its outcome

Table 2 Timeline and projected outputs of the Ecosystem Approach roadmap implementation

0.3 Sustainable Consumption and Production (SCP) background and policies

This report investigates the extent to which the Sustainable Consumption and Production (SCP) approach can contribute to the development of policies and measures to be included under part vi and vii) of the Ecosystem Approach *Development and review of relevant action plans and programmes*. It is, therefore, useful to give a brief overview of the current status of SCP on the international and European agenda.

At the UN Conference on Environment and Development, held in Rio de Janeiro in 1992, SCP was recognised as an overarching theme, to link environmental and development challenges. The conference's final report, Agenda 21, states that the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production. The debate continued in 1994 at the Oslo Symposium on Sustainable Consumption, which analysed the role of stakeholders.

Ten years after the Rio Conference, the world leaders signed the Johannesburg Plan of Implementation (JPOI) at the World Summit on Sustainable Development (WSSD). Chapter 3 of the plan was devoted to, "Changing Unsustainable Patterns of Consumption and Production" and declared that, "fundamental changes in the way societies produce and consume are indispensable for achieving global sustainable development. All countries should promote sustainable consumption and production patterns". It also called for the development of a 10-Year Framework of Programmes (10 YFP) to accelerate the shift towards sustainable consumption and production, and to promote social and economic development within the carrying capacity of ecosystems by de-linking economic growth from environmental degradation. The Marrakech Process responds to this call by the JPOI through supporting the implementation of SCP programmes, projects and policies, and helping to construct the 10 YFP.

At the European Union level, different policies and strategies had been put in place addressing several aspects for more sustainable consumption and production patterns. In 2006 sustainable consumption and production was given full political recognition at EU level when it was considered one of the seven key challenges to be tackled in the reviewed EU Sustainable Development Strategy (EUSDS). Amongst other provisions, the EUSDS established the need to define an Action Plan on SCP.

In 2008, the European Commission presented the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan. It included a series of proposals for strengthening existing sustainable consumption and production policies such as the Ecodesign Directive, the Energy Label Directive and the Ecolabel Regulation and policy on Green Public Procurement (GPP). It also included further proposals such as the Retailer Forum to further increase the demand for more sustainable goods and

production technologies. It also sought to encourage EU industry to take advantage of opportunities to innovate. The SCP/SIP will undergo a review during 2012.

The SCP/SIP Action Plan is complemented with numerous thematic strategies, policies and instruments such as the Thematic Strategy on Waste Prevention and Recycling, the Thematic Strategy on the Sustainable use of Natural Resources and the Eco-Management and Audit Scheme (EMAS).

More recently, in 2010, the Europe 2020 Strategy included a flagship initiative on resource efficiency that aims to create a framework for policies to support the shift towards a resource-efficient and low-carbon economy. The flagship initiative was subsequently described in an EU communication in early 2011. A Commission proposal for the implementation of the Flagship initiative – A Roadmap to a Resource Efficient Europe - was presented in September 2011. This includes sustainable consumption and production as a specific theme, but also a number of other themes, which are directly relevant to SCP, such as turning waste into a resource, supporting research and innovation and "getting the prices right" i.e. using economic instruments to reduce the environmental impacts of consumption and production.

Member States of the EU have also implemented a wide range of actions both top-down and bottom-up, addressing SCP directly or indirectly. In fact, a large number of states are developing or have defined overarching policies to foster SCP patterns in a more systematic way and are taking SCP into consideration when drafting thematic strategies (ETC/RWM 2007).

At the Mediterranean level, in 2005 the Contracting Parties to the Barcelona Convention approved the Mediterranean Strategy for Sustainable Development (MSSD), which establishes SCP as a major objective for attaining sustainable development in the region. Since then SCP has become a priority in the Mediterranean Regional Policy Agenda. SCP is one the key thematic priorities in the current 5-year Work Programme 2010-2014 of UNEP/MAP. Accordingly, one of the MAP components, the Regional Activity Centre for Cleaner Production (CP/RAC), has a specific mandate and a programme of actions assigned and endorsed by the Contracting Parties to the Barcelona Convention to promote SCP in the Mediterranean region.

Fig. 3 shows the international framework of the adoption and implementation of the SCP together with the international framework of the Ecosystem Approach, explained in the previous section.

This report explores the synergies between the two roadmaps (SCP and Ecosystem Approach) in the framework of the Mediterranean.

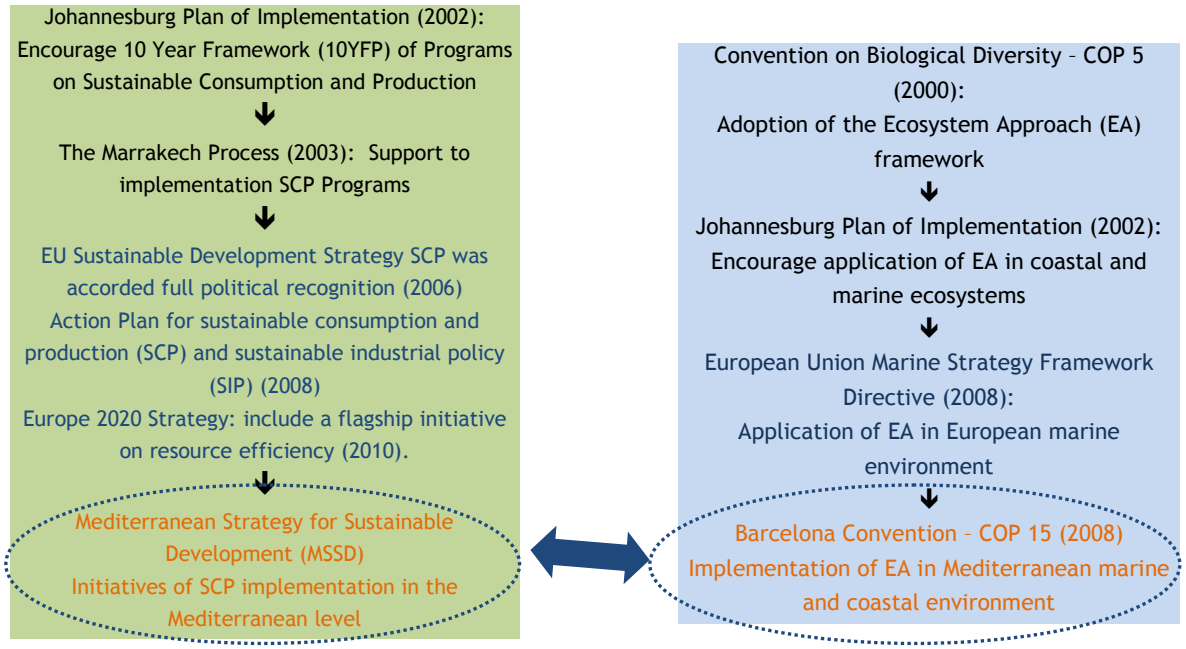

Fig. 3 International framework of the adoption and implementation of the SCP vs. the Ecosystem Approach

1. KEY ENVIRONMENTAL CONCERNS IN THE MEDITERRANEAN AND DESCRIPTION OF THE ECOLOGICAL OBJECTIVES

1.1 Summary of main concerns for the Mediterranean Sea

Degradation of Mediterranean coastal and marine environments continues due to direct and indirect impacts of its use by various sectors. The main environmental issues of concern in the Mediterranean are:

- **Coastal development and sprawl**, driven by urban and tourism development, leading to habitat loss and degradation, and erosion/ shoreline destabilisation
- **Over-fishing**, and incidental catch or by-catch, affecting community structure, ecological processes, and the delivery of ecosystem services
- **Destructive fishing**, including bottom trawling and fishing methods resulting in benthic disturbance
- **Contamination of sediments and biota** caused by pollution, primarily from urbanisation and industry, but also from antifoulants and atmospheric inputs of hazardous compounds
- **Nutrient over-enrichment**, leading sometimes to eutrophication and hypoxia, but more regularly leading to ecological imbalances (reduced water quality and growth of algae)
- **Disturbance and pollution caused by maritime industries**, including shipping, energy, aquaculture, and desalination
- **Invasive non-indigenous species spread**, in many cases mediated by climate change and compounded by shipping

1.2 Description of the State of the Mediterranean Sea and ecological objectives established by MAP

The state of the Mediterranean is defined by the following 11 descriptors: Biological diversity, Non-indigenous species, Harvest of commercially-exploited fish and shellfish, Marine food webs, Eutrophication, Sea-floor integrity, Hydrography, Coastal ecosystems and landscapes, Contaminants, Marine and coastal litter and Underwater noise. For each of these descriptors MAP has established ecological objectives and their corresponding operational objectives.

The main source for the information provided is the Initial integrated assessment of the Mediterranean Sea: Fulfilling step 3 of the Ecosystem Approach process (UNEP (DEPI)/MED WG.363/Inf.21, 20 May 2011).

1. Biological diversity

It is estimated that there are between 10,000 and 12,000 marine species in the Mediterranean (about 8,500 species of macroscopic fauna, over 1,300 plant species and about 2,500 other taxonomic groups). This corresponds to 4-18% (depending on the taxonomic groups considered) of the world's known marine species. With about 0.82% and 0.32% of the surface area and volume of the world ocean respectively, the Mediterranean Sea constitutes one of the 25 biodiversity hotspots that are recognised on a planetary scale. This is also true for the continental domain of the Mediterranean basin, which, despite only constituting 1.6% of the surface area of the continents, contains 10% of the world's marine biodiversity.

At a biogeographical level, Mediterranean biota include 55-77% of Atlantic species (present in the Atlantic and the Mediterranean), 3-10% of pantropical species (species from the globe's hot seas), 5% of Lessepsian species (species from the Red Sea which entered the Mediterranean via the Suez Canal) and between 20 and 30% of endemics.

The Mediterranean Sea's flora and fauna are unevenly distributed between its various basins: 87% of the known forms of life in the Mediterranean are present in the western Mediterranean, 49% in the Adriatic and 43% in the eastern Mediterranean. However, many species are present in two or three basins. Furthermore, endemic species are more numerous in the western Mediterranean.

It is estimated that there are about 5,942 benthic invertebrate species in the Mediterranean. The differing distributions of these taxa around the Mediterranean basin reveal a gradient that drops from the west to the east.

Key or critical habitats supporting Mediterranean ecosystems include seagrass meadows; coralligenous communities; coastal lagoons and coastal soft-bottom communities; sea mounts and unique benthic features; frontal systems and other features of the pelagic (water column) environment.

The loss of Mediterranean marine and coastal biodiversity is due to concomitant causes and several pressures which act in synergy: habitat loss; fisheries over-exploitation and fishing-related environmental degradation; biological invasions of non-indigenous species (often linked to climate change and other environmental disturbances, including fishing pressure); pollution; and the spread of pathogens. Climate change is the background against which all these changes play out, sometimes speeding up the changes, sometimes causing irreversible alterations.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 1: Biological diversity	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions	1.1. Species distribution is maintained 1.2. Population size of selected species is maintained 1.3. Population condition of selected species is maintained 1.4. Key coastal and marine habitats are not being lost

2. Non-indigenous species

The number of exotic species found in the Mediterranean is currently around 1,000 and their rate of introduction in the basin is currently thought to be of one species every 1.5 weeks.

Their number in the Mediterranean has increased spectacularly since the start of last century. These species are represented by 13 branches dominated by molluscs (216 species), followed by fish (127 species), benthic plants (124 species) and crustaceans (106 species). Among these exotic species, over 500 are well established in the Mediterranean. The distribution of non-native species varies from country to country. Non-native species are more preponderant in the eastern basin that the western (see Fig. 4). Moreover, the origins of the introduction differ for the two basins. Non-native species in the western basin are mostly species that have been introduced by maritime transport and fish farming, whereas the species in the eastern basin are Lessepsian species that have entered the Mediterranean through the Suez Canal.

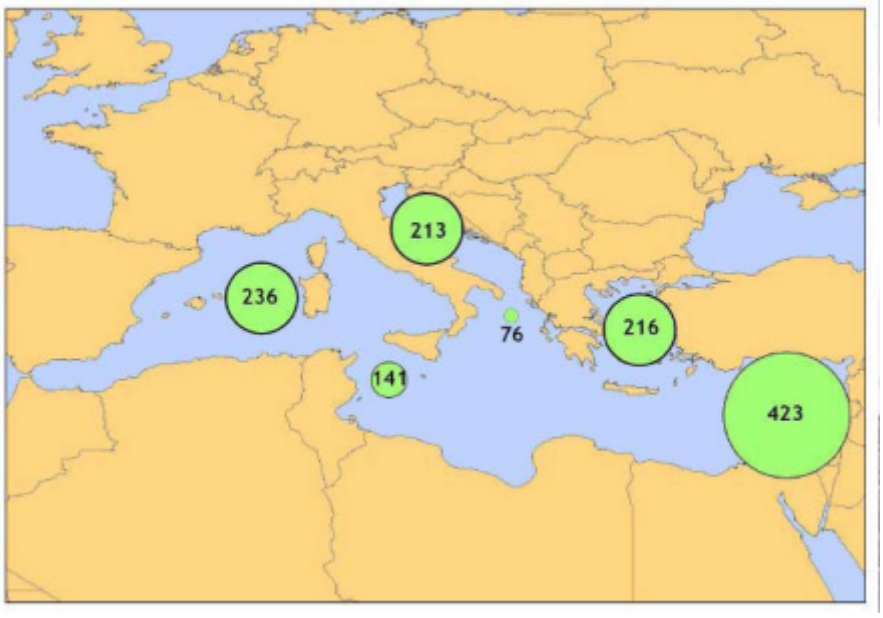

Fig. 4 Distribution of exotic species in the Mediterranean basins.
Source: Zenetos & Streftaris, 2008
Note: Numbers indicate the number of exotic species introduced in each Mediterranean basin and the size of the circles is proportional to the number of exotic species introduced.

Exotic invasive species are considered by several authors to be one of the biggest causes of biodiversity loss. Non-native species represent a growing problem, mainly due to the unexpected and harmful impacts that these species can have on the ecosystems and consequently on the economy and human health. Yet it is important to recognise that: not all non-indigenous species are invasive (e.g. in the Aegean Sea of the 172 alien species reported, only 26 are classified as Invasive alien species); some non-indigenous species have increased the biodiversity of the Eastern Mediterranean; a significant number of exotic species have become valuable fishery resources in the Levantine area.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 2: Non-indigenous species	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem	2.1. Invasive non-indigenous species introductions are minimized 2.2. The impact of non-indigenous particularly invasive species on ecosystems is limited

3. Harvest of commercially exploited fish and shellfish

In many Mediterranean nearshore areas, including in coastal lagoons and estuaries, fishing is one of the most extensive use of resources. The main species of fish of commercial interest in the lagoons belong to the Sparidae, Mugilidae, Anguillidae and Moronidae families, which are present in over 75 Mediterranean lagoons. However, other invertebrate species are used for commercial purposes, particularly natural deposits of some mollusc species.

The main species of fish exploited in the coastal areas are sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicholus*) among the small pelagic species, and hake (*Merluccius merluccius*), mullet (*Mullus* spp.), whiting (*Micromesistius poutassou*), angler fishes (*Lophius* spp.), sea bream (*Pagellus* spp.), octopus (*Octopus* spp.), squid, encornet squid (*Loligo* spp.), and red shrimp (*Aristeus antennatus*) among the demersals, and large pelagic species like Atlantic bluefin tuna (*Thunnus thynnus*) and swordfish (*Xiphias gladius*). These species represent 70-80% of the total landed in the Mediterranean. However, other species of invertebrate are exploited, such as the red coral (*Corallium rubrum*), many sponge species *(Spongia* spp., *Hypospongia* spp.), natural beds of bivalves (*Lithophaga lithophaga*, *Acanthocardia* spp., *Callista chione*, etc.).

Fisheries also exploit Mediterranean deep seas, essentially targeting decapodal crustaceans. The main biological resources exploited are the deep sea pink shrimp *Parapenaeus longirostris* and the Norwegian lobster *Nephrops norvegicus*, to which are associated other species like *Merluccius merluccius*, *Micromesistius poutassou*, *Conger conger*, *Phycis blennoides* and, to a lesser extent, *Lophius* spp. in addition to the cephalopod *Todarodes sagittatus*. The deeper fisheries (going down to approximately 400-800 m) almost exclusively target the shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus*.

High levels of fishery resource extraction in Mediterranean fisheries have led to over-exploitation. Over-fishing in the Mediterranean over the past ten years is the result of uncontrolled growth of the industry (by about 12%), with highest exploitation of stocks of demersal and big pelagic species (tuna and swordfish). Over-fishing has caused a collapse of beds of the red coral *Corallium rubrum*, the date shell *Lithophaga lithophaga*, some sponges (*Hypospongia communis*, *Spongia* spp., etc.) as well as some species of decapodal crustaceans (*Homarus gammarus*, *Palinurus elephas*). Several other species of fish are over-exploited (*Anguilla anguilla*, *Epinephelus marginatus*, *Sciaena umbra*, *Thunnus thynnus*, *Xiphias gladius*, etc.).

Another major impact of fishing arises from the fact that many fishing practices lead to incidental catch (known as by-catch) and discards. Several fishing gears used by commercial fisheries have high levels of by-catch, and some are responsible for physical damage to the seabed and the degradation of associated communities. Cetaceans and turtles, and other threatened species, frequently constitute the by-catch of pelagic fishing.

A regional study on discards in the western Mediterranean gave discard estimations of 23-67% of total catch at depths of less than 150 m; 13-62% at depths of 150-350 m and 14-43% at depths of over 350 m. Discarding can also involve commercial species of the smallest size classes. The effect of discards on marine communities includes both single-species levels, where the population dynamics of a species is altered, and ecosystem levels, where important changes occur because of the disruption to food webs, favouring scavengers, etc.

Illegal fisheries have broad impacts across the Mediterranean as:

- The illegal trawling on seagrass beds that impacts ecosystems both by suspending sediments and direct mechanical destruction of the vegetal mass. Sediment suspension affects macrophyte photosynthesis by decreasing light intensity.
- The date mussel (*Lithophaga lithophaga*) fisheries, based on the demolition of substrates by commercial divers. The consequence of this pressure is the

desertification of long stretches of rocky shore caused by the mechanical destruction of habitats and the associated communities.

The Mediterranean high seas contain a great diversity of habitats, both pelagic and benthic. The protection of the fauna in these areas is important for fisheries and the conservation of the ecosystem, for the organisms can determine the health of an ecosystem. The sessile benthic fauna has an important role as organisms that structure the habitats providing a refuge for many other marine species (e.g. cold water coral reefs, deep sea sponges, and crinoid beds). Bottom trawling is a potentially harmful practice that was forbidden at depths of over 1,000 metres in 2005 in order to protect Mediterranean seabeds and vulnerable deep sea fauna. In the Mediterranean open seas we find mainly fisheries such as purse seines targeting Atlantic bluefin tuna, and pelagic longlines targeting swordfish, Atlantic bluefin tuna and albacore. Apart from over-exploitation of target stocks, these fisheries can have a potential impact on elasmobranchs, marine turtles and seabirds taken as by-catch. Pelagic driftnets targeting Atlantic bluefin tuna and swordfish, used intensively in the 1980s, were forbidden in the Mediterranean in 2005. However, despite regulations and fishing fleet conversions, this activity is still practised, constituting in a potential threat for marine turtles cetaceans and elasmobranchs.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 3: Harvest of commercially-exploited fish and shellfish	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Populations of selected commercially-exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock	3.1. Level of exploitation by commercial fisheries is within biologically safe limits 3.2. The reproductive capacity of stocks is maintained

4. Marine food webs

Low primary production, linked to low development of the higher levels of the trophic chain, including a low production of fish, are the main features that characterise the Mediterranean.

Fisheries can have cascading effects on the trophic structure of the marine ecosystem by the harvesting of top predators, either pelagic or demersal species. Over-fishing reduces the populations of more valuable large-sized fish that are at higher trophic levels, such as piscivorous species. As a result, average trophic levels of landings are

reduced in accordance with the degree of fishing effort. According to FAO fishery statistics, the mean trophic level of Mediterranean fisheries declined one level in the last 50 years. However, fisheries also cause significant ecological changes at lower trophic levels among fish of small body size.

Trawling activities have been involved in shifting the seabed communities from long-lived to more opportunistic species.

The effect of discards on marine communities includes both single-species levels, where the population dynamics of a species is altered, and ecosystem levels, where profound changes occur because of the disruption to food webs, favouring scavengers, etc.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 4: Marine food webs	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability	4.1. Ecosystem dynamics across all trophic levels are maintained at levels capable of ensuring long-term abundance of the species and the retention of their full reproductive capacity 4.2. Normal proportion and abundances of selected species at all trophic levels of the food web are maintained

5. Eutrophication

The Mediterranean is oligotrophic, with relatively few nutrients, low primary productivity, a west-east decreasing trend ranging between 59 and 150 g C m^{-2} y^{-1} (Papadopoulou, 2011); and low phytoplankton biomass, less than 0.2 µg chl a l^{-1} (Papadopoulou, 2011). These characteristics contribute to the clarity of the waters and the light penetration that has made the Sea so aesthetically pleasing to humans. Yet there are regions with relatively high productivity, driven either by frontal systems and upwelling, or by delivery of nutrients from human activities that constitute important additional sources of nutrients (river runoff, including inputs from industry, municipal discharge, and agriculture; direct inputs of municipal discharge and industrial waste; the atmosphere, emissions from agriculture, fuel combustion, including traffic; and marine activities such as fish farming).

In the Mediterranean Sea approximately 80 major rivers, the top four of which are the Nile, Rhone, Po and Ebro, contribute nutrient inputs, with very variable seasonality in their hydrological patterns depending on their geographical position around the basin.

Concentrations of nutrients in Mediterranean rivers are generally at least four times lower than in equivalent rivers in northwest Europe, although there is evidence of an increasing trend in both nitrogen and phosphate concentrations.

These sources lead to increased concentrations of nutrients in coastal waters and, in particular, partially enclosed sea areas. Excessive nutrient enrichment from human activities is termed eutrophication and can cause reduced water transparency, algal blooms (red tides, foam or green tides on beaches), fish and benthos kills owing to decreased amounts of oxygen in the bottom waters, bad smells (hydrogen sulphide), and changes in the communities and biodiversity of planktonic and bottom-living organisms.

Open waters of the Mediterranean show no signs of eutrophication; the effects are confined to nearshore areas and enclosed coastal bays, which are subject to inputs from rivers, increased urban and industrial discharges, as well as an expanding aquaculture industry in the eastern Mediterranean. The northern shores of the Mediterranean (particularly the Adriatic) are most seriously affected by eutrophication, although serious problems also exist on the southern shores of the sea where detailed information is lacking (ICES, 2003).

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 5: Eutrophication	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters	5.1. Human introduction of nutrients into the marine environment is not conducive to eutrophication 5.2. Direct effects of nutrient over-enrichment are prevented 5.3. Indirect effects of nutrient over- enrichment are prevented

6. Sea-floor integrity

Coastal development and urbanisation exert great pressures on the Mediterranean environment. Habitats are lost and degraded by constructions, the placement of infrastructures, and land reclamation. Habitat loss is one of the greatest drivers of biodiversity loss and decline in ecosystem services.

Coastal constructions affect not only the area where they are installed, but also wide swaths of the coast, due to the changes they cause in coastal currents and sedimentary processes that may exacerbate erosion of shorelines.

Population pressures lead to increased use of resources and habitats, and indirect degradation as well. Tourism, an industry of great importance to the Mediterranean region, drives much of the habitat loss as well as indirect degradation. Recreational boating activities cause damage to habitats and species, in particular due to boat anchoring.

Sand mining and other extractive activities can lead to major changes in habitat and loss of services.

Offshore constructions include oil platforms, wind farms, and other energy sector infrastructure cause physical damage to the seabed and disturbance on benthic communities by the construction and the dumping of waste (cuttings from oil platforms).

The use of bottom gear can cause a series of cascade effects on the ecosystem. Trawling is responsible for changing grain size distribution and sediment texture and for destroying bedforms. Coralligenous and maërl communities are mainly endangered by trawling, responsible for the disappearance of maërl in large sectors of the Mediterranean. Fishing disturbance may cause shifts in the benthic community structure.

Seagrass meadows provide important spawning and nursery areas for many fish species. *Posidonia oceanica* seagrass meadows, however, are declining partly as a result of trawling as well as from the mooring of boats. Seagrass beds that are regularly fished show lower density and biomass.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 6: Sea-floor integrity	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Sea-floor integrity is maintained, especially in priority benthic habitats	6.1. Extent of physical alteration to the substrate is minimized 6.2. Impact of benthic disturbance in priority benthic habitats is minimized

7. Hydrography

In the Mediterranean, hydrological processes are largely variable both in time and space due to the high variability of the rainfall regime, the influence of topography and the spatial distribution of soil and land use. The temporal variability of precipitation within

and between years is one of the specific characteristics of this climate, characterised by a succession of dry and flash flood periods that affect salinity locally.

A large thermohaline cell encompasses the whole Mediterranean and is mainly driven by water deficit and by heat fluxes, compensated by the exchanges through the Straits of Gibraltar. The formation and subsequent spreading of the intermediate water, together with the inflow of the Atlantic Water through the Straits of Gibraltar, contributes to this thermohaline circulation. Besides the main thermohaline circulation, several local features characterise the Mediterranean circulation, such as gyres and fronts. Atlantic Water is present almost everywhere in the basin. It forms two anticyclonic gyres in the Alboran Sea, constrained by the bathymetry, and then bifurcates around Sardinia in two different branches: one into the Tyrrhenian Sea as the source of the large-scale cyclonic circulation occurring in the northwestern Mediterranean. The other crosses the Sicilian Channel and penetrates into the Ionian Sea. The water from the Tyrrhenian Sea produces a large cyclonic circulation in the western Mediterranean, with the central gyre between the Balearic Islands and Sardinia being the region of deep water convection.

Hydrographic conditions may be altered by coastal and offshore constructions. Changes in currents have direct effects on the ecosystems, mainly on the behaviour and ecology of pelagic organisms, and indirect effects through erosion processes along shorelines.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 7: Hydrography	
ECOLOGICAL OBJECTIVE	**OPERATIONAL OBJECTIVES**
Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems	7.1. Impacts to the marine and coastal ecosystem induced by climate variability and/or climate change are minimized 7.2. Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimized 7.3. Impacts of alterations due to changes in freshwater flow from watersheds, seawater inundation and coastal freatic intrusion, brine input from desalination plants and seawater intake and outlet are minimized

8. Coastal ecosystems and landscapes

The major Mediterranean coastal habitats types which constitute natural coastal landscapes are: Sand Dunes; Coastal Wetland, Estuaries, and Lagoons; Nearshore or Neritic Marine Areas; Seagrass Meadows; Coralligenous Communities; *Cystoseira* Forests and *Lithophyllum* Rim Habitats, Vermetid Platforms, and other Hard-Bottom Habitats.

1. Sand Dunes

Sand dunes support a wide variety of species. Dunes are exclusive habitats for many animal (gastropods, arthropods, reptiles, etc.) and plant species. These are highly fragile ecosystems containing considerable endemic flora. One-third of the dune flora is endemic to the Mediterranean. Dunes play a major part in preserving beaches and protecting the forests, biological communities and facilities that lie behind them. The decline of the Mediterranean dunes has become severe since the 1900s and losses have been estimated at over 70% of the dunes. The indigenous vegetation of the dunes in this region is threatened by the invasion of exotic species. Dune developments, particularly to develop seaside tourism, constitute an undeniable threat to these formations in many countries around the Mediterranean.

2. Coastal Wetland, Estuaries, and Lagoons

They are extremely dynamic and highly productive ecosystems. These transitional waters are usually characterised by low biodiversity and contain species that are well adapted to the wide, stressful variations in environmental conditions. They provide important services by fighting against floods, stabilising shores, conserving sediment and nutritive elements, locally reducing climate change, enhancing and maintaining water quality, acting as biodiversity and biomass reservoirs, and are of value for recreation, tourism and cultural events.

Mediterranean estuaries and coastal lagoons offer a diversity of habitats for a large number of species. They constitute nursery areas and feeding sites for many coastal fish.

Primary production in Mediterranean coastal lagoons is very much greater than in the sea. Benthic invertebrates exhibit relatively low densities in eurythermal-euryhaline lagoon communities (shallow lagoons <3 m) but greater species richness in deeper benthic communities, which form on silty sand in calm conditions. Very few fish are resident in Mediterranean lagoons.

Macroalgal biomass in lagoon environments is generally high. A rich and varied avifauna uses these ecosystems as stopover or wintering sites, since they find favourable ecological conditions there. Many coastal lagoons are now listed on the Ramsar Convention List as sites of international importance for birds.

3. Nearshore or Neritic Marine Areas

In the coastal waters, the distribution of Mediterranean fauna and flora differs greatly depending on the distance from the coast, longitude and depth. The marine biodiversity is basically concentrated within the shore area (between 0 and 50 m), which contains about 90% of the known plant species and 75% of the fish species of the Mediterranean. The photosynthetic flora disappears at between 50 and 200 m down (depending on the region and the transparency of the water). Primary production is on average three times lower in the eastern basin than in the western. In the euphotic area, primary production is 40, 78 and 155 (mg C m^{-2}) in the eastern, central and western basins respectively. Some 470 species of zooplankton have been listed in the Mediterranean (coastal waters and open sea). The Mediterranean continental shelf possesses rich and important benthic habitats. The Mediterranean marine macroflora is estimated to consist of about 1,000 macroscopic species, five of these being marine phanerogams. They are generally distributed in the shallow areas that constitute less than 10% of the surface area of the Mediterranean.

4. Seagrass Meadows

Posidonia oceanica meadows are considered to be one of the Mediterranean Sea's most important ecosystems. These meadows are present on most of the Mediterranean shores (except for those of Israel, Palestine and perhaps Lebanon). *Cymodocea nodosa* meadows are second most significant seagrass habitat in the Mediterranean after *Posidonia oceanica*. *Zostera marina*, another Mediterranean seagrass also forms meadows. It is a species that is widespread throughout the northern hemisphere but rare, only growing very locally in the Mediterranean (mainly the northwestern Mediterranean, the Adriatic, and the Aegean Sea). In addition, *Zostera noltii* meadows, widespread throughout the North Atlantic (from Sweden to Mauritania), are rarer and more localised in the Mediterranean (western Mediterranean, the Adriatic, Greece and Egypt). Finally, *Halophila stipulacea* meadows occur, but are restricted to specific areas. Collectively these seagrass habitats are among the most productive ecosystems in the marine environment.

The five species of marine phanerogam described above (*Cymodocea nodosa*, *Halophila stipulacea*, *Posidonia oceanica*, *Zostera marina* and *Zostera noltii*) form vast underwater meadows at depths of between 0 and 50 m in the open sea and in lagoons.

5. Coralligenous Communities

These communities, comprised of biogenic constructions made by calcium carbonate forming organisms, are the second most important hotspot of species biodiversity in the Mediterranean. The coralligenous habitats and bioconcretions consist of the following: pre-coralligenous populations, shelf coralligenous, associations with rhodoliths – maërl, pralines and *Lithothamnion minervae* facies, association with *Peyssonnelia rosa-marina* - free Peyssonneliaceae facies and large bryozoan facies of the coastal detrital bottoms.

6. *Cystoseira* Forests

Forests of macroalgae of the genus *Cystoseira* can occupy large areas in the marine ecosystems, where they form highly productive communities with remarkable biodiversity. Speciation is still occurring within the genus *Cystoseira*, which has led to many varieties within a single species. Furthermore, these algae present significant morphological variability.

7. *Lithophyllum* Rim Habitats, Vermetid Platforms, and other Hard-Bottom Habitats

Lithophyllum rim habitats are common in the northern and central parts of the western Mediterranean and in the Adriatic Sea. The rims are rare in the southern part of the western Mediterranean and in the eastern Mediterranean. Vermetid platforms are basically built up by the association of *Dendropoma petraeum* (gastropod) and a crusting coralline alga *Neogoniolithon brassica-florida*. Vermetid platforms are usually formations that are typical of the hot parts of the Mediterranean.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 8: Coastal ecosystems and landscapes	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved	8.1. The natural dynamic nature of coastlines is respected and coastal areas are in good condition 8.2. Integrity and diversity of coastal ecosystems, landscapes and their geomorphology are preserved

9. Contaminants

Marine pollution takes many forms, including hazardous substances such as heavy metals and persistent organic pollutants (POPs); excessive nutrients (discussed above); petrochemicals; microbiological pollutants; and debris (discussed below). These pollutants enter Mediterranean waters via discharge points and dumping grounds, from rivers and runoffs, and through atmospheric deposition.

For hazardous substances, compounds of regional concern are PCBs, DDT, HCHs, and HCB, amongst others. Other compounds, e.g., phthalates, alkylphenols and PBDE/PBBs, are suspected to be ubiquitous.

The concentration of chemical pollutants at low levels of the food web can be magnified at higher trophic levels and have consequences on both marine species and human health.

The main sources of oil pollution in the Mediterranean originate from maritime transport, both through accidental and deliberate discharges, atmospheric deposition (from military activities and commercial jet flights), coastal refineries and offshore installations, as well as land-based activities (either discharging directly or through riverine inputs). The installation and operation of offshore constructions may pose a significant threat.

Oil discharges and spills to marine areas can have a major impact on marine ecosystems in this and other subregions of the Mediterranean. The consistency of oil can cause surface contamination and smothering of marine biota, and its chemical components can cause acute toxic effects and long-term accumulative impacts. The damage of oil spills is not restricted to the environment but also has a socioeconomic component. Oil spills in fishing (catching, spawning and feeding) or aquaculture areas or coastal locations that rely upon tourism can be severely impacted. Fisheries may close and tourism decline, with the associated loss of income and livelihoods. Even if there is little or no actual environmental damage, the perception that an oil spill has affected the coastline can still have an impact.

The level of nutrients entering the Mediterranean has been rising over the last few decades. Localised enrichment by nutrients and organic matter may often lead to increased primary productivity and eventually also to algal blooms. When marine algae occur in significant numbers and produce biotoxins, they are termed Harmful Algal Blooms (HABs). HABs are a global phenomenon, and have also affected the Mediterranean Sea. Impacts include human illness and mortality following consumption of or indirect exposure to HAB toxins, substantial economic losses to coastal communities and commercial fisheries, and HAB-associated fish, bird and mammal mortalities.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 9: Contaminants	
ECOLOGICAL OBJECTIVE	**OPERATIONAL OBJECTIVES**
Contaminants cause no significant impact on coastal and marine ecosystems and human health	9.1. Concentration of priority contaminants is kept within acceptable limits and does not increase 9.2. Effects of released contaminants are minimized 9.3. Acute pollution events are prevented and their impacts are minimized 9.4. Levels of known harmful contaminants in major types of seafood do not exceed established standards 9.5. Water quality in bathing waters and other recreational areas does not undermine human health

10. Marine and coastal litter

The main sources of marine and coastal litter in the Mediterranean are land-based activities (80% of marine and coastal litter) and activities at sea (20%) such as shipping and offshore oil and gas platforms debris (Clean up Greece *et al.*, 2007). The bulk of this litter apparently originates in households, with direct disposal into the sea. Tourism infrastructure also contributes, as does river-based input, litter from boats and ships, and disposal by municipalities (see Fig. 5). Disposal of garbage generated by vessels (except food waste) is prohibited in Mediterranean waters.

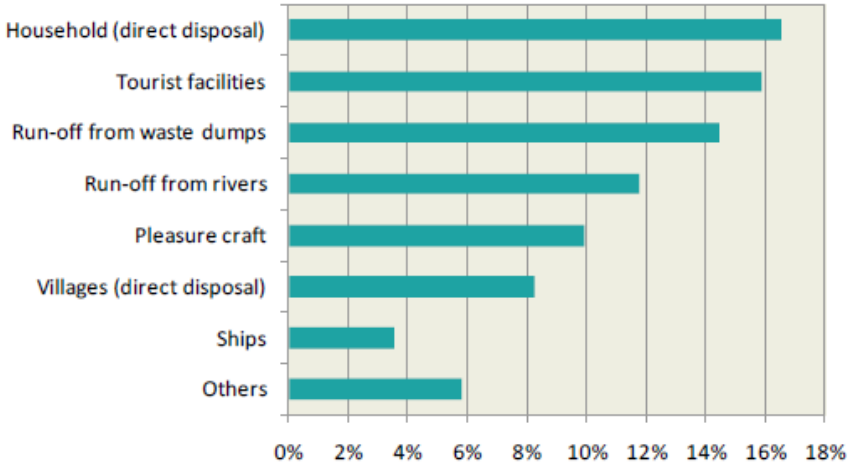

Fig. 5 Sources of marine litter in the Mediterranean
Source: UNEP/MAP-PLAN BLEU, 2009

The problem is compounded by the fact that almost 90% of floating marine litter is plastic-based and therefore does not degrade quickly in the environment. This allows garbage in the marine environment to continue increasing over time and to travel vast distances with ocean currents and winds, impacting the remotest parts of the world's oceans and coasts.

Marine and coastal litter remains an issue for many Mediterranean areas. It spoils the landscape and may affect the marine ecosystem. Pollutants contained in litter are extracted and diluted into rainwater, freshwater or marine water and may enter the food chain.

Marine and coastal litter poses a major threat to wildlife. Marine mammals, sea turtles and birds can be injured or killed either through entanglement in or ingestion of garbage items. Globally, it is estimated that over 1,000,000 seabirds and 100,000 marine mammals and sea turtles die each year from marine litter (Clean up Greece *et al.*, 2007).

Much of the marine litter eventually reaches the coastline, constituting a major source of aesthetic pollution that may deter tourists and impact local economies. Not only does marine litter cost coastal communities lost revenues from tourism, but cleaning up beaches from litter can also be very expensive.

Lost or discarded fishing gear can have financial implications for the fishing industry, which will have to replace it. In addition, "ghost fishing" (entrapment of marine life in discharged fishing gear) from lost nets also kills thousands of fish.

Marine and coastal litter may cause costly or irreparable damage to boats. Fishing nets can wrap around propellers, plastic sheeting can clog cooling water intakes, and lost nets or lines can entangle vessels.

Marine and coastal litter may also endanger human health and safety. Sharp objects, such as broken glass and rusty metal, may cause serious injuries when people step on them on the beach or seabed. Contaminated medical and sewage waste may pose a public health hazard through disease transmission. Abandoned fishing nets and lines may entangle scuba divers.

The ecological objective and the operational objectives established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 10: Marine and coastal litter	
ECOLOGICAL OBJECTIVE	OPERATIONAL OBJECTIVES
Marine and coastal litter do not adversely affect coastal and marine environment	10.1. The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized 10.2. Impacts of litter on marine life are controlled to the maximum extent practicable

11. Underwater noise

Underwater noise is the noise arising from human activities in the marine environment such as underwater explosions, ships, seismic exploration, offshore construction (for example wind farms and hydrocarbon production activities) and industrial activities, sonar of various types and acoustic devices designed to deter mammals from approaching (so called Acoustic Harassment Devices –AHDs- or Acoustic Deterrent Devices -ADDs).

For many marine organisms, including most mammals, many fish, and perhaps even some invertebrates, sound is important for communicating, locating mates, searching

for prey, avoiding predators and hazards, and for short- and long-range navigation. Anthropogenic sound emitted into the marine environment can potentially affect marine organisms in various ways. It can mask biologically relevant signals; it can lead to a variety of behavioural reactions; hearing organs can be affected in the form of hearing loss, and at very high levels, sound can injure or even kill marine life.

Underwater noise is a growing concern in the Mediterranean as a result of increasing maritime activities. The western Mediterranean, in particular, is one of the busiest regions. There is currently very little information available on the effects of marine noise in the Mediterranean, despite the fact that there is a great need for these data.
The ecological objective and the operational objective established by MAP for this descriptor are presented in the following table:

DESCRIPTOR 11: Underwater noise	
ECOLOGICAL OBJECTIVE	**OPERATIONAL OBJECTIVE**
Noise from human activities cause no significant impact on marine and coastal ecosystems	11.1. Energy inputs into the marine environment, especially noise from human activities is minimized

2. THE CONCEPT: LINKING THE ECOSYSTEM APPROACH TO CONSUMPTION AND PRODUCTION MODELS

2.1 Linking lifestyle and consumption options to the environmental state of marine ecosystems

The previous section provided a brief description and assessment of the environmental status of Mediterranean marine ecosystems. It also listed the established environmental objectives to be achieved in the Mediterranean within the framework of the implementation of the Ecosystem Approach in the MAP.

This section aims to formulate the relations between, on one hand, the environmental status of marine ecosystems; and, on the other, the consumption and production patterns (see Fig. 6), in order to identify the contribution and potential applications of the Sustainable Consumption and Production Approach in the achievement of the established ecological and operational objectives.

For this purpose, the Drivers-Pressures-State-Impact-Response (DPSIR) framework outlined below has been applied. It will help trace the relations between consumption and production patterns, and the environmental status of ecosystems, as well as the introduction of complementary and emerging concepts such as the ecosystem services and societal benefits.

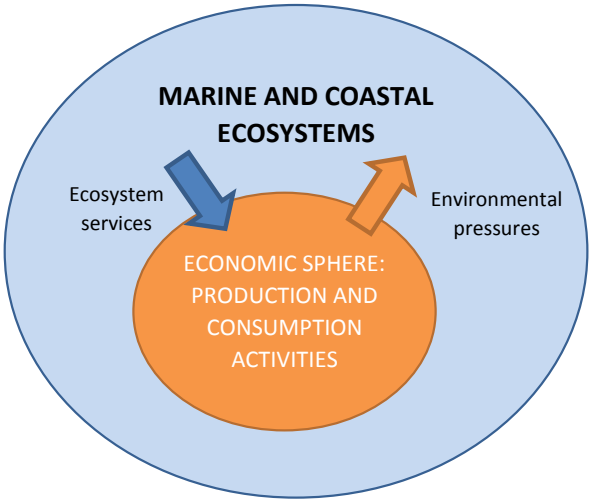

Fig. 6 Consumption patterns, consumption activities and marine ecosystems

2.2 The DPSIR framework

The DPSIR framework, adopted by the European Environmental Agency and others, is a causal framework permitting the assessment of the causes, consequences and responses to environmental change.

The DPSIR is based on the systematic identification of the relations between human activities and the environment, taking into consideration human demands functioning as *Drivers* that create *Pressures* on the environment, causing change on the environmental *State* that have an *Impact* on ecosystem health and human welfare. Finally, these impacts and changes are faced through the development of appropriate *Responses.*

Therefore, the DPSIR framework is a tool that helps organise the information we have in relation to the environmental change of a specific ecosystem, thus facilitating analysis and evaluation.

Table 3 shows the definition of each of the components of the DPSIR framework and provides an example to illustrate it. It should be pointed out that the boundary and definitions of the individual elements of the DPSIR are not entirely clear and have been interpreted slightly differently in different contexts. Here we use the interpretations used by Atkins *et al.* (2010) where "impacts" refers only to effects on human welfare. In this case, the effects on the health of ecosystems are excluded from the "impact" category; these effects are included in the State change components.

COMPONENT	DEFINITION	EXAMPLES
Drivers (D)	Human activities	Agriculture production to satisfy food demands
Pressures (P)	Mechanisms by which drivers contribute to a change in state	Use of fertilisers that cause phosphorous and nitrogen loading
State changes (S)	State variables are attribute(s) reflecting ecosystem integrity of a specific use	Increments in the concentration of phosphorous that provokes eutrophication
Impact (I)	Effect on human welfare attributable to change in state	Loss of water quality for recreational activities
Response (R)	Initiatives intended to reduce impact	Techniques for optimising the use of fertilisers

Table 3 Components of the DPSIR framework and examples

An initial conception of the DPSIR framework can be illustrated (see Fig.7) with a single cycle with linear interactions of the 5 components mentioned above, which could be associated with a specific issue (for example: fisheries). It would include the feedback of *Responses* to *Drivers* and *Pressures* (mitigation) and State Change (compensation and adaptation).

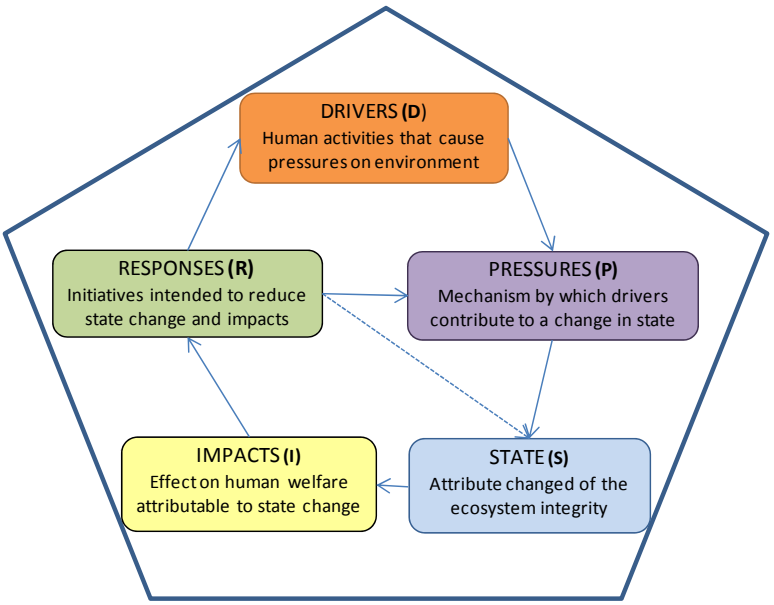

Fig. 7 The DPSIR framework

The proper use of the DPSIR requires the defining of a **boundary of the system** it describes. This boundary will depend on the issue we face. In our case, this issue will be the Mediterranean ecosystem as a whole, with its specific boundary defined by the ecological objectives established in the framework of the MAP ecosystem approach roadmap.

The operational definition of the boundary frequently presents significant challenges, since part of the DPSIR chain may be outside the ecosystem. A particular consideration of the transboundary interactions is then necessary in order to gain a global understanding of the key processes taking place.

Along these lines, in relation with the pressures, we can distinguish between endogenic managed pressures and exogenic unmanaged ones (Elliot, 2010). The latter refer to those for which our local management cannot address the causes of change, but only the consequences. In our case, for instance, climate change can affect the Mediterranean system, but it is not possible for the Mediterranean stakeholders to tackle the causes of the climate change single-handedly, since these causes depend largely on external global drivers.

On the other hand, we also must consider the existence of socioeconomic drivers inside the boundaries of our system that cause pressures outside. For instance, the demand for fish by Mediterranean societies can be delivered by fisheries in other seas, causing pressures on other marine ecosystems. However, the demand from non-Mediterranean societies for fish species extracted from the Mediterranean (e.g. tuna) is causing pressure on the Mediterranean marine ecosystem.

Therefore, **international trade has a great impact on the DPSIR analysis**, introducing relevant transboundary interactions between the Mediterranean economy and the rest of the world economy (see Fig. 8). These fluxes not only add more complexity to the DPSIR assessment, but can also affect the effectiveness of responses aimed at consumption patterns, since it is difficult to have a clear idea of where the consumed products are being produced.

The application of the DPSIR framework faces others challenges such as the **interactions between different components of the same nature** (for instance: interactions between different drivers, different states, etc.). The inclusion of this new category of interactions allows for a more complex model that is closer to the real processes that are occurring (see Fig. 8). We do not simply have a sum of independent DPSIR cycles, but rather a system of overlapping DPSIR cycles.

In the case of interactions between socioeconomic drivers, we can illustrate the phenomenon with the example of fisheries. An increase in fish consumption requires greater fishing efforts. However, the scarcity of stock can then cause a growth in mariculture activity, increasing the intensity of the mariculture.

In the case of the interactions between states, we can mention the change in key nutrient concentrations (N, P) in the water column (indicator 5.1.1 of ecological objectives for the Mediterranean), which is an effect of nutrient loading pressure, but at the same time, a cause of the state of toxic algal blooms (indicator 5.2.3) and water transparency (indicator 5.2.2).

In next few chapters, each of the DPSIR elements will be described and discussed, except for the *Impact* element (defined only as effects on human welfare attributable to a change in state), which is not particularly relevant within the context of this report.

Impacts on human welfare considered within the DPSIR framework could be associated with the reduction (or increase) in ecosystem services due to a negative (or positive) change in the State of the Ecosystem (see the Table 1 in Chapter 1).

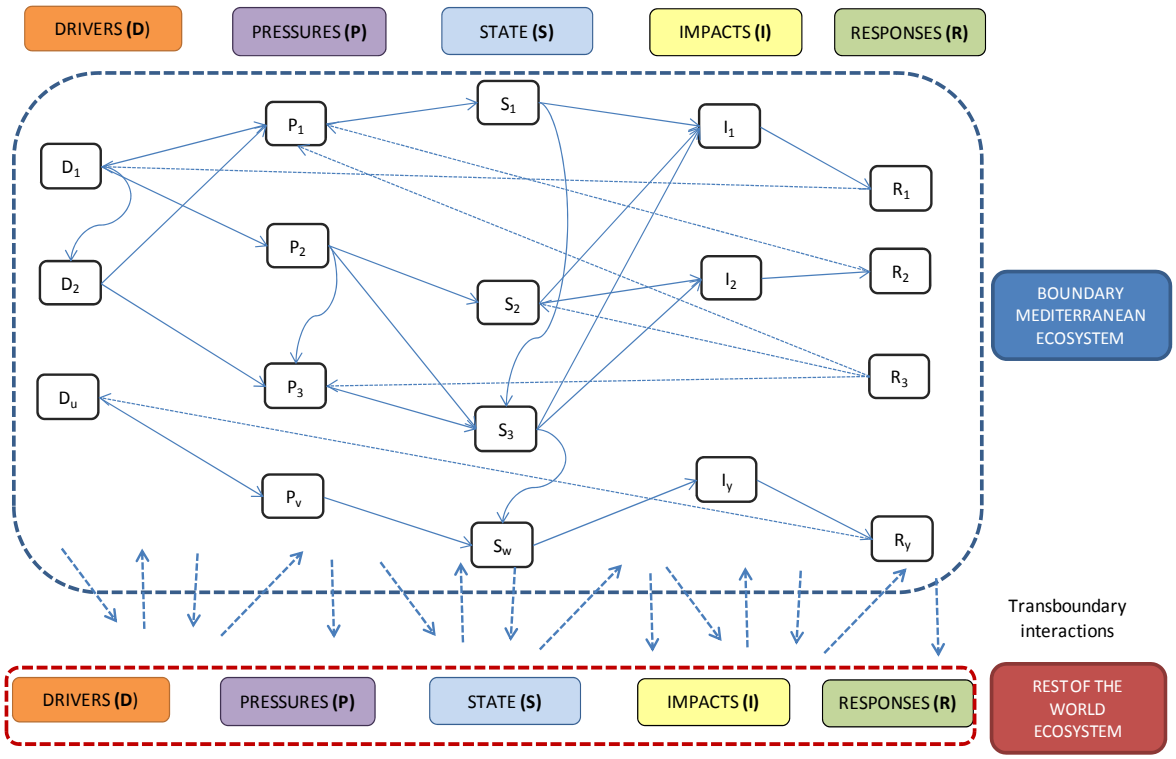

Fig. 8 Relations between drivers, pressures, state, impact and response in the DPSIR framework

2.3 State of the marine ecosystem: ecological and operational objectives

The ecological and operational objectives established in the Ecosystem Approach roadmap for the Mediterranean ecosystem cover the key and principal variables of the *State* of the Mediterranean ecosystem.

Thus, in order to apply the DPSIR framework in the Mediterranean we shall associate the State Changes to the operational objectives directly. This approach will permit us to identify the link of the ecological objectives directly upstream to consumption and production activities and their socioeconomic drivers. Fig. 9 illustrates the DPSIR cycles by considering the state variable for each cycle related directly to the MAP ecological and operational objectives.

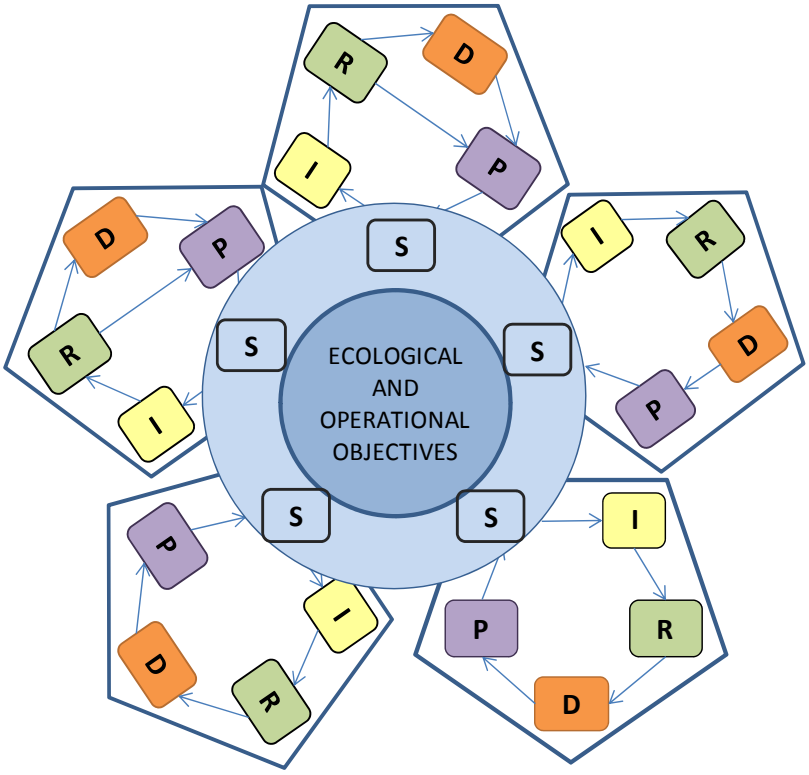

Fig. 9 Ecological and operational objectives in the DPSIR framework
Source: Modified and adapted from Atkins, J.P. et al., 2011

However, if we analyse the operational objectives in depth in terms of the DPSIR framework, we find that the objectives are not only stated as an environmental State but also include objectives that relate to a pressure or a pressure and state combination. Examples of these are provided below:

-	**Pressure variable** (e.g. *3.1.: Level of exploitation by commercial fisheries*)
-	**A Pressure variable combined with a State variable** (e.g. *5.1 Human introduction in nutrients into the marine environment is not conducive to eutrophication*)
-	**State variable** (e.g. 1.1 Species distribution is maintained)

Only two operational objectives that could be classified as pure pressure variables in the DPSIR framework have been identified.

In the case of the second category, for operational needs and the characteristics of the Ecosystem Approach, we have opted to emphasise the character of the State of the objective in relation to the character of the Pressure.

Table 4 lists all the ecological and operational objectives, and their classification in terms of the categories of variables included in the DPSIR framework.

ECOLOGICAL OBJECTIVES DESCRIPTORS	OPERATIONAL OBJECTIVES
1. Biological diversity	1.1. Species distribution is maintained 1.2. Population size of selected species is maintained 1.3. Population condition of selected species is maintained 1.4. Key coastal and marine habitats are not being lost
2. Non-indigenous species	2.1. Invasive non-indigenous species introductions are minimized 2.2. The impact of non-indigenous particularly invasive species on ecosystems is limited
3. Harvest of commercially-exploited fish and shellfish	3.1. Level of exploitation by commercial fisheries is within biologically safe limits 3.2. The reproductive capacity of stocks is maintained
4. Marine food webs	4.1. Ecosystem dynamics across all trophic levels are maintained at levels capable of ensuring long -term abundance of the species and the retention of their full reproductive capacity 4.2. Normal proportion and abundances of selected species at all trophic levels of the food web are maintained
5. Eutrophication	5.1. Human introduction of nutrients in the marine environment is not conducive to eutrophication 5.2. Direct effects of nutrient over-enrichment are prevented 5.3. Indirect effects of nutrient over- enrichment are prevented
6. Sea-floor integrity	6.1. Extent of physical alteration to the substrate is minimized 6.2. Impact of benthic disturbance in priority benthic habitats is minimized
7. Hydrography	7.1. Impacts to the marine and coastal ecosystem induced by climate variability and/or climate change are minimized 7.2. Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor-anchored structures are minimized 7.3. Impacts of alterations due to changes in freshwater flow from watersheds, seawater inundation and coastal freatic intrusion, brine input from desalination plants and seawater intake and outlet are minimized
8. Coastal ecosystems and landscapes	8.1. The natural dynamic nature of coastlines is respected and coastal areas are in good condition 8.2. Integrity and diversity of coastal ecosystems, landscapes and their geomorphology are preserved

ECOLOGICAL OBJECTIVES DESCRIPTORS	OPERATIONAL OBJECTIVES
9. Contaminants	9.1. Concentration of priority contaminants is kept within acceptable limits and does not increase
	9.2. Effects of released contaminants are minimized
	9.3. Acute pollution events are prevented and their impacts are minimized
	9.4. Levels of known harmful contaminants in major types of seafood do not exceed established standards
	9.5. Water quality in bathing waters and other recreational areas does not undermine human health
10. Marine and coastal litter	10.1. The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized
	10.2. Impacts of litter on marine life are controlled to the maximum extent practicable
11. Underwater noise	11.1. Energy inputs into the marine environment, especially noise from human activities is minimized

Pressure variable	*State* variable combined with *Pressure* incidence to other *State* variables	*State* variable

Table 4 Ecological and operational objectives

2.4 Drivers and pressures: lifestyles, consumption and production

Drivers of social and economic development refer to the need for food, recreation, living space and other human demands (Gray and Elliot, 2009), which are delivered through fisheries, recreational sites, urbanised areas, industrial activities, agriculture and livestock, bioremediation of waste, and so forth.

Therefore, the initial point in the DPSIR chain is the consumption activities made by members of human societies, depending on their lifestyle and consumption choices, within the constraints of their wealth, available technology and the legal system.

The consumers' demand is satisfied by production activities (e.g. agriculture, industry, tourism,), which cause environmental pressures (e.g. pollution loading). In some cases, the consumption activities themselves can generate environmental pressures directly (e.g. fish take from recreational fishing, emissions from private cars and boats, littering of beaches, etc.).

As described by the DPSIR framework, environmental *Pressures* cause a change of *State*, and human societies can introduce a *Response* to tackle a change in state, or alternatively to reduce pressures or influence the drivers of these pressures. The latter types of responses – those focused on the drivers of pressures and also some of the responses focused on reducing pressures - lie within the policy area of Sustainable Consumption and Production (see Fig. 10).

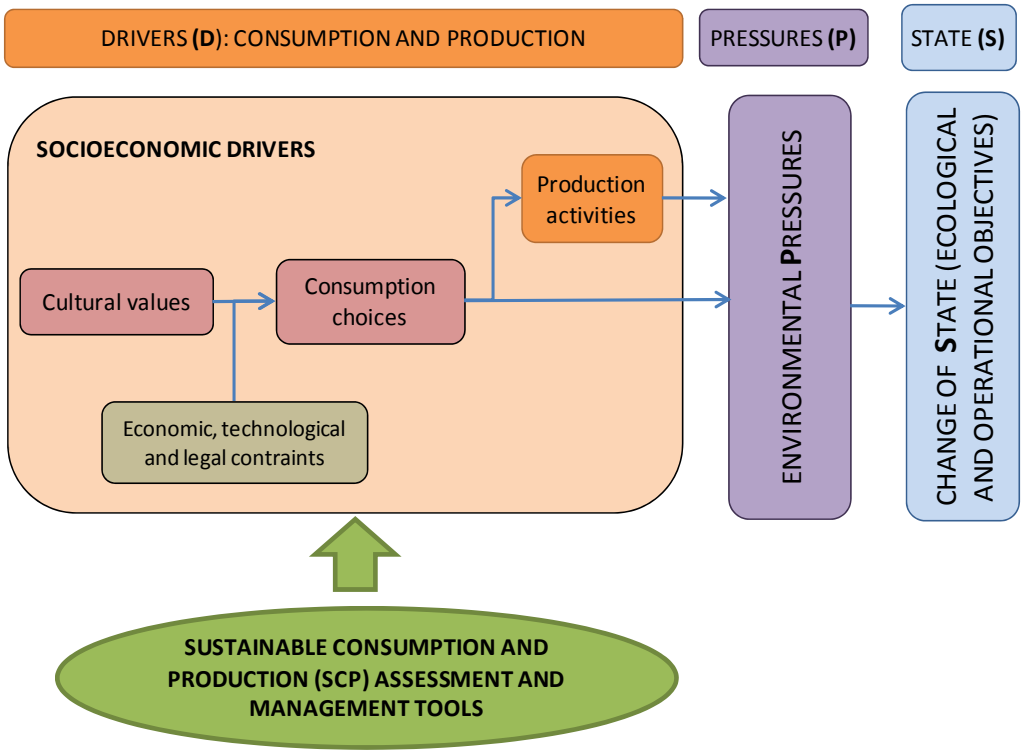

Fig. 10 Relation between consumption options, production and pressures on marine ecosystems
Source: Langmead, O., MacQuatter-Gollop, A. and Mee, L.D. (2007)

Fig. 11 presents an example of a simplified chain of relations between consumption and production activities, between production activities, and finally between production activities, environmental *Pressure* and change of *State* of the Marine Ecosystems. In brief, it shows a specific example of the footprint of a consumption activity within the Mediterranean ecosystem. The example is given for the consumption of animal protein (meat and fish).

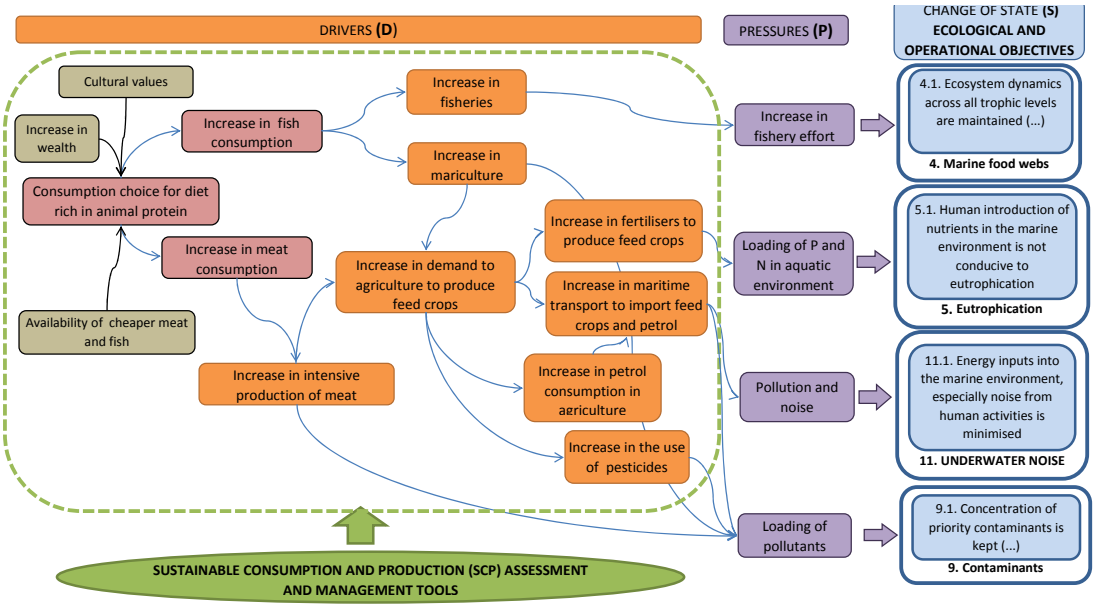

Fig. 11 Example of the relation between consumption options and pressures on marine ecosystems

The previous Fig. 11 shows the complexity of the relations inside the socioeconomic drivers related to the consumption of animal protein. In this context, we can distinguish the following drivers:

- Consumption demand (e.g. meat consumption)
- Production activities (e.g. livestock) to satisfy the citizens' demand for goods or services
- Production of other activities (e.g. agriculture or maritime transport) required as an intermediate demand for the production of final goods or services.

These complex relations reveal the existence of a lifecycle of the goods and services consumed by human societies, which establishes a complex supply chain with different stages (e.g. meat consumption requires livestock production, livestock production requires the agricultural production of feed crops, agricultural production requires the extraction and refining of petrol, and petrol activities require international maritime transport). The supply chain can include production activities located in the very country or region that is meeting local consumption demand. However, production activities can also be located outside of the country or region from which the goods (final or intermediate) are imported. Similarly, the production of goods (including fishing activities) in the Mediterranean region can be driven by consumption demand in the rest of the world.

Each stage of the supply chain located in the Mediterranean region can put *Pressure* on the marine ecosystem. *Pressure* on the marine ecosystem caused by each unit of

consumption of a product or service should take into consideration this complex chain where consumption demand comes both from the Mediterranean region and also the rest of the world (ROW). This diagram broadly identifies how the *Pressure* on the marine ecosystem, and its consequences for the achievement of the ecological objectives associated with the *State*, can be linked to consumption and production models.

The Sustainable Consumption and Production (SCP) approach focuses on the assessment of these complex interactions between consumption demand and production activities, and also between consumption-production and the *Pressure*. Knowledge of these interactions can help define more accurate and effective policies.

The SCP approach also includes policies and management tools aimed at reducing the *Pressure*, at both consumption and production levels.

Therefore, in terms of the DPSIR framework, the SCP applies to the DPR elements, covering the mechanisms taking place in the economy plus pressures crossing the membrane between the economy and the environment (in this case the Mediterranean), but not what happens in the environment.

In later chapters the SCP approach and tools are discussed in more detail.

2.5 Responses: Linking consumption and production and ecological objectives for the Mediterranean

The responses can make an impact at different levels of the DPSIR framework: especially in the modification of *Drivers* (e.g. change of consumption patterns) and in the mitigation of *Pressure* (e.g. wastewater treatment), but also in the compensation of a *State* (e.g. bioremediation of polluted areas) and *Impact* (e.g. promotion of diversification and new markets for economic activities that compensate for the reduction of fishing due to excessive pressure in fisheries).

The SCP consists of a specific typology of *Response,* which provides a specific subset of tools focused both on different components of the socioeconomic *Drivers* and also on the mitigation of *Pressure*.

The SCP responses include only those that operate within the economy on economic processes – either aimed at drivers or pressure – but not aimed at the consequences of pressure once released into environment. This limits their power with respect to dealing with location-specific impacts in an ecosystem. On the other hand, it provides opportunities for additional leverage points beyond the traditional ecosystem management/end-of-pipe solutions.

The SCP tools introduce a more global and systemic view to the process, trying to make an impact on the whole production supply chain, and also on the most upstream drivers, such as the population's consumption patterns.

In any case, the SCP tools are complementary to the most traditional ones. Depending on the environmental issue we are faced with, SCP contribute significantly to the responses given, or on the contrary, it can be very of little relevance and unviable.

In subsequent chapters, these tools are presented and described in detail.

Fig. 12 shows in summary the conceptual relation between the SCP potential Responses and the Ecosystem Approach in the Mediterranean Ecosystem by using the DPSIR framework, including the main aspects introduced previously.

On one hand, the SCP tools are a subset of all the potential Responses, and on the other hand, the ecological objectives of MAP Ecosystem Approach roadmap are mostly variables of the State of the Mediterranean marine and coastal ecosystem.

Transboundary interactions are those that take place between the Mediterranean economy and its ecosystem and the rest of the world's economy and ecosystem. As mentioned earlier, these interactions take place at each step of the DPSIR components (Drivers-Pressures-State-Impact-Response).

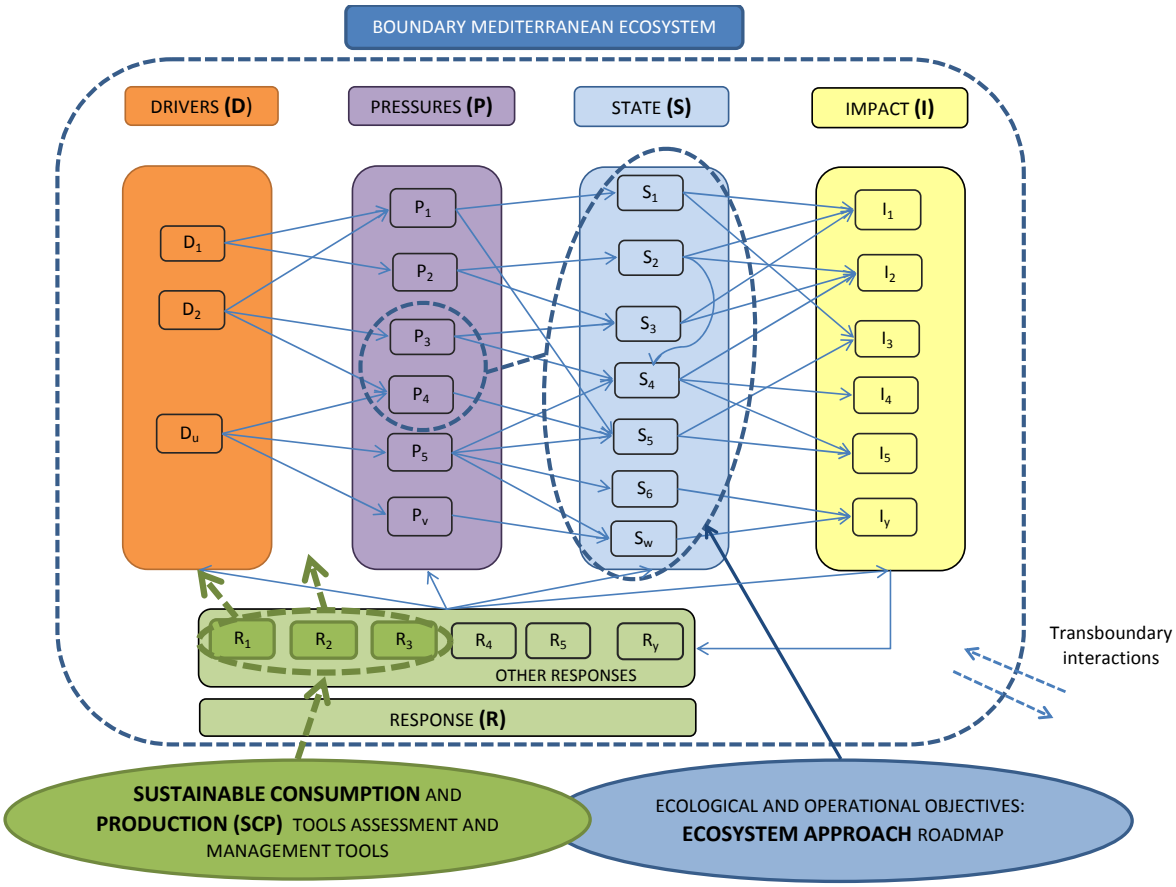

Fig. 12 Conceptual relations between SCP and Ecosystem Approach using the DPSIR framework

3. MAPPING LINKS BETWEEN HUMAN ACTIVITIES AND THE ECOLOGICAL OBJECTIVES

In this chapter, the key relations between the human activities (Drivers), the Pressure and the State have been mapped out in detail within the context of the Mediterranean ecosystem.

For this exercise, the DPSIR framework introduced in the previous chapter has been applied, focusing on the identification of the next key categories of relations: (1) Between Drivers and Pressure; and (2) between Pressure and State.

In order to facilitate the mapping of DPSIR relations, the following human activities have been identified as key drivers of environmental impacts in the Mediterranean:

- Urbanisation
- Fisheries and mariculture
- Extraction of non-living resources
- Placement of infrastructures
- Maritime transport
- Tourism and recreational activities
- Discharge from land-based sources and activities
- Dumping of waste

In some cases these human activity categories are equivalent to production activities (Fisheries and Mariculture, Maritime transport and Tourism).

For each human activity, consumption demand-related upstream drivers, and specific production-related downstream drivers respectively, have been identified and their relations with human activity have been established.

Fig. 13 provides a schematic overview of these relationships, which is subsequently filled in with specific drivers, pressures and state changes for each type of human activity in Figures 14–22.

Also Pressure and the manners through which a pressure acts upon a marine environment State have been prioritised. On the other hand, as previously discussed, ecological and operational objectives have been developed within the Ecosystem Approach under the following broad descriptors:

1. Biological diversity
2. Non-indigenous species
3. Harvest of commercially exploited fish and shellfish
4. Marine food webs
5. Eutrophication
6. Sea-floor integrity
7. Hydrography
8. Coastal ecosystems and landscapes
9. Contaminants
10. Marine and coastal litter
11. Underwater noise

State variables have also been prioritised according to the influence of the corresponding Pressure. As identified in Chapter 2, while some of the environmental objectives of the Ecosystem Approach can be directly interpreted as States within the DPSIR framework, others can be identified as pressures or pressure/state pairs. Environmental objectives have been placed in the schematic diagrams for each human activity, according to whether they represent a State, a Pressure or a Pressure/State pair.

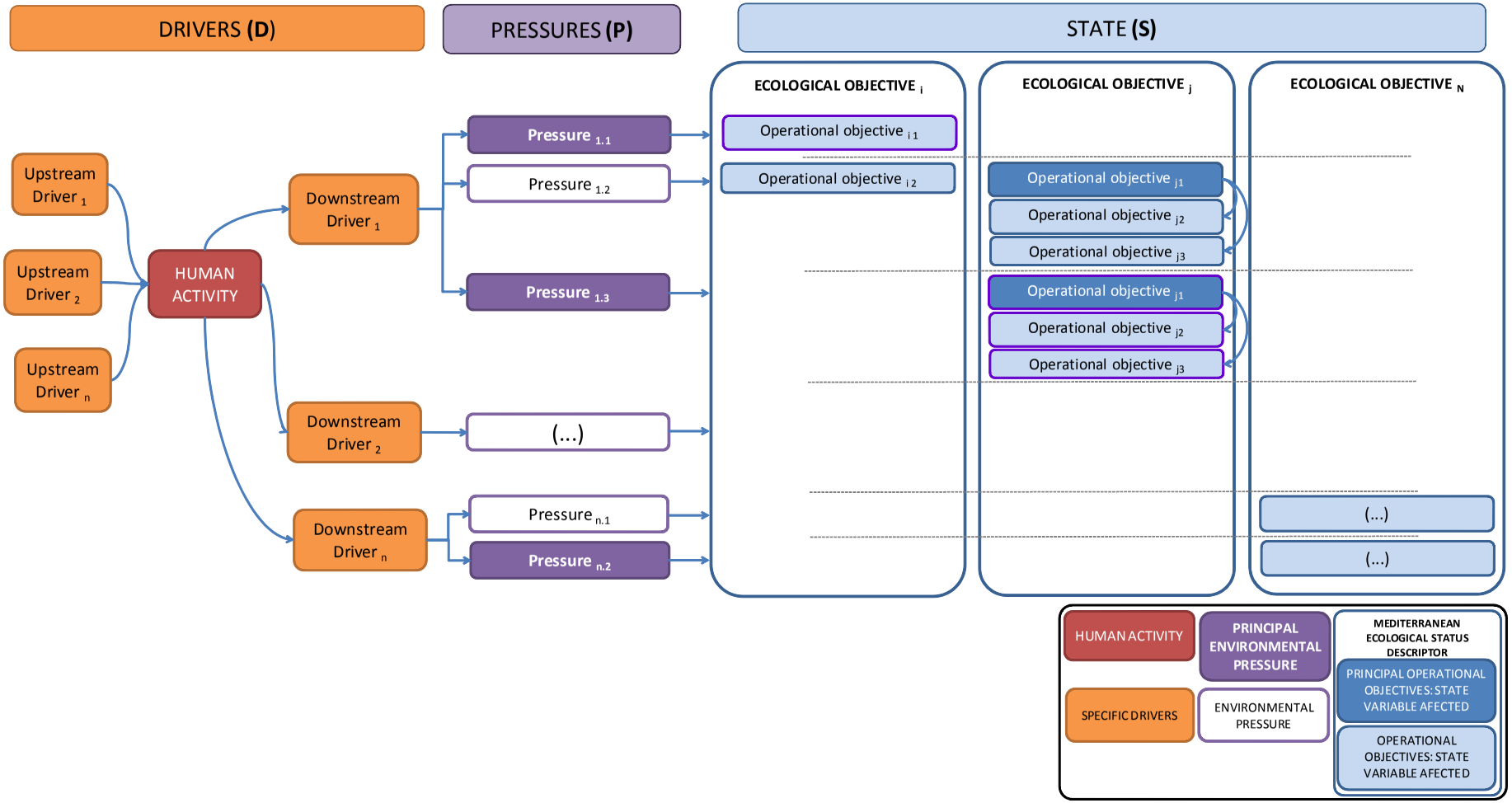

Fig. 13 Detail of the relations between Drivers, Pressures and State

The following key MAP documents have been used to identify the key drivers and pressures described for each human activity in this chapter:

- Initial Integrated Assessment of the Mediterranean Sea: Fulfilling step 3 of the Ecosystem Approach process (UNEP/MAP, 2011)
- State of the environment and development in the Mediterranean (UNEP/MAP, 2009)
- The changing faces of Europe's coastal areas (EEA, 2006)
- Priority issues in the Mediterranean environment (UNEP/EEA, 2006)
- Transboundary diagnostic analysis for the Mediterranean Sea (UNEP/MAP/MED POL, 2005)
- State and pressures of the marine and coastal Mediterranean environment (UNEP/EEA, 1999)

3.1 Urbanisation

Mediterranean coastal areas have always been attractive sites for development and as tourist destinations. Accordingly, the population of the Mediterranean coastal countries is increasingly occupying the coastal zone. In 2008, the Mediterranean coastal states had a permanent population of around 460 million (projected to reach 520 million by 2025) 150 million of which lived on more than 46,000 kilometres of coastline. The projections for the coastal regions estimate approximately 186 million by 2025 (UNEP/MAP-PLAN BLEU, 2009).

Another effect of development in Mediterranean coastal areas is the increase of the urbanisation rate, which was 62% in 1995, forecast to grow to 72% by 2025. However, the urbanisation rate in the north is only expected to increase from 67% to 69%, while in the south it is expected to rise from 62% to 74% (UNEP/MAP-PLAN BLEU, 2009). Increasing demand for living space per capita is partly due to demographic changes (e.g. in European countries an increased number of people living alone, higher divorce rates, etc.) forcing growth in construction.

This urbanisation rate grows at a faster rate than urban population, which leads to a serious problem of urban sprawl in coastal areas. However, the biggest problem with the continued growth in the population and the infrastructure is the linear nature of coastal urbanisation, resulting in nearly 40% of the total length of the coastal area already being occupied.

The growth in the coastal population increases demand for domestic water, food, energy and construction material, causes atmospheric pollution[5], and creates problems in relation to the treatment and disposal of solid waste and effluent.

On the other hand, residential development and the construction of infrastructures (transport, water and electricity supplies, waste and water treatment facilities, etc.) lead to the occupation of land and sea, land reclamation, the alteration of the coastal landscape, the alteration of local hydrodynamics and coastal erosion, and reduce the space for natural ecosystems and their biodiversity.

Therefore, as outlined above, urbanisation in the Mediterranean has a direct impact on the following ecological status descriptors:

[5] The analysis of this pressure goes beyond the scope of this project.

1. Biological diversity
3. Harvest of commercially exploited fish and shellfish
4. Marine food webs
5. Eutrophication
6. Sea-floor integrity
7. Hydrography
8. Coastal ecosystems and landscapes
9. Contaminants
10. Marine and coastal litter

In Fig. 14 all these relations between urbanisation activity and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

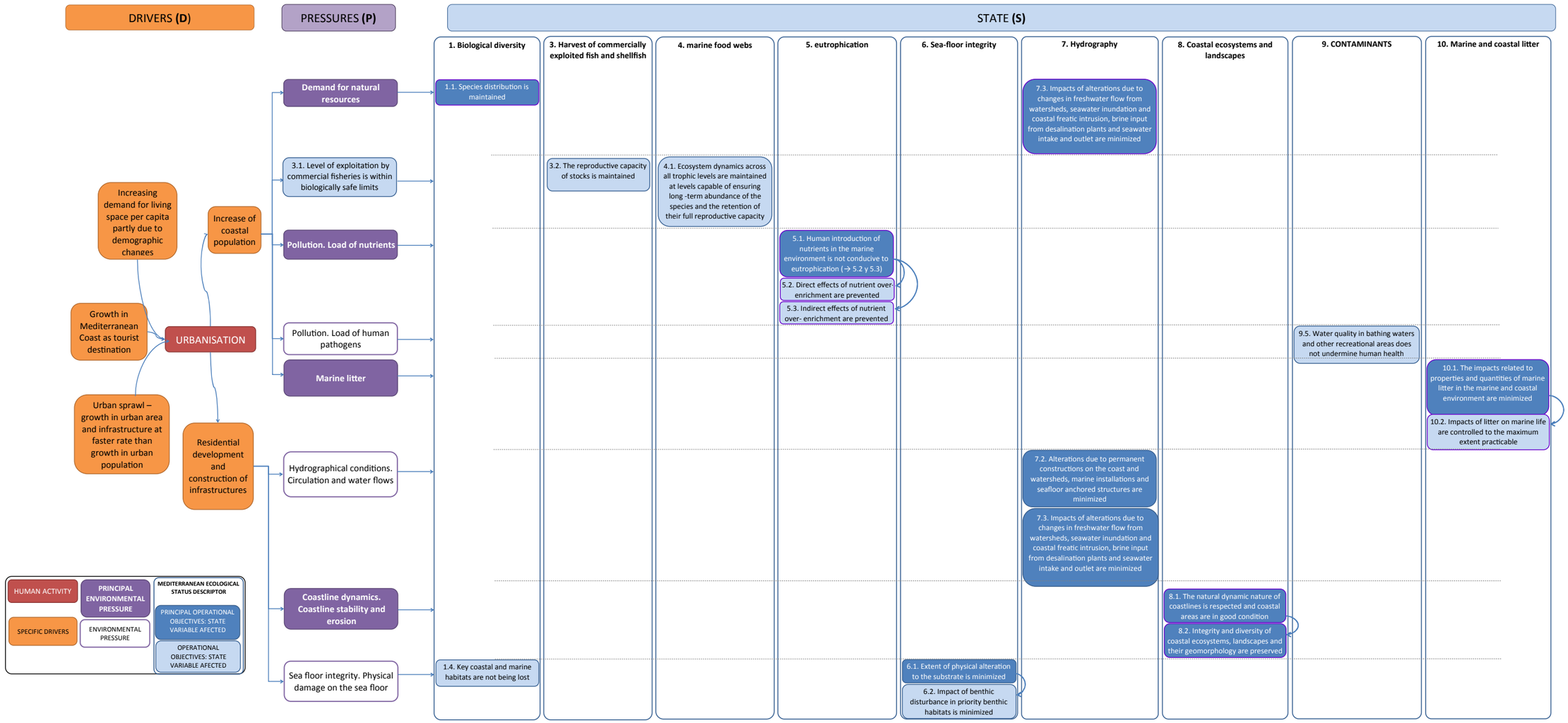

Fig. 14. Map of the key relations between drivers-pressure-state: Urbanisation

3.2 Fisheries and Mariculture

Fisheries

Although Mediterranean fish catches represent a small part of total catches worldwide (a little over 1% of the total catches), they are significant given that the Mediterranean Sea represents less than 0.8% of the global oceans. Moreover, fishing in the Mediterranean tends to be concentrated in coastal areas on the continental shelf. Production currently ranges between 1,500,000 t to 1,700,000 t per year, and 85% is attributable to six countries (Italy, Turkey, Greece, Spain, Tunisia and Algeria) (UNEP/MAP-PLAN BLEU, 2009).

Fishing has increased by about 12% in the past decade, with high exploitation of both bottom-living (demersal) and large pelagic stocks, which is however more intense in the northern Mediterranean. Over-exploitation in the northern Mediterranean has led to a serious decline in the red coral *Corallium rubrum*, the date mussel *Lithophaga lithophaga* and many other invertebrates (UNEP/MAP/MED POL, 2004).

According to the General Fisheries Commission for the Mediterranean, certain species of economic and commercial importance are in an alarming state as a result of over-fishing. Such is the case for hake *Merluccius merluccius*, red mullet *Mullus barbatus*, the deep water rose shrimp *Parapenaeus longirostris* (from the north of the Alboran Sea, the Balearic islands, northern Spain, the Gulf of Lion, the Ligurian Sea and southern Sicily), sole *Solea solea* (from the northern Adriatic), sardine *Sardina pilchardus* and anchovy *Engraulis encrasicholus* (from the north of the Alboran Sea, northern Spain, the Gulf of Lion, southern Sicily and the northern Adriatic). The situation is also of major concern with regard to the Atlantic bluefin tuna (*Thunnus thynnus*), which is widely over-fished in the Mediterranean and the Eastern Atlantic.

Various factors could have led to this increase. Although the Mediterranean diet has traditionally been high in fish, in recent times there has been a growth in health awareness leading to an increase in fish consumption. On the other hand, the large amount of food wasted between factory and fork makes it necessary to increase catches to meet the fish demands. However, along with over-fishing there is a lack of consumer awareness and information on which species of fish are fished sustainably i.e. within biological limits.

The increase in fishing has been conducted by increasing the fishing effort. This has led to reductions in population sizes and shifts in the population structure of target species.

Regarding fishing gears used, non-selective gears have an impact on marine ecosystems, causing incidental catches (by-catch) of non-target species, also including birds, marine mammals and discarded fish. The bottom trawling gear causes physical disturbance of the sea bottom and therefore an adverse effect on benthic habitats and communities,

while, “ghost fishing” -when discarded fishing gear continues to catch fish and other animals– is not only a threat to fisheries and other marine species but instead is also a danger to passing boats if it becomes entangled in their propellers or in their own fishing gear.

Finally, illegal, unregulated and unreported fishing (IUU) has become a common practice, which alters fish populations and destroys sensitive habitats.

Mariculture

Mediterranean fishing no longer satisfies demand in the riparian states (1/3 of demand) (UNEP/MAP-PLAN BLEU, 2009). In order to satisfy the demand for fish and seafood products, Mediterranean countries have long resorted to breeding aquatic organisms. Aquaculture in the Mediterranean represents about 5% of the total world production (UNEP/MAP/MED POL, 2004).

Aquaculture has been the world’s fastest growing food production system for the past decade, particularly for gilthead sea bream *Sparus aurata*, sea bass *Dicentrarchus labrax*, the Mediterranean mussel *Mytilus galloprovincialis* and the Pacific cupped oyster *Crassostrea gigas*. Half of this growth was actually achieved in different types of marine farming (mainly in floating cages for fattening bass, bream and Atlantic bluefin tuna and on lines for mussels) from 1996 to 2000, followed by fish farming in brackish waters (particularly in Egypt for tilapia, genus *Oreochromis*). 58% of production comes from the western European countries, although Greece is the leading marine offshore fish-farming producer with over 120,000 tonnes of bass and bream annually. As for bivalve mollusc farming, mussels and cupped oysters take first and second place respectively, with a joint annual production of some 500,000 tonnes for Spain and France (UNEP/MAP-PLAN BLEU, 2009).

Although mariculture relieves the pressure on natural stocks, the development of this activity has degraded the quality of the marine environment and habitats in the Mediterranean in different ways: mariculture facilities alter coastal landscapes and, in some cases, involve the occupation of protected areas such as salt marshes; the release of metabolic waste products (faecal and excretory materials) and uneaten food into the marine environment causes nutrients and organic matter enrichment, degradation of the sea-floor and consequently disturbances to benthic communities; and the chemicals used in coastal mariculture (those associated with structural materials, soil and water treatments, antibacterial agents, disinfectants, pesticides, feed additives, anaesthetics and hormones) affect the natural invertebrates and fish populations.

On the other hand, mariculture supposes the introduction of non-indigenous species through the harvest of non-indigenous species and through the introduction of parasites of the target or non-target species, and some incidents derived from the activity, such

as escaped farmed fish, causing alteration of wild fish populations through these interactions.

Therefore, as stated above, fisheries and mariculture in the Mediterranean have a direct influence on the following ecological status descriptors:

1. Biological diversity
2. Non-indigenous species
3. Harvest of commercially exploited fish and shellfish
4. Marine food webs
5. Eutrophication
6. Sea-floor integrity
8. Coastal ecosystems and landscapes
9. Contaminants

In Fig. 15 and Fig. 16 all these relations between fisheries and mariculture activities and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

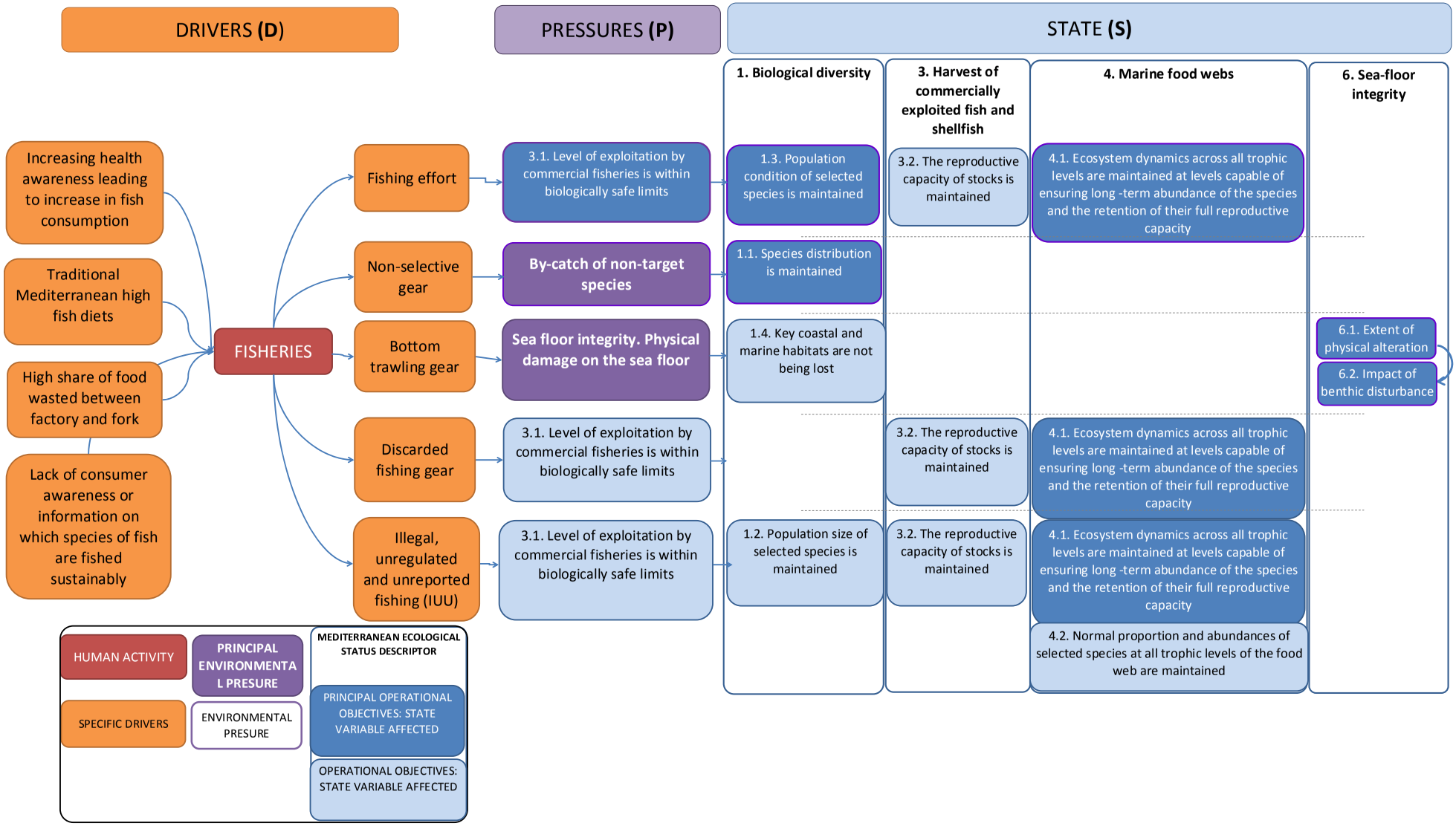

Fig. 15 Map of key relations between drivers-pressure-state: fisheries

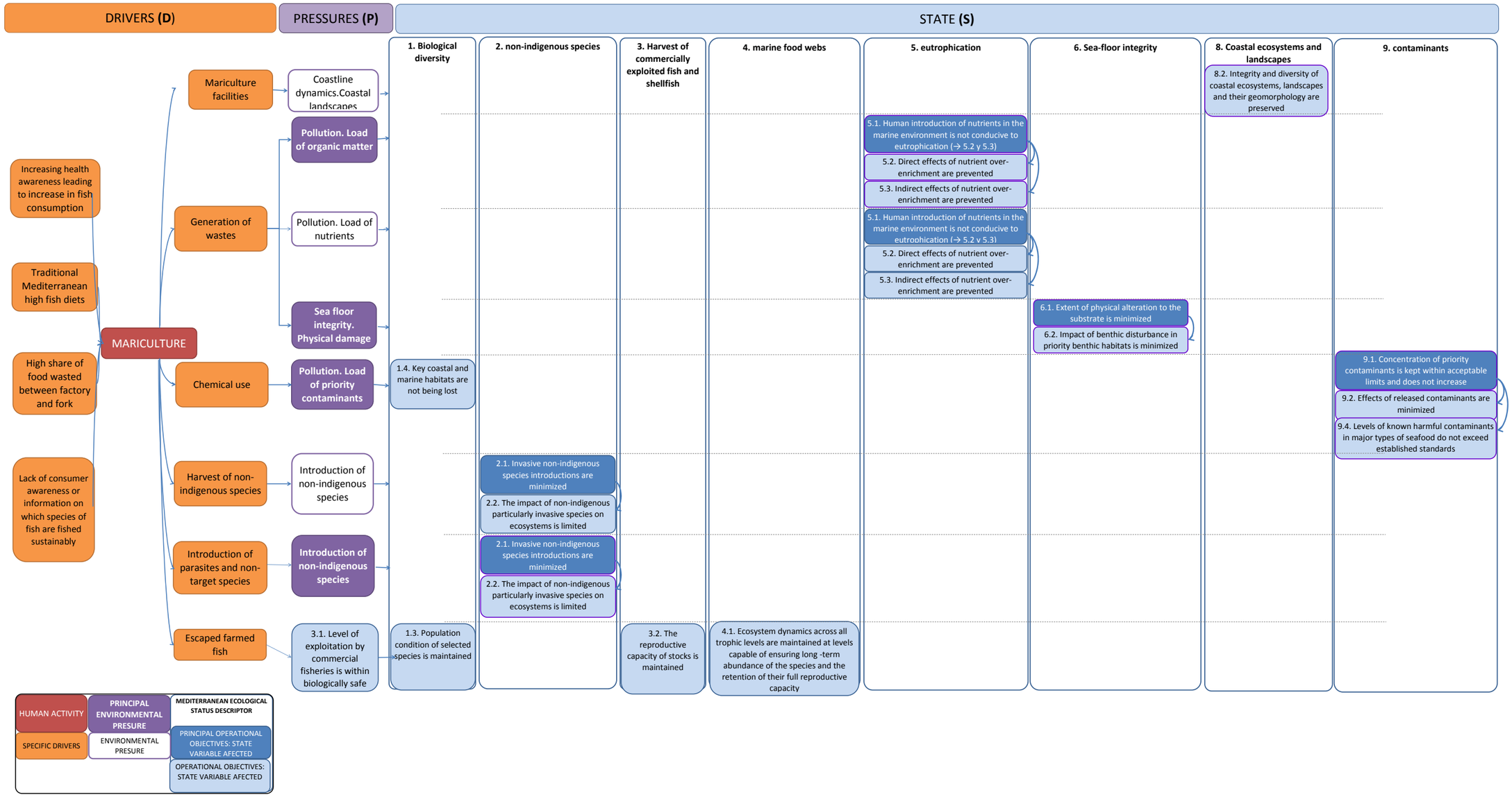

Fig. 16 Map of key relations between drivers-pressure-state: Mariculture

3.3 Extraction of non-living resources

The extraction of non-living resources involves marine mineral deposits and oil and gas extraction activities.

Marine mineral deposits are extracted from the seabed from licensed areas as a source of material for the construction industry, land reclamation or for beach nourishment. Growth in the construction industry –mainly due to rising demand for living space per capita and the urban sprawl- has increased the demand for aggregates in recent decades, although increasing recycling of demolition waste has partially reduced this demand. Moreover, the demand for marine sand and gravel is likely to increase in the next few years as a result of rises in the sea level.

Although gravel and sand (aggregates) are the main materials extracted, in some countries significant volumes of non-aggregate marine mineral resources such as maërl or shelly sands are also extracted. By its very nature, the dredging of aggregates is a shallow-water coastal activity.

Aggregate extraction implies the removal of substrate and any biota associated with it (benthic habitats and species). It causes changes to the nature and stability of sediments and disturbance of erosion and deposition rates. Moreover, during the extraction increases the turbidity and releases to the water column of substances bound in the sediment can occur, which alter water quality and associated ecosystems.

On the other hand, the Mediterranean Sea is an area in which the oil industry is highly active. Several important producers are located in the region. Offshore oil and gas reserves are located along the Adriatic coast of Italy and in the Greek Aegean, but the most important areas are offshore of Tunisia and Libya. Exploration is taking place off the coasts of Israel, Turkey and Morocco. In the early 1990s there were 116 offshore platforms in operation in the Mediterranean Sea. Nowadays, some 60 petrol refineries dump nearly 20,000 tonnes of petrol into the sea each year (UNEP/MAP website).

Increasing needs for oil and gas consumption are related to increasing car ownership and use and therefore increasing demand for transport fuels; household demand for gas for heating and cooking; and fuel switching from coal to gas power plants.

Oil and gas exploration activities previous to extraction activities produce marine noise that can affect marine organisms, and discharges of oil and other hazardous substances (e.g. benzene, phenols, benzoic acids, barium) that may cause damage to human health, ecosystems, habitats and biodiversity.

In addition to generating marine noise, oil and extraction activities also produce atmospheric emissions (mainly CO_2, NO_x, organic compounds and CH_4)[6] and cause physical damage to the seabed and benthic disturbance by the offshore platform itself and by the dumping of waste (cuttings).

Thus, as discussed above, the extraction of non-living resources in the Mediterranean has a direct impact on the following ecological status descriptors:

1. Biological diversity
6. Sea-floor integrity
8. Coastal ecosystems and landscapes
9. Contaminants
11. Underwater noise

In Fig. 17 all these relations between extraction of non-living resources activity and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap, are displayed in a graphical format.

[6] The analysis of this pressure goes beyond the scope of this project.

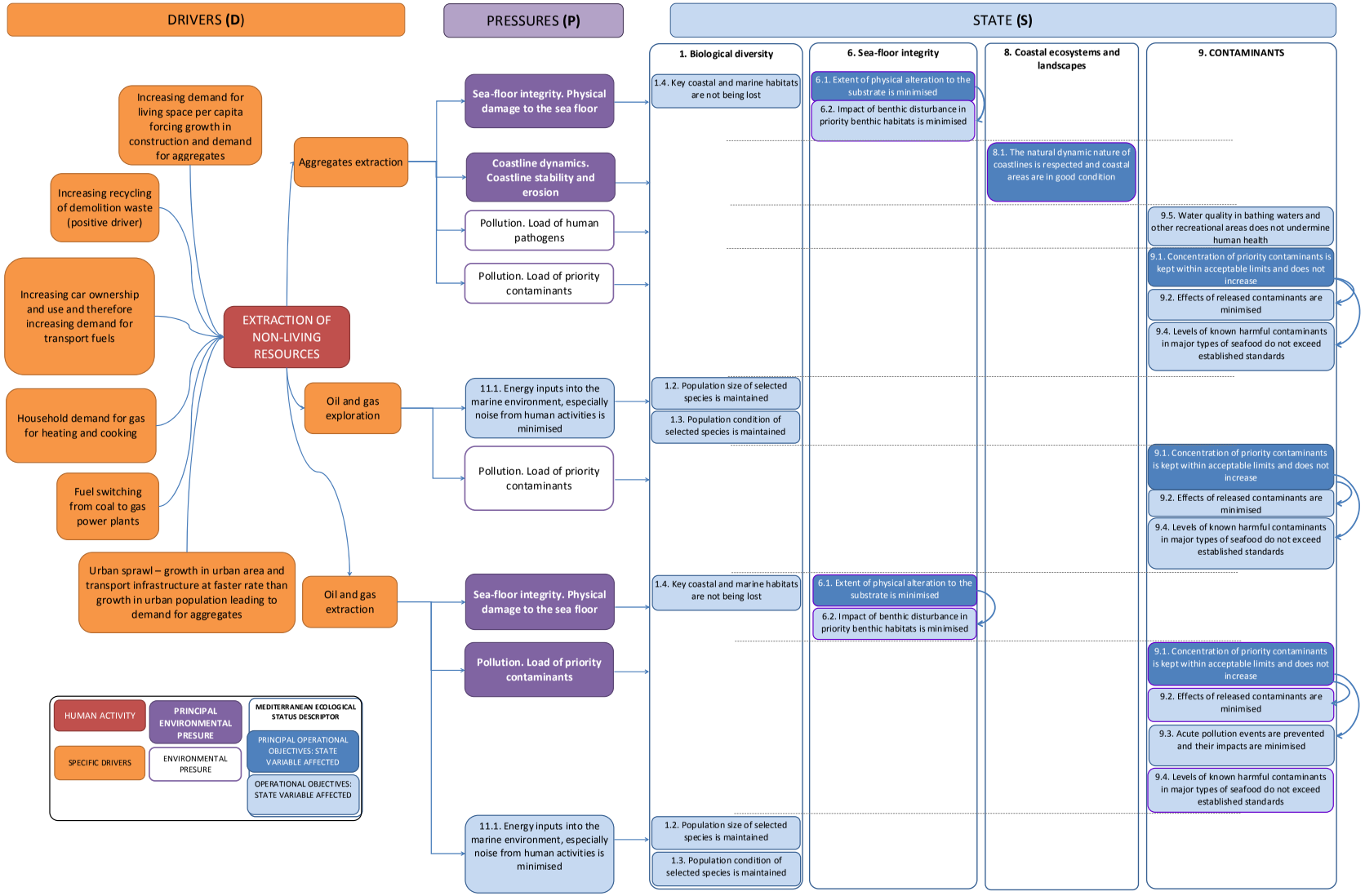

Fig. 17 Map of key relations between drivers-pressure-state: Extraction of non-living resources

3.4 Placement of infrastructures

The placement of infrastructures in the marine environment, both coastal and offshore, responds to different needs depending on the infrastructure concerned. Regarding consumption needs these are: increasing car ownership and use and therefore increasing demand for transport fuels and for transport infrastructure along coasts, household demand for gas for heating and cooking, fuel switching from coal to gas power plants and switching to renewable energies e.g. wind power.

These infrastructures include: sanitation infrastructures (submarine outfalls), communication and energy infrastructures (submarine cables and pipelines for oil and gas) and coastal defence structures.

The artificial infrastructures constitute a physical presence in the marine environment that involve the introduction of artificial hard substrate that attracts flora and fauna that may not be typical of the area, seabed habitats disturbance and imbalances in ecosystems.

The aim of submarine outfalls is to ensure that the wastewater, both urban and industrial, is discharged in the best practicable environmental manner. Despite their beneficial effects on the quality of the marine environment, submarine outfalls also produce negative effects such as physical structure introduced into the marine environment as outlined above. There are a high number of submarine outfalls placed along the Mediterranean coasts and the number has increased in recent times by the development of the seawater desalination industry.

Submarine cables are found throughout the Mediterranean region. These cables supply islands and offshore installations with electrical power or serve as transfer cables between the terrestrial grids of different countries. It is expected that the number of submarine telecommunication and power cables in particular will increase in coming years. In particular, the number of offshore wind farm transmission cables is predicted to grow rapidly due to the installation of offshore wind farms. This could intensify the potential environmental impacts resulting from submarine cables. Developments in the European energy market may also result in an increase in submarine electricity transfer cables.

Submarine cables, particularly power transmission lines, may have operational impacts in the form of electromagnetic fields and thermal radiation, which may induce changes in benthic communities and on migrating species (fish, marine mammals).

Submarine oil pipelines are related to offshore mining activities for oil and its transport to the land-based facilities for refining. Submarine gas pipelines are generally used for gas transportation, such as the trans-Mediterranean gas pipeline that connects Algeria

and Italy via Tunisia and the gas pipeline that links Algeria and Spain, which was put into operation in early 2011.

Finally, the need for coastal defence structures (flood defence and seawalls, scour protection, breakwaters, dykes, groynes, etc.) arises directly from the increasing coastal erosion that affects many coasts. The majority of these coastal erosion problems are induced by human activities.

Natural sediment discharges by rivers in the Mediterranean basin may be in the range of 1,000 million tonnes per year. Because of the massive construction of reservoirs, around 45% of these sediments might be retained behind dams or extracted from the riverbeds, for sand and gravel. Problems in sediment balance lead to coastal erosion that became one of the most important issues along the Mediterranean coast. Based on the results of the Eurosion Project (2005), approximately one fourth of the EU coastline suffers from erosion. In order to stop such processes, sea defences have been constructed along 10% of European coastlines. However, these defences often cause undesirable effects on local hydrodynamics and sedimentary processes. They create new eroded areas. In addition, upstream dam construction on discharging rivers causes severe reductions in the amount of sediments reaching the sea. This is leading to an overall deficit of sediments on the coast.

Moreover, coastal defence structures alter the coastal landscape and the occupation of land and sea.

In the future, the impact of global warming and climate change (sea level rise, storm surges and coastal floods) will grow. People are increasingly occupying low-lying areas that are exposed to flooding, thus exacerbating their vulnerability to extreme events. The importance and scale of coastal defence structures will increase accordingly, potentially generating greater environmental impacts. The environmental impacts of coastal defence structures are closely related to the different techniques used.

Generally speaking, in the construction phase (i.e. the placement) of infrastructures, the associated pressures (noise, release of contaminants, changes in turbidity, smothering, habitat loss/disturbance, displacement, visual intrusion, barrier effects to migrating, feeding or breeding biota, interference to other users, e.g. fishermen, etc.) are generally not likely to be detrimental to the overall quality status of the marine environment because they are mostly local and temporary.

Thus, as stated above, the placement of infrastructures in the Mediterranean has a direct impact on the following ecological status descriptors:

1. Biological diversity
6. Sea-floor integrity

7. Hydrography
8. Coastal ecosystems and landscapes

In Fig. 18 all these relations between the placement of infrastructures activity and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

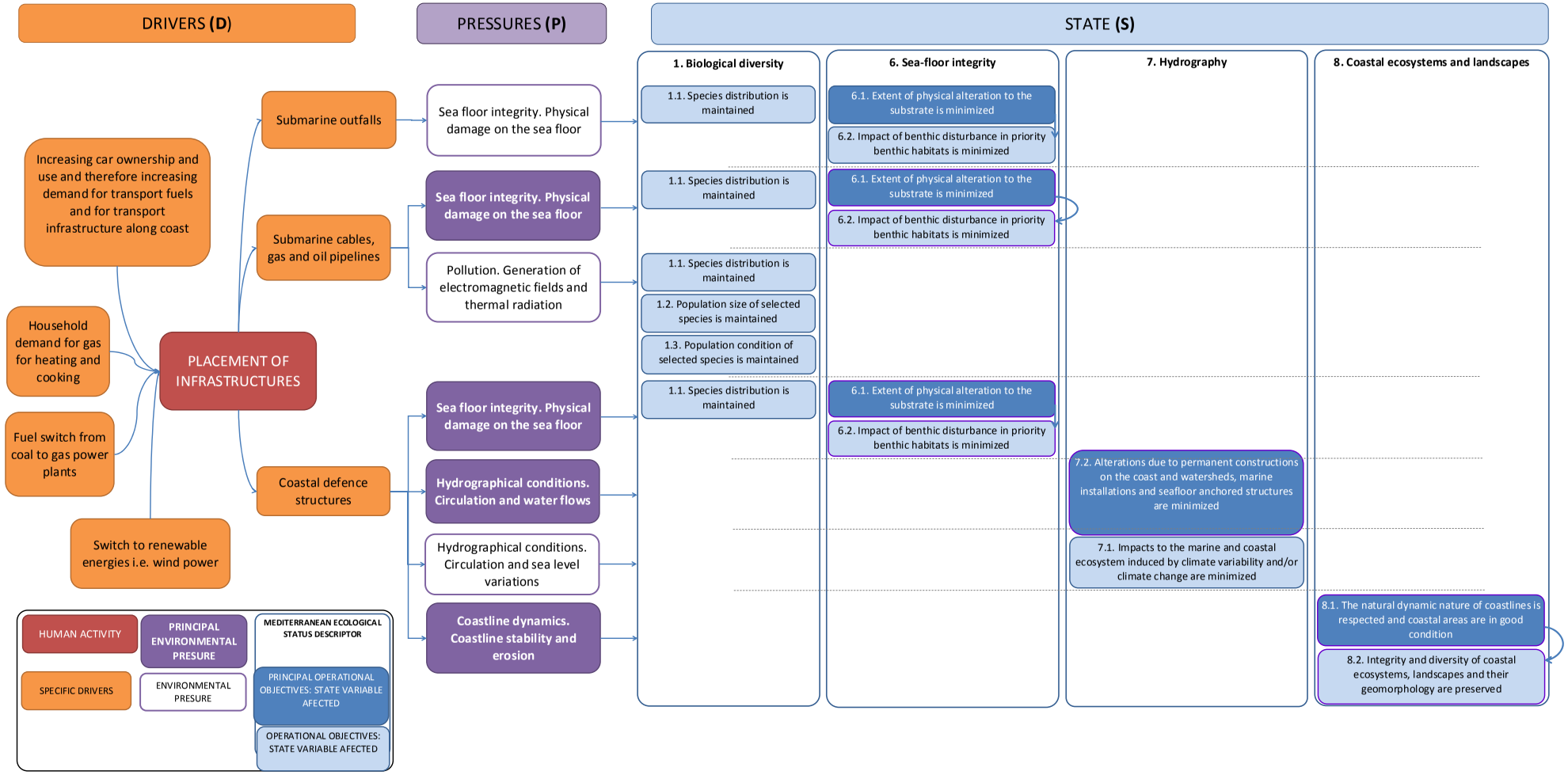

Fig. 18 Map of key relations between drivers-pressures-state: Placement of infrastructures

3.5 Maritime transport

Maritime transport comprises the carriage of passengers, general cargoes in both the traditional way and in containers, livestock and cars, dry and liquid bulk cargoes, and many other goods, resulting in the co-existence of various types and sizes of vessel. Maritime transport also includes the operation of fishing vessels.

Maritime traffic in the Mediterranean is characterised by the existence of a large number of ports in the region (more than 300), but also by a significant volume of traffic, which only transits the Mediterranean Sea, without ships entering any of these ports.

The density of merchant vessel traffic in the Mediterranean, which represents less than 1% of the total area covered by the world's oceans, is particularly high. It is estimated that approximately 30% of the international sea-borne trade volume originates or is directed to the Mediterranean ports or passes through the Mediterranean Sea, and that some 20-25% of the world's sea-borne oil traffic transits the Mediterranean (REMPEC, 2002). The largest exporters of oil are Libya, Algeria, Egypt and Syria, with major imports taking place into France, Italy, Spain and Turkey.

Some of the hazardous and noxious substances usually referred to as chemicals are regularly transported in the Mediterranean. However, the quantity of these products transported by sea annually is only a fraction of the volume of oil carried by tankers.

Moreover, for the transport of passengers, total demand for cruises tripled globally between 1995 and 2007, achieving 17.5 million passengers (UNEP/MAP/BLUE PLAN, 2008). The classical itineraries in the Mediterranean fall into two groups: the eastern destinations (Croatia, mainland Greece and the Greek islands, Turkey, Cyprus, Malta and Egypt) and the western cruises (Spain, France, Italy, Tunisia, Algeria and Morocco).

This high level of maritime transport in the Mediterranean is mainly due to increasing car ownership and use, and therefore increasing demand for transport fuels to be shipped, increasing globalisation of trade, increasing demand for consumer goods and electronics etc. to be transported from China, and increasing wealth and affordability for cruise holidays.

On the other hand, in 2010, the Mediterranean fishing fleet (boats over 15 m) consisted of about 93,000 fishing boats (data extracted from FAO, 2010).

Although maritime transportation is considered to be a comparatively environmentally friendly means of transport, shipping has clear impacts on the marine environment.

Maritime traffic produces air pollution through emissions and particulate matter from engine exhaust gases[7].

Vessels can cause collisions with marine mammals and the operation of ships' machinery and propellers produces underwater noise that can affect marine organisms. The use of antifouling substances involves the release of toxic chemicals into marine waters.

Harbours constitute a physical presence that involves the alteration of the coastal landscape, the introduction of artificial hard substrate, the occupation of land and sea, land reclamation, the alteration of local hydrodynamics and coastal erosion. Harbour maintenance works for navigational purposes (dredging and dumping of dredged material) can damage the sea floor, induce benthic disturbance, alter sediment dynamics and they may resuspend contaminants content in the sediments in the water column.

Untreated ballast water exchange and associated sediments and fouling on ships' hulls may cause the introduction of non-indigenous species. Other discharges of oil and hazardous and toxic substances -accidental as well as operational and illegal- may cause pollution in the marine environment and affect human health. Finally, waste from operational discharges from ships, including raw sewage and garbage, may cause eutrophication due to its content in organic matter and nutrients, affect human health and create floating marine litter that spoils the landscape and may disturb the marine ecosystem.

Thus, as outlined above, maritime transport in the Mediterranean has a direct impact on the following ecological status descriptors:

1. Biological diversity
2. Non-indigenous species
5. Eutrophication
6. Sea-floor integrity
7. Hydrography
8. Coastal ecosystems and landscapes
9. Contaminants
10. Marine and coastal litter
11. Underwater noise

In Fig. 19 all these relations between maritime transport activity and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

[7] The analysis of this pressure goes beyond the scope of this project.

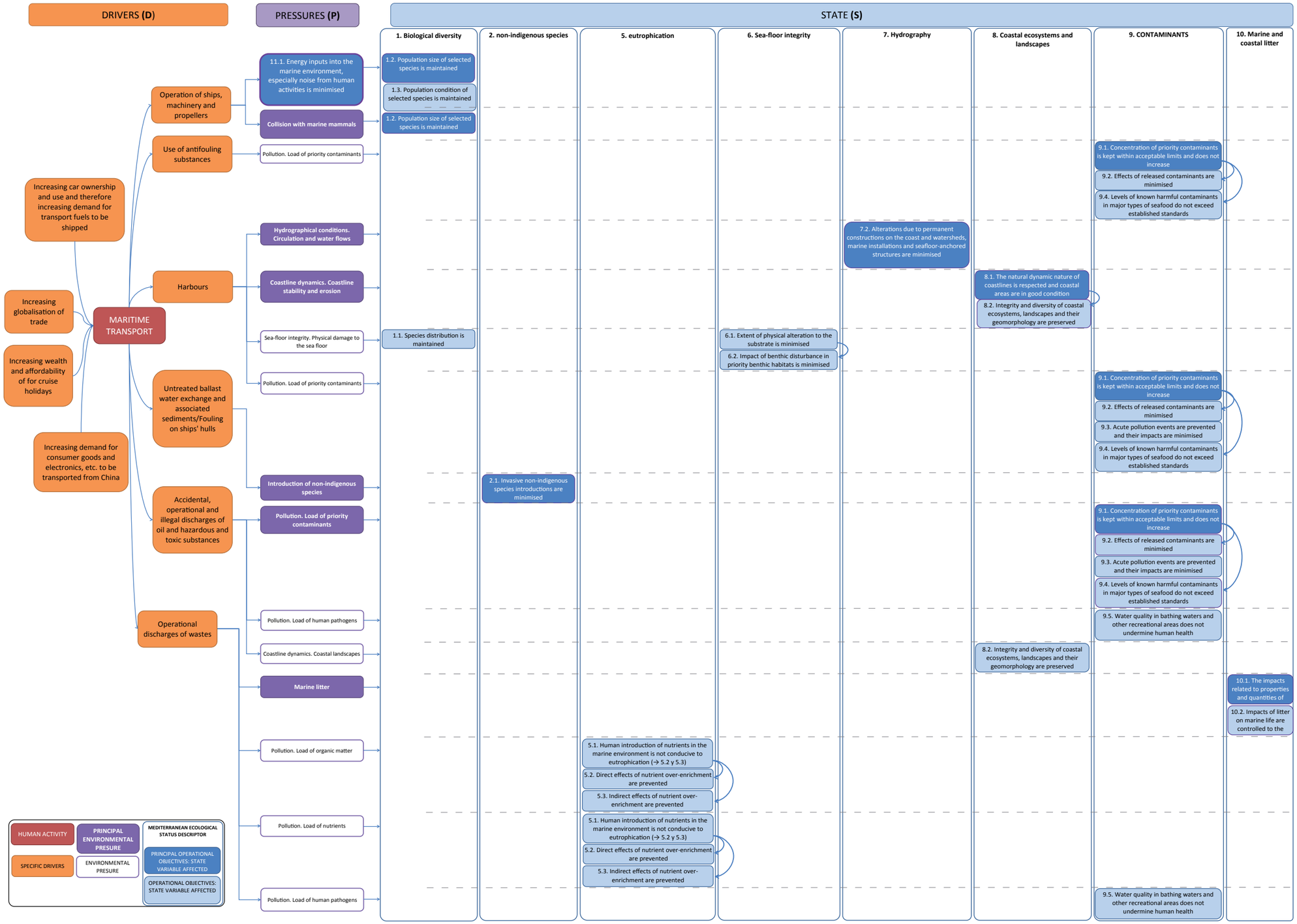

Fig. 19 Map of key relations between drivers-pressure-state: Maritime transport

3.6 Tourism and recreational activities

Tourism is a major industry in the Mediterranean and a major source of income for some countries. In the period from 1995-2004, average annual growth in the number of foreign visitors was shooting up in countries such as Croatia (20%), Syria (15.7%), Egypt (11.7%), Algeria and Turkey (10.1%) (UNEP/MAP/BLUE PLAN, 2008). In 2007, 275 million international tourists visited the Mediterranean states, representing 30% of global international tourism (UNEP/MAP-PLAN BLEU, 2009). Forecasts of international tourist arrivals indicate that it is in the countries to the south and east of the Mediterranean and in the eastern Adriatic that the most marked growth will occur.

Although the activity cruise travelling has been analysed above as a form of passenger transport, the cruise market share is valued at around 4% of the global tourist market, with massive growth potential. In Europe, for example, sector forecasters are talking of a 60% increase in passengers from 2005 to 2015, with the Mediterranean being largely responsible for this growth.

Mediterranean tourism is characterised by the demand for cheap package holidays and budget airlines and low cost flights from Northern Europe. Moreover, it is characterised by a low consumer awareness of the environmental impacts of mass tourism.

The most popular destinations are coastal zones, where tourism and recreation are one of the human activities most directly related to the environment, since the natural characteristics of the coast attract tourists. However, the diversity and fragility of these coastal and marine ecosystems may suffer greatly from tourism-related impacts.

Tourism and biodiversity are closely linked. Although tourism contributes to the loss of biodiversity by causing land and marine areas to become built-over, outstanding sites to become degraded or non-native species to be introduced by the very resources which it generates, it can also contribute to their protection and help safeguard the force of attraction of biodiversity.

On the other hand, in 2006, international tourist spending in the Mediterranean amounted to some 208 billion USD (UNEP/MAP/PLAN BLEU, 2009). Being a job-creating and foreign currency-generating sector, international tourism contributes to the countries' economic development. However, the development sustainability of this sector implies an equitable redistribution of the wealth it generates, as well as a minimisation of its environmental impacts.

Tourism implies a rise in the coastal population, which increases demands for resources such as water, food, energy and construction material, and also increases waste and wastewater generation. Moreover, the artificial surfaces due to housing, services and recreation in the coastal zones (harbours and marinas, transport, waste and water

treatment facilities, etc.) and the high level of armouring of the shorelines by coastal defences and harbours lead to an alteration of coastal landscape, the occupation of land and sea, land reclamation, the alteration of local hydrodynamics and coastal erosion.

The increase in the frequentation of coastal areas (dunes, wetlands, beaches and sea-cliffs) has an impact on the conservation status of natural sites and species.

Regarding beach-related activities, the beach nourishment needed to maintain beaches functionality causes physical damage to the seafloor, alters marine water quality and disturbs benthic communities.

Recreational boating activities may cause damage to habitats and species, in particular due to collisions, underwater noise; boat anchors, especially in sites containing meadows or coralligenous formations; pollution by oil, wastes and wastewater discharges; the use of products for the maintenance of boat hulls; and the voluntary or involuntary introduction of non-indigenous species stuck to the hulls of the boats or hanging to their anchors.

The watching of species (whales watching) and underwater landscapes (scuba diving) may cause damage if the rules necessary for the safeguarding of the species and habitats are not considered and enforced, or if endangered or threatened species are taken out of their environment.

Finally, recreational fishing activity may lead to a depletion in fish stocks.

Therefore, as discussed above, tourism and recreational activities in the Mediterranean have a direct impact on the following ecological status descriptors:

1. Biological diversity
2. Non-indigenous species
3. Harvest of commercially exploited fish and shellfish
4. Marine food webs
5. Eutrophication
6. Sea-floor integrity
7. Hydrography
8. Coastal ecosystems and landscapes
9. Contaminants
10. Marine and coastal litter
11. Underwater noise

In Fig. 20 all these relations between tourism and recreational activities and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

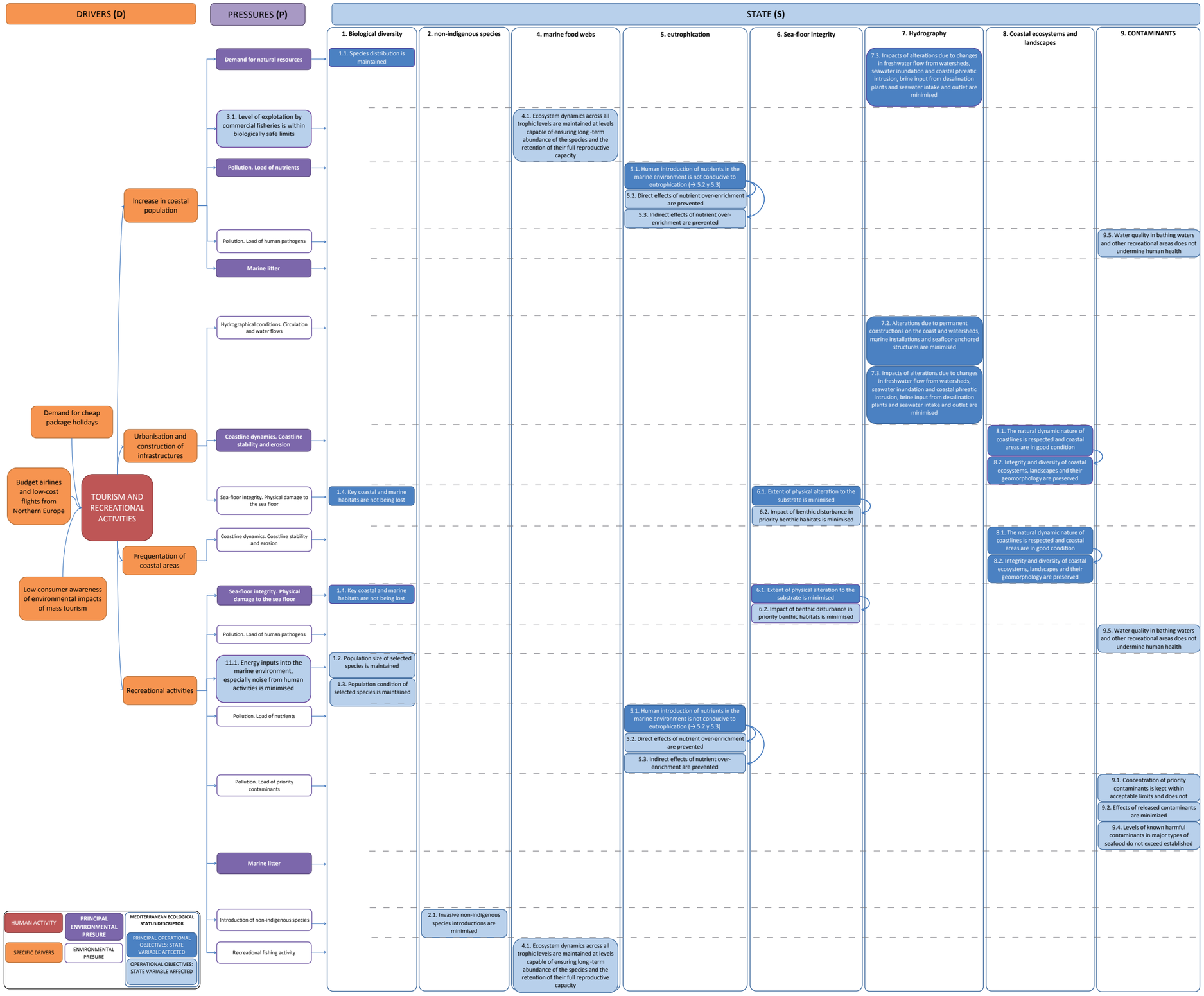

Fig. 20 Map of key relations between drivers-pressure-state: Tourism and recreational activities

3.7 Discharges from land-based sources and activities

The danger posed to the marine environment's living resources and human health by pollution from land-based sources and activities and the serious problems resulting from them in many coastal waters and river estuaries of the Mediterranean Sea are primarily due to the release of untreated, insufficiently treated or inadequately disposed of domestic or industrial discharge.

Urban wastewater is discharged directly in coastal areas or in rivers flowing into the Mediterranean, either untreated (raw), or having undergone various treatment processes. In certain cases, it reaches the sea by infiltration, following leaks in sewers. In the Mediterranean, urban wastewater is composed of a mix of domestic wastewater (generated mainly by households) and industrial wastewater. Industrial wastewater is either collected by sewerage systems, or directly discharged into wastewater treatment plants, with or without preliminary treatment. Sewers also collect groundwater and storm water that infiltrate into the sewerage networks.

The problem occurs mainly in developing countries; at present, only a fraction of domestic wastewater is being collected there, and of existing water treatment plants, most do not work efficiently or reliably. At a Mediterranean level, 53% of wastewater discharged remains untreated (UNEP, 2004) and there are no treatment plants in 40% of the cities with over 2,000 inhabitants, representing 19% of population or 14 million people in 2004 (UNEP/MAP-PLAN BLEU, 2009).

Urban sewage generally contains organic carbon, suspended solids, plastics and other debris, nutrients and human pathogens, as well industrial chemicals, oils and greases. The effects of the discharge of improperly treated urban sewage into water bodies include: disturbances in the ecosystem, including the destruction of habitats, damage to biota and biodiversity; effects on human health through exposure via bathing waters or contaminated shellfish and effects on economic activities, principally fisheries and tourism.

For the industry, there is major industrial development (production of raw materials such as mercury, phosphates, chromium, lead, steel manufacturing) in France and Italy, followed by Spain, the former Yugoslavia and Turkey. Industries are scattered all around the Mediterranean basin where most countries have an important public industrial sector, which is composed of large industries that include: energy production, oil refineries, petrochemicals, basic iron and steel metallurgy, basic aluminium metallurgy, fertiliser production, paper and paper pulp and cement production. In this respect, the main environmental problem of coastal water pollution is the management of chemicals due to inadequate technical capabilities. Demand for consumer goods and vehicles by households and cement by the construction industry (due to drivers described under

3.1) and oil from refineries due to growth in car use, have an impact on this industrial development.

On the other hand, caused by demand for fresh water by households, agriculture and industry, seawater desalination by Mediterranean countries is a steadily growing industry. The total production capacity of existing seawater desalination plants in the Mediterranean countries at the end of 1999 was 1,955,686 m^3/day (UNEP/MAP/MED POL, 2003); Spain had the highest total capacity of 648,980 m^3/day covering 33.18% of the total capacity of the Mediterranean region. This practically unlimited water resource requires energy consumption and results in environmental impacts. These impacts are generated mainly by the brine produced during the desalination, but also by the discharge of chemicals used in the desalination processes.

Thermal discharges from thermal and nuclear power plants and their effects on the Mediterranean marine environment are also considered as a concern resulting from human activities.

Industrial waste discharged from industrial activities include a) heavy metals; b) polihlorovani bifenili (PCBs), polycyclic aromatic hydrocarbons (PAHs) and organometallic compounds; c) radioactive substances; d) organic matter, nutrients and suspended solids; and e) thermal and hypersaline wastewater. These pollutants are generated in large quantities by industrial activities and their discharge into the marine environment can cause damage to human health, ecosystems, habitats and biodiversity. Moreover, salinity and temperature changes affect the local hydrographic conditions.

Finally, the nutrient load from agriculture, mainly intensive agriculture, represents a high proportion of the total anthropogenic load of nutrients in coastal zones. Intensive agriculture, which encompasses high crop production or high-density animal husbandry, caused by demand from food products, from intensively managed high-input farms, can be a major contributor to nutrients due either to the use of large quantities of fertilisers, or the production of high amounts of solid and liquid manure by farm animals. Nutrient over-enrichment of oceans is probably one of the most important worldwide problems. In the Mediterranean Sea, concentrations of nutrients in rivers are generally at least four times lower than rivers in northwest Europe, but there is evidence of an upward trend in both nitrogen and phosphate concentrations (ICES, 2003).

Surface runoff is the one of the primary transport routes into the marine and costal environment for persistent organic pollutants (POPs). They are a set of organic compounds (including pesticides, industrial chemicals and unintended by-products) that: (I) possess toxic characteristics, including effects on the function of the endocrine system, (ii) are persistent, (iii) are liable to bioaccumulate, (iv) are prone to long-range

transport and deposition, and (v) can result in adverse environmental and human health effects at locations near and far from their source. Surface runoff, both agricultural and industrial, is another land-based source that introduces heavy metals and oils into the marine environment. These pollutants damage habitats, are toxic for the aquatic life and can affect human health.

Agricultural runoffs contain fertilisers and nutrients in general. Imbalances in nutrient ratios cause changes in the entire structure and functioning of an ecosystem. This includes: stimulation of growth of phytoplankton and benthic algae, often favouring toxic or otherwise harmful species, as well as reduced penetration of light; large-scale oxygen depletion from the decomposition of excess organic matter; general degradation of habitats, including the destruction of coral reefs and sea-grass beds; the alteration of marine food-webs, including damage to larval or other life stages; and mass mortality of wild or farmed fish and shellfish as well as of mammals, seabirds and other animals.

Finally, atmospheric depositions are the main source of POPs, heavy metals and nutrients.

Thus, as stated above discharges from land-based sources and activities in the Mediterranean have a direct impact on the following ecological status descriptors:

1. Biological diversity
5. Eutrophication
7. Hydrography
9. Contaminants
10. Marine and coastal litter

In Fig 22 all these relations between discharges from land-based sources and activities and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

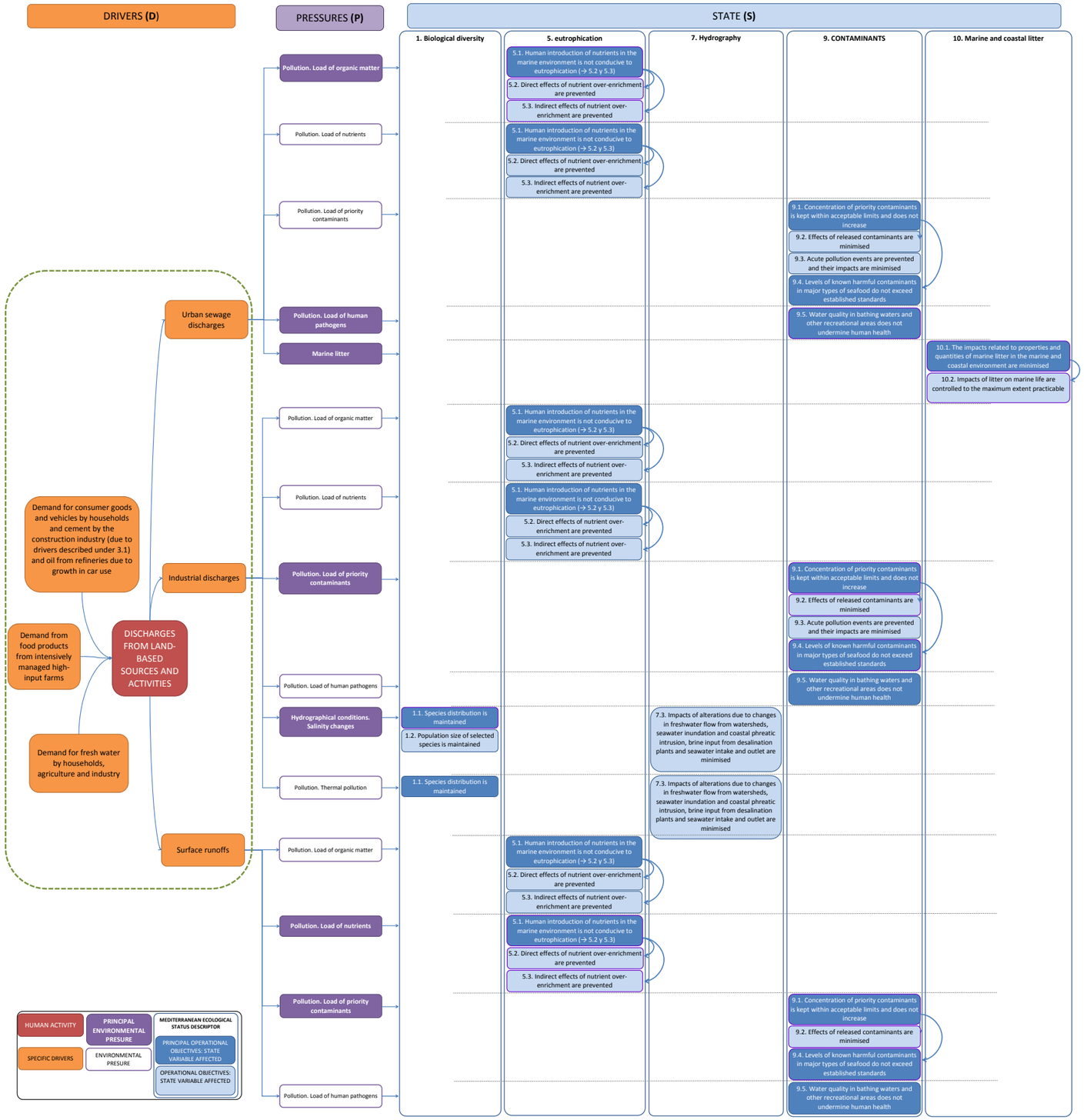

Fig. 21 Map of key relations between drivers-pressure-state: Discharges from land-based sources and activities

3.8 Dumping of wastes

Dumping as defined by the Barcelona Convention protocol[8] is any deliberate disposal or storage of wastes or other matter on the seabed or in the marine subsoil from ships or aircraft.

Dumping of wastes and other matter is prohibited in the Mediterranean with the exception of: dredged material; fish waste or organic materials resulting from the processing of fish and other marine organisms; platforms and other manmade structures at sea, provided that material capable of creating floating debris or otherwise contributing to pollution of the marine environment has been removed to the maximum extent; and inert uncontaminated geological materials the chemical constituents of which are unlikely to be released into the marine environment. Dumping of these wastes requires a prior special permit from the competent national authorities.

Dumping of wastes is mainly due to the increase in maritime transport and demand for navigation waterways, increased activity of factory ships and the industrialisation of fishing, the presence of oil drilling platforms, and the demand for construction materials and mining activities.

Dredged material constitutes the largest quantity of waste material dumped at sea. Dredging is an activity that is essential in order to ensure the navigability of harbours and rivers, for the development of docks, to mitigate the effects of flooding and to remove sediments for other human structures such as water intake structures for industrial processes. The material removed during this activity is often disposed of at sea. Generally, the majority of the dredged material is by nature similar to the undisturbed sediment of the coastal seafloor; however a small part is contaminated by anthropic activities.

On the other hand, although ammunitions and war materials are not eligible for dumping, useless and obsolete ammunitions, explosives and war material of any sort have been dumped in oceans and seas for decades. Among the military ordnance dumped at sea, chemical weapons and riot control agents represent a significant percentage, in the Mediterranean Sea too. The yearly rate of dumping of this material is

[8] The Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (the Dumping Protocol) was adopted on 16 February 1976 by the Conference of Plenipotentiaries of the Coastal States of the Mediterranean Region for the Protection of the Mediterranean Sea, held in Barcelona. The Protocol entered into force on 12 February 1978.
The original Protocol was modified by amendments adopted on 10 June 1995 by the Conference of Plenipotentiaries on the Convention for the Protection of the Mediterranean Sea against Pollution and its Protocols, held in Barcelona on 9 and 10 June 1995. The amended Protocol, recorded as "Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea", has not yet entered into force.

slowly diminishing, also because of the entry into force of international conventions stimulating the adoption of other disposal practices. However, the actual amount of dumped war material, subject to the corrosive action of seawater, which causes the release of chemical products, has to be considered as a not negligible source of persistent pollutants.

With regard to the effects of dumping of wastes, the mechanical burial of the benthic animals is usually the principal effect of dumping on benthic communities, resulting in the total depletion of the communities or disturbing their balance. On the other hand, sediment dumping induces persistent changes in sediment texture and increases turbidity in the water column.

The introduction of large quantities of organic matter, mainly from fish waste, may alter marine ecosystems. In addition, the soluble components of the wastes (chemicals, heavy metals, etc.) may be toxic to organisms and may affect the food chain through the process of bioaccumulation.

Finally, the release of plastics and other solid wastes such as wood, metal, glass, rubber, etc. can damage fauna and flora and threaten public safety.

Therefore, as outlined above, the dumping of wastes in the Mediterranean has a direct impact on the following ecological status descriptors:

1. Biological diversity
5. Eutrophication
6. Sea-floor integrity
9. Contaminants
10. Marine and coastal litter

In Fig 22 these relations between dumping of wastes activity and specific drivers, and the environmental pressures and states affected expressed as operative objectives established by MAP Ecosystem Approach roadmap are displayed in a graphical format.

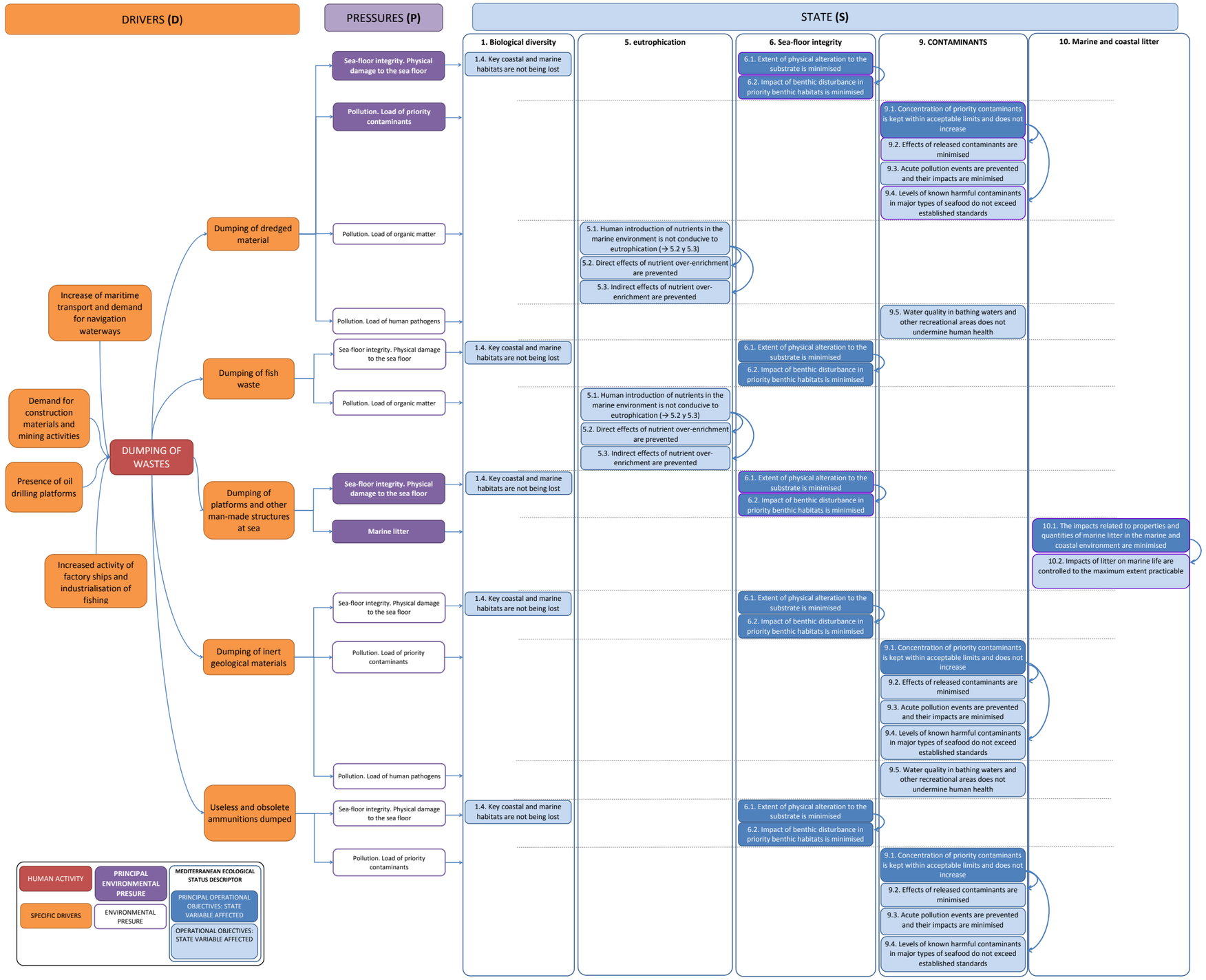

Fig. 22 Map of key relations between drivers-pressure-state: Dumping of wastes

4. CONCEPTS AND TOOLS FOR THE SUSTAINABLE CONSUMPTION AND PRODUCTION APPROACH

4.1 Concept, objectives and approach

Sustainable consumption and production is a holistic perspective on how society and the economy can be better aligned with the goals of sustainability[9]. Sustainable consumption and production (SCP) has been defined as:

> "a holistic approach to minimizing negative environmental impacts from the production-consumption systems in society. SCP aims to maximise the efficiency and effectiveness of products, services, and investments so that the needs of society are met without jeopardizing the ability of future generations to meet their needs" (Norwegian Ministry of Environment, Oslo Symposium, 1994).

SCP is a practical approach to achieving sustainable development, which addresses the economy, society and the environment.

SCP aims to reduce emissions, increase efficiencies and prevent unnecessary wastage of resources within society, through the stages of material extraction, investment, production, distribution, consumption, to waste management. In addition to these environmental and economic goals, the social component is concerned with equity within and between generations, improved quality of life, consumer protection and corporate social responsibility[10]. Some key principles and challenges include:

i) improving the quality of life of populations without increasing environmental degradation, and without compromising the resource needs of future generations;

ii) decoupling the link between economic growth and environmental degradation, by

- reducing the material intensity and energy intensity of current economic activities and reducing the generation of emissions and waste during extraction, production, consumption and disposal
- encouraging a shift of consumption patterns towards groups of goods and services with lower energy and material intensity without compromising the quality of life;

[9] UNEP and EEA, 2007, Sustainable consumption and production in South East Europe and Eastern Europe, Caucasus and Central Asia).
[10] Ibid

iii) applying life-cycle thinking, which considers the impacts from all life-cycle stages of the production and consumption process and guards against unforeseen shifting of impacts from one life-cycle stage to another, from one geographical area to another, or from one environmental medium to another;

iv) guarding against the rebound effect, where technological efficiency gains are cancelled out by resulting increases in consumption.

Cross-cutting in character, SCP needs the active involvement of all stakeholders and a wide range of locally-adapted policy responses. These can range from the introduction of more eco-efficient technologies, holistic policy approaches which combine regulatory frameworks, the use of economic instruments, dissemination of environmental information, development of physical and social infrastructure and improved education and public awareness[11].

A mixture of conceptual frameworks and disciplines can be found under the umbrella of SCP. The main frameworks and disciplines are listed below:

- Clean Production
- Sustainable resource management
- Resource Efficiency
- Sustainable Product Design
- Cycle thinking
- Green industry / Green economy
- Circular economy
- Cradle to Cradle
- Industrial Ecology
- Green banking
- Fair Trade

At the conceptual level, within the framework of the SCP, the concept of Cleaner production has developed a progressive widening of the horizons of pollution prevention, a widening that began with a focus on production processes (cleaner production), and products (ecodesign), then moved on to product-systems

[11] Ibid

(incorporating transport logistics, end-of life collection and component reuse or materials recycling) and from there to sustainable innovation (design for sustainability).

The concept of SCP expands the traditional focus on the production site and manufacturing processes and incorporates various aspects over a product's entire life cycle from cradle to cradle (i.e. from the extraction of resources, through the manufacture and use of the product, to the final processing of the disposed product).

For example, the different conceptual emerging frameworks and disciplines linked to SCP include: Sustainable Resource Management, Life Cycle thinking, Green industry, Green economy, Circular economy, Cradle to Cradle, Sustainable Product Design and Industrial Ecology.

Besides the widening of the scope of the production, the SCP makes it possible to include the scope of the consumption progressively, evaluating the environmental impact of the different consumption options and introducing policies, initiatives and tools to reduce these impacts.

Consequently, SCP introduces "lifecycle thinking", which encourages a more systemic approach to the evaluation of the environmental impacts of human activities (production and consumption) and the use of natural resources required from the ecosystems.

At the operational level, within the framework of the SCP, firstly a set of tools can be included for the evaluation of the linkages between consumption and production patterns and the resulting environmental pressures and demands on resource use. These tools can be used to identify the environmental hotspots of consumption and production systems. They include Life Cycle Analysis (LCA), Environmentally Extended Input-Output Analyses (EE-IOA), Material Flow Analysis (MFA), Ecological Footprint (EF) and Carbon Footprint (CF).

In addition to evaluation, the SCP policy area includes a number of response-based concepts, tools and initiatives, aimed at influencing the various consumption and production drivers of environmental pressures and resource use. This category includes or overlaps with elements such as cleaner production, the efficient use of resources, green public procurement, education of sustainable consumption and others.

Although it is not possible to establish an accurate clear border between SCP tools and traditional tools, Table 5 shows their principal differentiating attributes.

	Traditional tools	SCP tools
General approach	Sectorial view	Holistic view: social, economic and environment
Territorial scope	Territorial view (focus on the location of the environmental pressure and change of State)	Global view (including material, energy and monetary fluxes between territories)
Life cycle scope	Single point in life cycle	Whole life cycle ("life cycle thinking")
DPISR framework scope	Final environmental Pressure and remediation of change of State	Socioeconomic *Drivers* (origin and causes or pressures) and relation between *Drivers* and environmental *Pressures*: from upstream consumption *Drivers* to *Pressures*
Scope of pressures/ impacts considered	Direct pressures *(e.g. load of pollutants in production site)*	Direct and indirect pressures/impacts along the lifecycle of a product
Economic-Environment relation	Low economy-environment win-win potentialities: environment protection measures as a cost	Medium/High economy-environment win-win potentialities: environmental protection as an economic opportunity

Table 5 Principal differences between traditional tools and SCP tools

Fig. 23 further develops the diagram shown in the figures in the previous chapter, now including responses and showing how different types of responses act on different stages of the DPS causal framework, taking into consideration the scopes described in the table above.

Fig. 23 shows how the SCP responses address the socioeconomic Drivers (origin and causes or pressures) and the relation between Drivers and environmental Pressures. The more traditional responses, on the other hand, act on the final environmental pressure (i.e. wastewater treatment) and the remediation of the change of State (i.e. ecosystem habitat management/protected areas, etc.).

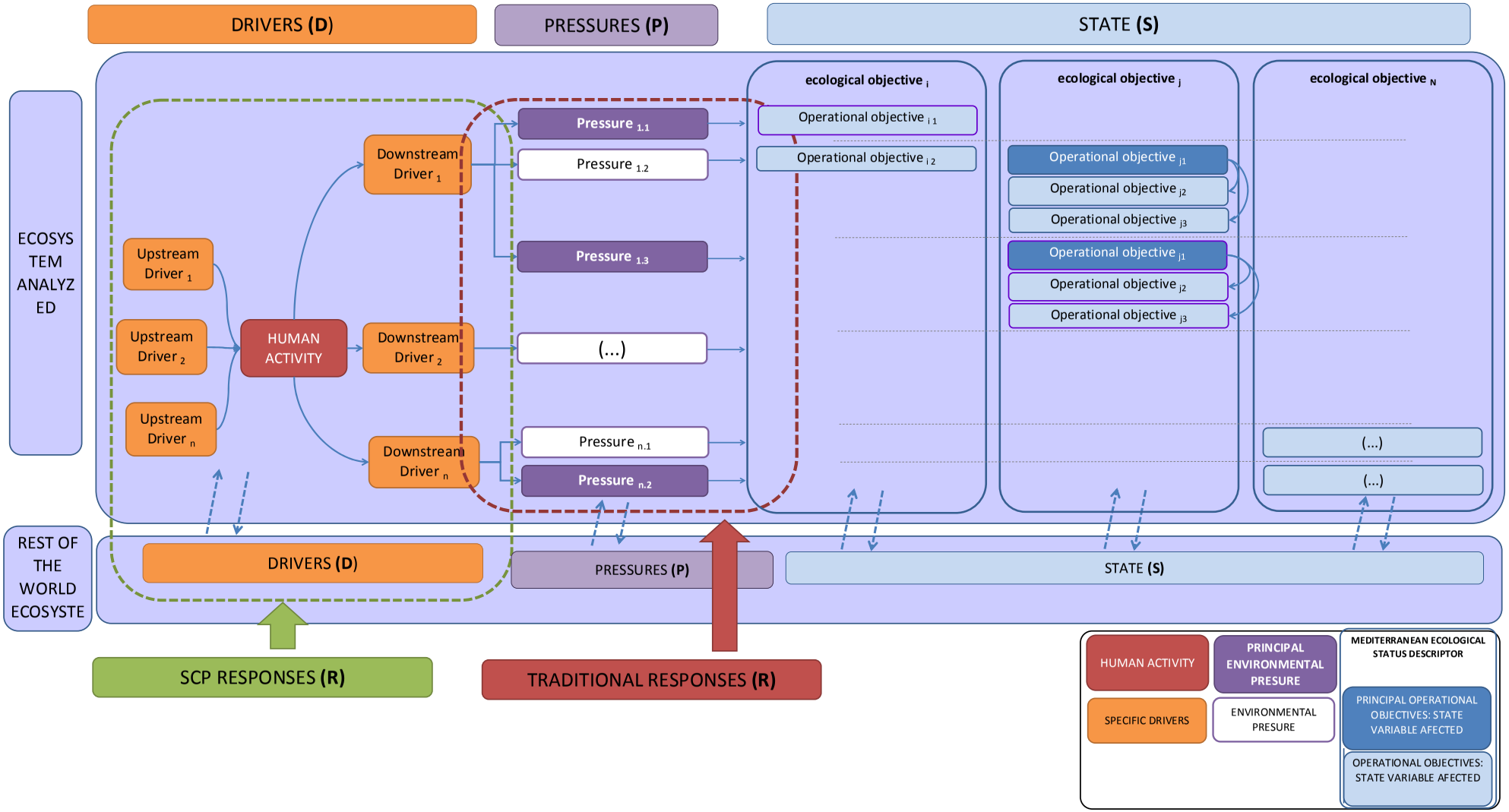

Fig. 23 Potential scopes of intervention of SCP responses and traditional responses within the framework of DPSIR

Accordingly, the SCP tools have a broader impact than the more traditional ones. The most effective approach should be an optimal combination of both, with more or less weight of each type of tool depending on the environmental issues faced.

4.2 Main tools for evaluation and management linked to the SCP approach

In the context of this project, the SCP approach will be considered as the set of methodologies for the identification of the consumption and production patterns that generate the greatest environmental impact on ecosystems and the intervention instruments for the prevention and minimization of these impacts.

The concepts and tools identified take into consideration the framework of application we are considering in the present report, which is the potential contribution of SCP in the implementation of the Ecosystem Approach in the Mediterranean.

Useful concepts and tools in the SCP policy area, which are relevant to achieving the MAP ecological objectives are:

(1) A set of **tools to evaluate the relations between the socioeconomic *Drivers*** variables (consumption and economic system), **and between the socioeconomic *Drivers* and *Pressures*.**

(2) A set of **tools to reduce the pressures** produced by the socioeconomic Drivers, including a vast diversity of initiatives linked to technology, management systems, ecodesign, education and others.

Table 6 lists the main tools and initiatives included under the umbrella of the SCP approach, including the distinction between evaluation tools and management tools.

These tools are described briefly in the following chapter.

CATEGORY	MAIN TOOLS AND INITIATIVES
Evaluation tools of the environmental impact of Consumption and Production	• Life Cycle Analysis (LCA) • Environmentally Extended Input-Output Analyses (EE-IOA) • Material Flow Analysis

Response-based tools and policies for mitigation of the environmental impact from consumption and production	• Clean Production/ Resource Efficient and Cleaner Production:
	  ○ Best Available Techniques (BATs)
	  ○ Best Environmental Practices (BEPs)
	  ○ Cleaner Technologies (CTs)
	• Integration of sustainability into sectorial policies:
	  ○ Sustainable agriculture
	  ○ Sustainable fisheries
	  ○ Sustainable buildings and construction
	  ○ Sustainable transport and mobility
	  ○ Sustainable tourism development
	  ○ Sustainable urban development
	• Life Cycle Management (LCM)
	• Supply chain management
	• Ecodesign
	• Market instruments and environmental tax reform (ETR)
	• Social innovation and eco-innovation
	• Product declarations and product minimum standards
	• Environmental Labelling and Certification
	• Sustainable Public Procurement / Green Public Procurement
	• Education for sustainable consumption and production (ESCP)
	• Environmental management systems
	• Corporate social responsibility

Table 6 Summary of the main tools and initiatives included in the SCP approach

4.3 Tools for evaluating the environmental impact of Consumption and Production

4.3.1 General description

In Table 7 the main tools and initiatives for evaluating the environmental impact of consumption and production are described briefly.

These tools have some or all of the following distinguishing features compared to traditional instruments for analysing environmental pressures from human activities:

- They can be used to evaluate the **direct *and* indirect environmental pressures or impacts** of a human activity. This means that all the impacts of the **life cycle or supply chain of the product or service** considered can be accounted for.

- They distinguish the **environmental pressures or impacts from different levels** of the **life cycle/supply chain/*Drivers chain***, allowing for a complementary production and consumption assessment.
- They include direct and indirect environmental pressures of the consumption of a good **irrespective of the location of these impacts.**
- They can take into consideration the environmental impact, both in terms of the demands for natural resources (e.g. materials, biotic resources, water, bioproductive land, etc.) and waste generation (e.g. Greenhouse Gases –GHG-emissions, acidification, Biological Oxygen Demand –BOD-, nutrient loading, toxic emissions).

CONCEPT	DEFINITION
Life Cycle Assessment (LCA) / Environmental Life Cycle Assessment (ELCA)	Tool for the systematic evaluation of the environmental aspects of a product or service system through all stages of its life cycle. The extraction and consumption of resources (including energy), as well as releases into air, water and soil, are quantified through all stages of the life cycle. Their potential contribution to important environmental impact categories is then assessed. These include climate change, toxicity, ecosystem damage and deterioration of the natural resource base. LCA provides an adequate instrument for environmental decision support. Reliable LCA performance is crucial for achieving a life-cycle economy. The International Organization for Standardization (ISO), a worldwide federation of national standards bodies, has standardised this framework within the series ISO 14040 on LCA.
Environmentally Extended Input-Output Analyses (EE-IOA)	EE-IOA is a tool for following the links between the final use of products and global environmental emissions. The EE-IOA model is formed around an input-output table (IOT) showing monetary flows between all the sectors in the economy, and between them and final use (i.e. by households, government or sale on the export market). It also includes values and flows of imports. The IOT is then extended with environmental satellite accounts (e.g. the direct emissions to air from each industry) to give an environmentally-extended input-output table (EE-IOT). The EE-IOT is then processed to produce tables, which follow the full production chains of products and estimate the environmental pressures caused along this production chain. In this way, the direct and indirect pressures caused by the purchase of different final product groups can be estimated and compared.

Table 7 Brief description of the main tools and initiatives for evaluating the environmental impact of consumption and production

EE-IOA and LCA tools have some similarities in their approach, but each of them has a specific suitable scale of application.

The LCA adopts a bottom-up approach, using data inputs at product and specific process levels, and for very disaggregate categories of products, services and processes. On the other hand, EE-IOA adopts a top-down approach, using data inputs at regional and national levels, and for very aggregate categories of production activities and consumption options.

In short, the method to be used essentially depends on the objectives, the scale of analysis and the availability of data and resources. In general, an Input-Output analysis is preferable for determining the footprint of macro and meso systems such as industrial sectors, large corporations, the domestic sector and the government (Wiedmann and Minx, 2007). In contrast, a Process Analysis based on LCA has clear advantages for the study of micro systems, such as specific processes or products.

It is also possible to combine these two focuses using hybrid LCA-EEIOA methods in order to ensure precision and the required level of detail in a bottom-up methodology, while at the same time applying the methodology on a larger scale using EE-IOA (Heijungs *et al.*, 2006) (see Fig. 24). Work in this field has only recently begun to emerge in the sphere of ecological economics, and as yet no specific applications for the analysis of the territorial carbon footprint have been noted. However, it is hoped that in the coming years the models will improve progressively.

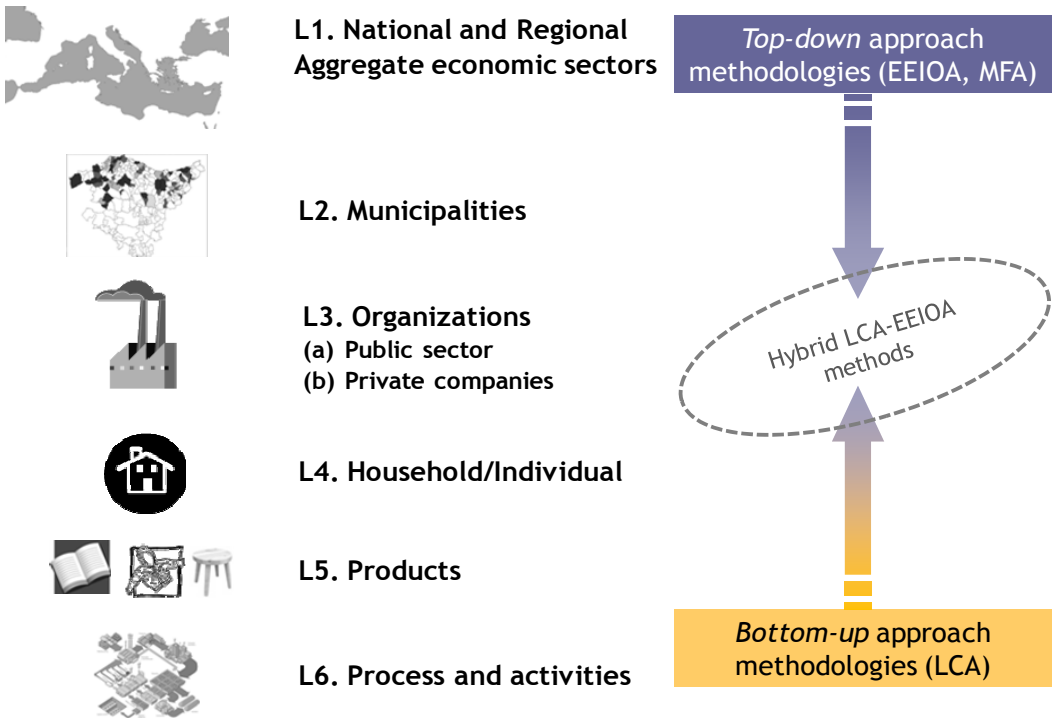

Fig. 24 Level of application of Top-down and Bottom-up approaches

The application of EE-IOA or LCA methods makes it possible to estimate the direct and indirect use of natural resources (materials, water, bioproductive land, etc.) and the production of waste (gas emissions, load of pollutants and nutrients, etc.) along the life cycle or production cycle of individual products or product groups.

Annex 2 is includes an example of the calculation of Spain's carbon footprint, carried out by using the EE-IOA.

This case study uses EE-IOA to link one group of environmental pressures – greenhouse gas emissions – to the final consumption of product groups. Although greenhouse gas emissions are not relevant to the MAP environmental objectives, this case study demonstrates the potential of the tool for linking environmental pressures that are of direct relevance to MAP for upstream drivers, i.e. consumption patterns.

4.3.2 Challenges facing the application of EE-IOA and LCA within the context of the Mediterranean Ecosystem Approach

As described earlier both LCA and EE-IOA are tools that allow us to discover the links between environmental pressures and the consumption of goods and services. LCA is a micro-scale approach whereby environmental pressures released by individual production, consumption and disposal processes along the full life cycle of a distinct product are gathered into a life cycle inventory for that individual product. These are then converted into environmental impacts. EE-IOA is a macro-scale approach, which allows environmental pressures to be estimated along the whole economy production chains of aggregated product groups.

In both cases, the tools offer the potential for linking environmental pressures to upstream drivers; i.e. the demand for (and consumption) of goods. This is a fundamental element of the SCP approach for supplementing more traditional approaches in order to meet the MAP ecological objectives. For example, the tools could potentially be used to identify which final products (LCA) or aggregated final product groups (EE-IOA) are responsible for eutrophying emissions or POPs into rivers that empty into the Mediterranean. The production and consumption of these products could then be targeted using policy tools in the SCP policy toolbox, leading to a reduction of these emissions into the water, thus contributing to environmental objectives 5 and 9 on reducing pollution in the Mediterranean.

However, several significant obstacles currently hinder the use of LCA and EE-IOA for identifying the products driving some of the important environmental pressures.

The main obstacle is linked to the lack of available information. The most relevant sources identified relating to the application of EE-IOA in the Mediterranean region are:

- **The EXIOPOL project** supported by the European Commission with the participation of a vast number of research centres in Europe.
  This project was the most ambitious initiative to generate and integrate economic and environmental national accounts. Include economic Input-Output tables and environmental extensions for all the EU-27 Mediterranean countries and Turkey.

- **The MEDSTAT programme** (linked to Eurostat)
  Includes Economic National Accounts for the 27 EU Member States and 10 Mediterranean countries: Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, occupied Palestinian territory, Syria, Tunisia and Turkey.

- **EUROSTAT**
  Includes Economic National Accounts of the 27 EU Member States and environmental extensions.

Taking into consideration on one hand the assessment of the available information from these sources, and, on the other, the assessment of how the characteristics of the EE-IOA and LCA tools match the ecological objectives, the main obstacles identified are:

1. The limited geographical scope of the data sets:

Since 1996, EU Member States have been obliged to provide Eurostat with economic input/output accounts, and are now (since July 2011) obliged to provide satellite environmental accounts regularly for a number of environmental pressures, allowing for the creation of regular Environmentally Extended Input-Output Tables (EE-IOT), which provide the basis for EE-IOA calculations. Of the other Mediterranean countries, only Croatia and Turkey are known to gather EE-IOT. Not many of the countries with EE-IOT have it at a useful level of sector disaggregation. In the countries around the Mediterranean, this is limited to France, Spain and Italy. Similarly, Life Cycle Inventory (LCI) data to enable use of the LCA tool are only available for European production processes and not for the rest of the Mediterranean region.

The MEDSTAT programme is promoting the development and harmonisation of economic input/output accounts of most of the Mediterranean countries. It is foreseeable that in the near future the input/output accounts of the different countries will become increasingly available and homogeneous.

2. The limited environmental pressures covered by EE-IOT:

Table 8 shows the main potential environmental extensions linked to the ecological objectives established in the MAP Ecosystem Approach roadmap.

The 6 ecological objectives not mentioned in the table do not have a clear environmental extension to allocate, due to their territorial size. Although there are environmental extensions not mentioned in the table that would seem to be linked to some of these ecological objectives, such as the artificialised land (objectives 7 and 8) or the water demand (objective 7), it is not feasible at all to allocate a unit of artificialised land per unit of the different economic activities linked, like construction or tourism activities.

ECOLOGICAL OBJECTIVES	Related environmental extensions
1. Biological diversity	Product extraction: Marine fish Bio-productive marine land demanded
3. Harvest of commercially exploited fish and shellfish	
4. Marine food webs	
5. Eutrophication	Loading to water: N, P and BOD
9. Contaminants	Loading of priority contaminants to water

Table 8 Main environmental extensions linked to ecological objectives

On the other hand, EU countries are only obliged to provide environmental satellite accounts for a handful of emissions to air. There are plans for this to be extended to energy and water by Eurostat. However, none of the accounts currently compiled is of particular relevance to any of the MAP ecological objectives apart from NOx emissions to air, which can have a eutrophying effect on marine waters. LCI data on the other hand include hundreds of environmental variables including toxic and eutrophying emissions to air, soil, and importantly in the MAP EO context, water. Therefore, hybrid models combining the economic data in input-output tables with the rich environmental LCI data present a possible means of overcoming the lack of scope of environmental pressures in EE-IOT.

3. The limitations in locational Information:

EE-IOT is generally gathered at a national level. As such, they only provide information about environmental pressures taking place within a country as a whole. Moreover, taking a consumption perspective, a large proportion of environmental pressures caused by consumption take place in other countries. In a typical national EE-IOT, imports are not identified by country and therefore these environmental pressures connected to imports could be taking place anywhere in the world. The MAP ecological objectives on the other hand are location specific, i.e. they are concerned with pressures acting

directly on the Mediterranean and its coasts. While a national level EE-IOT approach may be valid for countries around the Mediterranean where, for example, all rivers eventually flow out into the Mediterranean, for countries that have coastlines on other seas and oceans such as France and Spain, there is less validity in using EE-IOT to identify product groups that indirectly cause pressures on the Mediterranean.

There are, however, a number of positive developments, which should with time overcome some of these obstacles. With respect to obstacle 1, as mentioned earlier, MEDSTAT programmes promote the development and harmonisation of economic input-output accounts for most Mediterranean countries.

With respect to obstacle 2, the European Council have called for land accounts to be included in the environmental satellite accounts compiled by EU Member States. These could potentially be useful if the accounts divide land by class and include a coastal land class. Impacts of product groups on coastal regions could then be estimated. Land accounts are not likely to become available for several years, however.

As mentioned earlier, the development of hybrid LCA and EE-IOA approaches should also overcome some of the problems caused by the limited scope of environmental satellite accounts. These hybrid methods are becoming more widespread and increasingly mature.

With respect to obstacle 3, some regions of EU countries (including the Emilia Romagna region of Italy and Catalonia in Spain) are piloting regional EE-IOT, which would be more useful for identifying upstream causes of pressures on the Mediterranean. This may spread to other regions and countries in the future.

Finally, the EXIOPOL project (Environmental Accounting Framework using Externality data and imput-output tools ofr policy analysis) commissioned by the European Commission provides a potentially useful tool for identifying upstream drivers of pressures on the Mediterranean, overcoming some of the obstacles above. Firstly, the project has developed a multiregional input-output table (MRIOT) including all countries in the EU, plus 16 other key trade partners (including Turkey). Imports to each country are identified by source and thus the location of environmental pressures caused by consumption in one country can be identified at least by nation. Moreover, the environmental extensions are much more comprehensive than for national EE-IOTs in Europe, including 30 emitted substances and 80 resources including land use. Some of them include environmental extensions previously identified as relevant within the context of the Ecosystem Approach, such as the production and extraction of Marine fish and the loading of N, P and BOD into water. Finally, the MRIOT is relatively well disaggregated, including 129 different sectors and allowing more detailed identification of environmental hotspots.

4.4 Tools for managing the environmental impact of Consumption and Production

In Table 9 some of the main SCP tools for mitigating the environmental pressures of the consumption and production patterns of human societies are described.

CONCEPT	DEFINITION
Life Cycle Management	LCM is a dynamic process; organisations may begin with small goals and objectives with the resources they have and get more ambitious over time *(Hunkeler, D. Life-cycle Management (2004))*
Sustainable Procurement	**Green Procurement** is a process whereby organisations take into account environmental elements when procuring goods, services, works and utilities and achieve value for money on a whole life-cycle basis. **Sustainable Procurement** is a process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, while minimising damage to the environment. Sustainable Procurement seeks to achieve the appropriate balance between the three pillars of sustainable development i.e. economic, social and environmental. • Economic factors include the costs of goods and services over their entire life cycle, such as: acquisition, maintenance, operations and end-of-life management costs (including waste disposal) in line with good financial management; • Social factors include social justice and equity; safety and security; human rights and employment conditions; • Environmental factors include emissions to air, land and water, climate change, biodiversity, natural resource use and water scarcity over the whole product life cycle.
Resource Efficient and Cleaner Production (RECP)	Resource Efficient and Cleaner Production continuously applies integrated and preventive strategies to processes, products and services. This increases efficiency and reduces risks to humans and the environment. RECP specifically works to advance: • Production Efficiency – through the optimisation of the productive use of natural resources (materials, energy, water) at all stages of the production cycle; • Environmental Management - through the minimisation of the adverse impacts of industrial production systems on nature and the environment; • Human development – through the minimisation of risks to people and communities, and support to their development.

CONCEPT	DEFINITION
Product minimum standards	A product standard sets out specific characteristics of a product, such as its size, shape, design, functions and performance, or the way it is labelled or packaged before it is put on sale. In certain cases, the way a product is produced can affect these characteristics, and it may then prove more appropriate to draft technical regulations and standards in terms of a product's process and production methods rather than its characteristics per se. (Source: World Trade Organisation. www.wto.org/english/tratop_E/tbt_e/tbt_info_e.htm)
Market instruments	Includes fees and charges, taxes and subsidies, emission trading schemes, feed-in tariffs, tradable permits, deposit-refund systems, etc. (e.g. energy taxes, water taxes and subsidies for development or feed in tariffs for renewable energy installations).
Environmental Labelling and Certification	Labels are voluntary, participatory, market-based and transparent economic tools that aim to decrease environmental impacts and improve resource efficiency of products while enabling consumers to make informed decisions based on products' environmental credentials. They are multiple criteria-based, third-party certified programmes awarding a licence authorising the use of environmental labels on products. These indicate the overall environmental preferability of a product within a particular product category based on life-cycle considerations. Certification is awarded to those products that fully comply with a set of baseline standards.
Education for sustainable consumption and production (ESCP)	Education for Sustainable Consumption and Production (ESCP) aims to provide knowledge, values and skills to enable individuals and social groups to become actors of change towards more sustainable consumption behaviours. The objective is to ensure that the basic needs of the global community are met, quality of life for all is improved and the inefficient use of resources and environmental degradation is avoided. ESC is therefore about providing citizens with appropriate information and knowledge on the environmental and social impacts of their daily choices, as well as providing workable solutions and alternatives. ESC integrates fundamental rights and freedoms including consumers' rights, and aims at protecting and empowering consumers in order to enable them to participate in the public debate and economy in an informed, confident and ethical way *(UNEP and Marrakech Process Task Force on Education for Sustainable Consumption, 2010)*.

Table 9 Description of the main tools and initiatives for the mitigation of the environmental impact of consumption and production

Source: Adapted from ABC of SCP clarifying concepts on sustainable consumption and production (UNEP, 2010)

5. IDENTIFYING SCP TOOLS FOR ACHIEVING ECOLOGICAL OBJECTIVES

5.1 Identification of SCP tools for achieving ecological objectives per identified human activity

A specific identification of SCP tools for achieving the different ecological objectives has been done, grouped by the main human activities already used in Chapter 3.

For this identification, on one hand the links mapped previously in Chapter 3 between human activities and the ecological objectives in the context of the Mediterranean region and, on the other hand, the SCP tools previously introduced, have been taken into consideration.

For each of the human activities, the same diagram developed in Chapter 3 is reproduced with the addition of specific SCP tools, which can have relevance to that activity and its upstream (and possibly downstream) drivers. However, for a better understanding of the figures, relations between pressures and state are omitted. A general schematic of this is shown in Fig.25.

In addition to the diagram the following information is provided for each human activity:

- The conventional responses most typically applied
- An assessment of the relevance of SCP-type responses for this particular human activity (High/Medium/Low). This differs significantly from activity to activity depending on the importance of upstream drivers and their responsiveness to policy elements from the SCP toolbox
- A list of SCP-type responses that might be relevant
- Those operational objectives related to the human activity and which could be responsive to application of the SCP tools

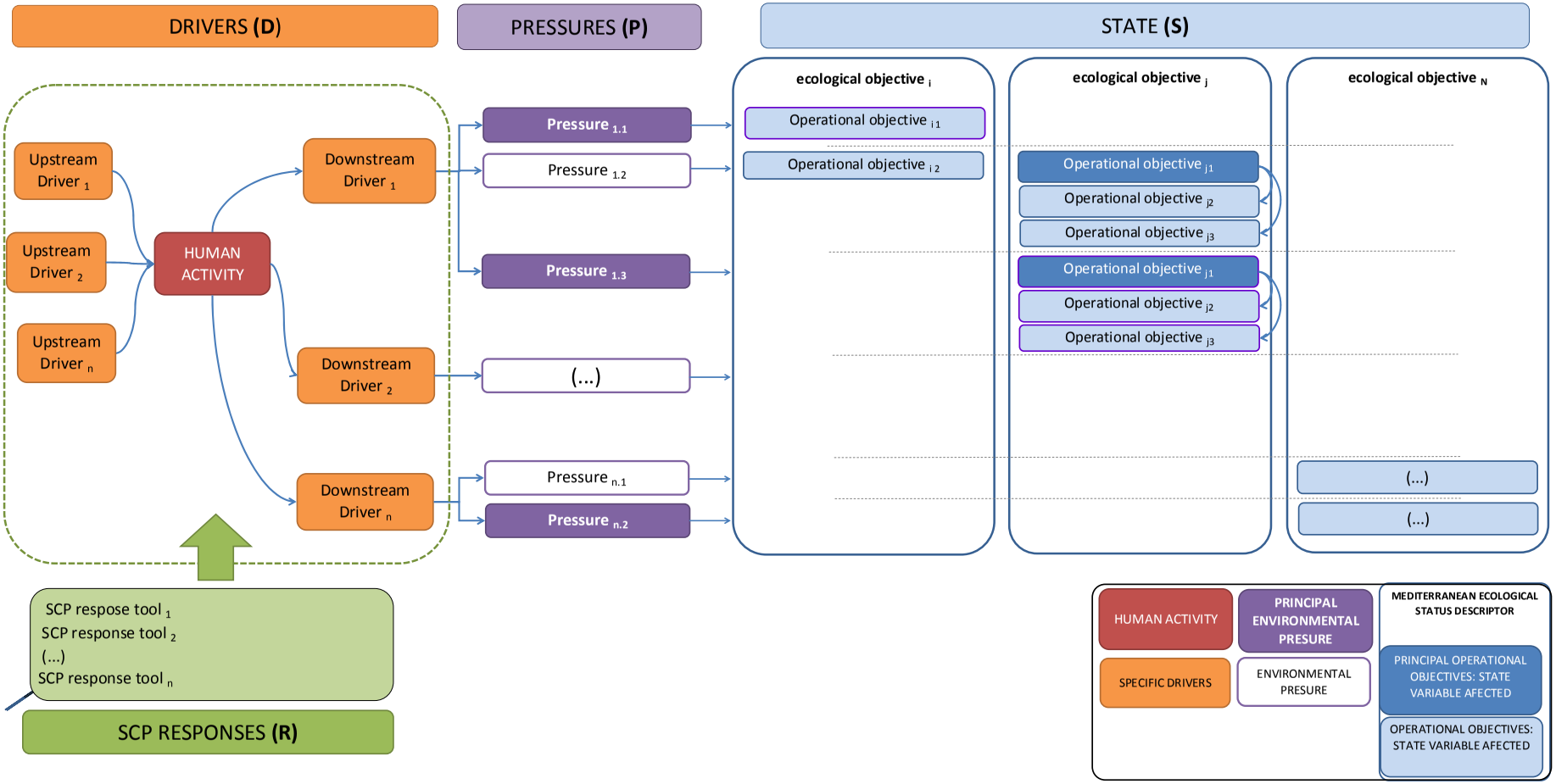

Fig. 25 Identification of SCP responses for achieving ecological objectives

Urbanisation

Fig. 14 in Chapter 3 shows the most relevant Drivers-Pressures-State relations related to urbanisation as a human activity in the Mediterranean, defining the State variables as the specific ecological and operational objectives established for the Mediterranean. This figure also highlights both the most important Pressures and the most important relationships between Pressures and State.

In relation to urbanisation activity, the more conventional intervention is urban and regional planning. These policies consist in a set of specific tools including regional, sub-regional and especially local planning instruments with a high regulatory capacity. The regional, and particularly the local authorities play a key role.

Another conventional relevant intervention is the creation and management of protected natural area systems. This instrument consists of a tool that complements the regional and urban planning, and usually comes under the jurisdiction of the national or regional authorities.

Land-use and town planning can reduce the impact of growth of urban areas on sensitive parts of coast and also contain urban sprawl, but will also need policies that address the key upstream driving forces of increased demand for living space.

Thus, the SCP tools, considered in a broad sense, can be also applied to prevent and minimize the pressures originating from urbanisation activities. Nevertheless, it must be pointed out that its relevance can be considered as medium, or even low, compared with the more conventional interventions. Furthermore, although local governments are mainly responsible for the implementation of the identified SCP tools, they are not as directly linked to the MAP framework as the national governments.

The most relevant potential SCP-type responses identified for managing urbanisation activities are (see Fig. 26):

- Quotas on total amount of new urban space allowed each year.
- Using Smart Growth principles to promote denser urban areas.
- Promotion of new types of community housing for single people, pensioners etc. to reduce the demand for new housing due to changing demographics.

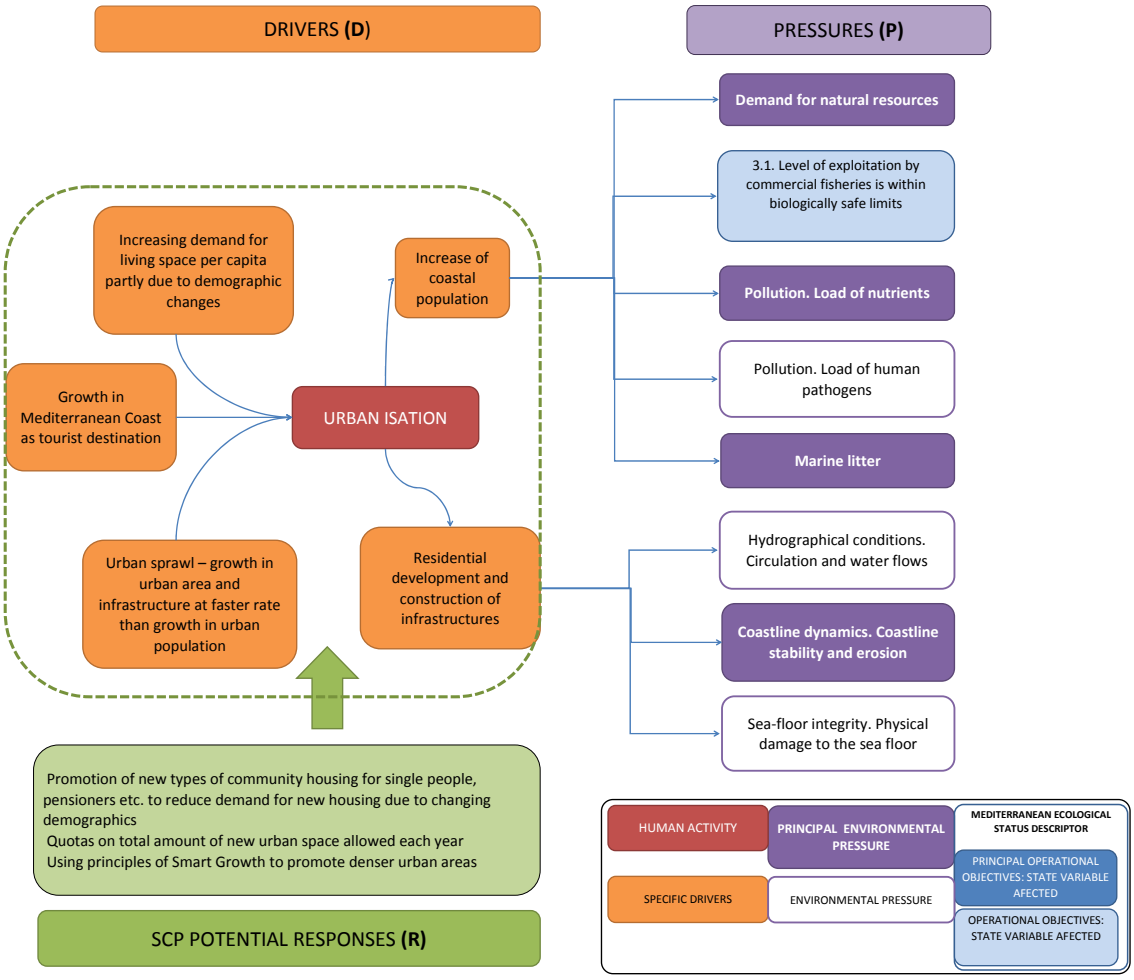

Fig. 26 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Urbanisation

Fisheries and Mariculture

Fig. 15 and Fig. 16 in Chapter 3 present the most relevant Drivers-Pressures-State relations related to the fisheries and mariculture respectively.

As shown in these figures, fisheries have a particularly relevant direct influence over ecological and operational objectives associated with: 1. Biological diversity; 4. Marine food webs; and 6. Sea-floor integrity. In the case of Mariculture, the ecological and operational objectives most directly affected are: 2. Non-indigenous species; 5. Eutrophication; 6. Sea-floor integrity; and 9. Contaminants.

In relation to the fisheries, there is a strong tradition of policies aimed at mitigating the pressures of the activity in the ecosystem and achieving a sustainable use of the fisheries. These measures include particularly relevant tools such as catch quotas, limitations on fishing effort (e.g. fleet size), and rules on the mesh size of nets and other operational aspects of fishing.

Better management of fishing and mariculture using conventional approaches such as the ones described above may reduce the impact of fishing on the sustainability of fish populations and other sea life. These conventional approaches can be supplemented by SCP policies aimed at some of the upstream drivers of fish consumption. However, this must be done with care, since a fish-rich diet can provide health benefits. SCP responses may therefore best be aimed at identifying the species of fish being consumed, and consumer information on which fish is being caught using sustainable methods.

The more relevant potential SCP-type responses identified related to the fisheries activities are (see Fig. 27):

- Education on sustainable consumption: awareness-raising amongst consumers on issues of sustainable and non-sustainable fishing in the Mediterranean.
- Labelling systems for sustainably caught fish e.g. the Marine Stewardship Council (MSC).
- Actions to reduce food waste in shops, restaurants and households e.g. Love Food Hate Waste campaign.
- Sustainable public procurement: introduce sustainable fishing criteria in the catering for public services.
- Choice editing in supermarkets – encouraging supermarket chains to offer only fish caught from sustainable stocks using sustainable fishing techniques, e.g. MSC-labelled fish.
- Best environmental practices in fishing activities.

In relation to the mariculture (Fig. 28), conventional tools can be used to regulate mariculture activities or to ban certain antifouling agents, chemicals, anti-bacterial agents etc. In this case, the SCP can introduce complementary tools such as Resource

efficient and cleaner production in mariculture activity, or encourage Environmental Management Certifications Systems.

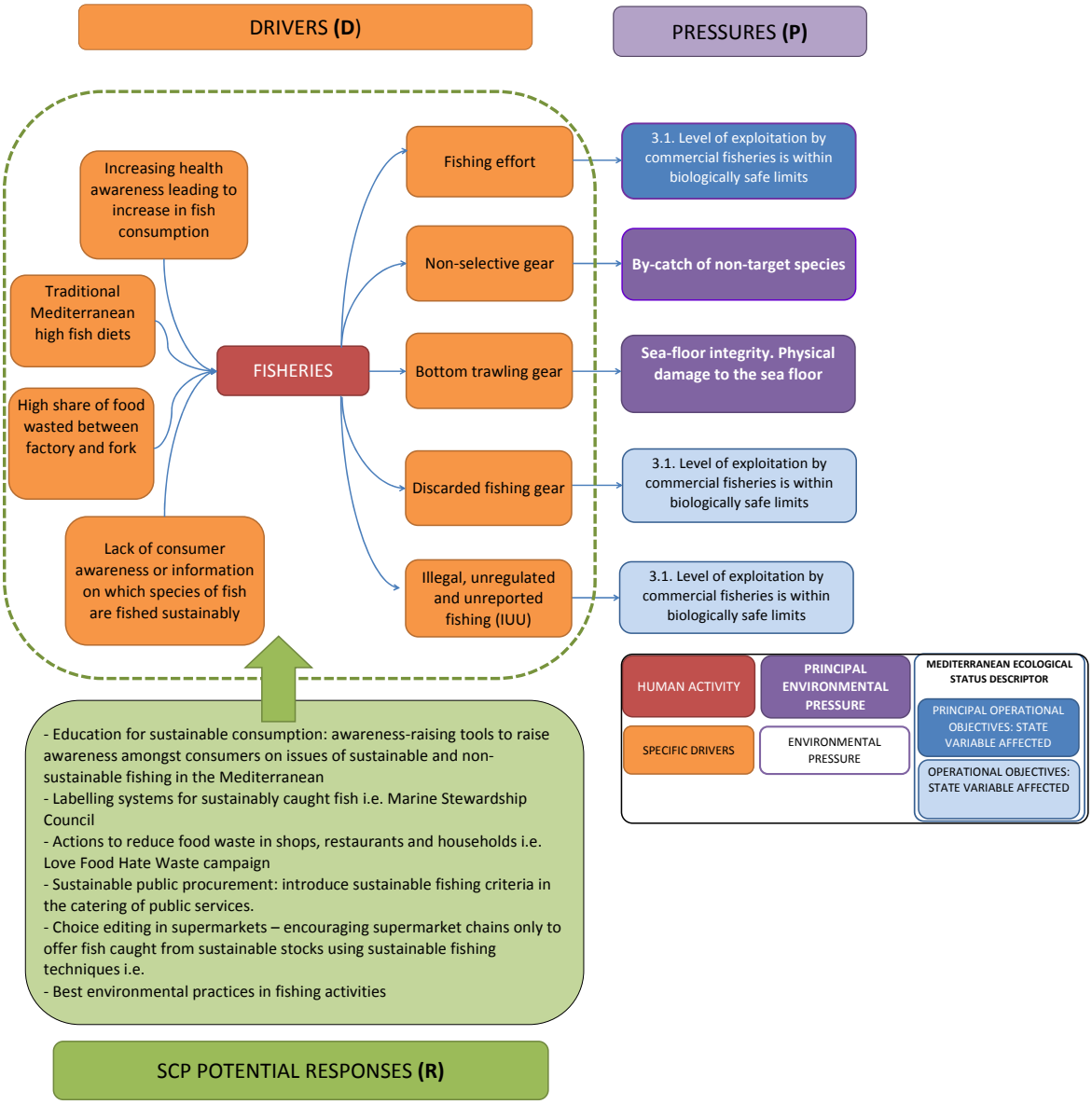

Fig. 27 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Fisheries

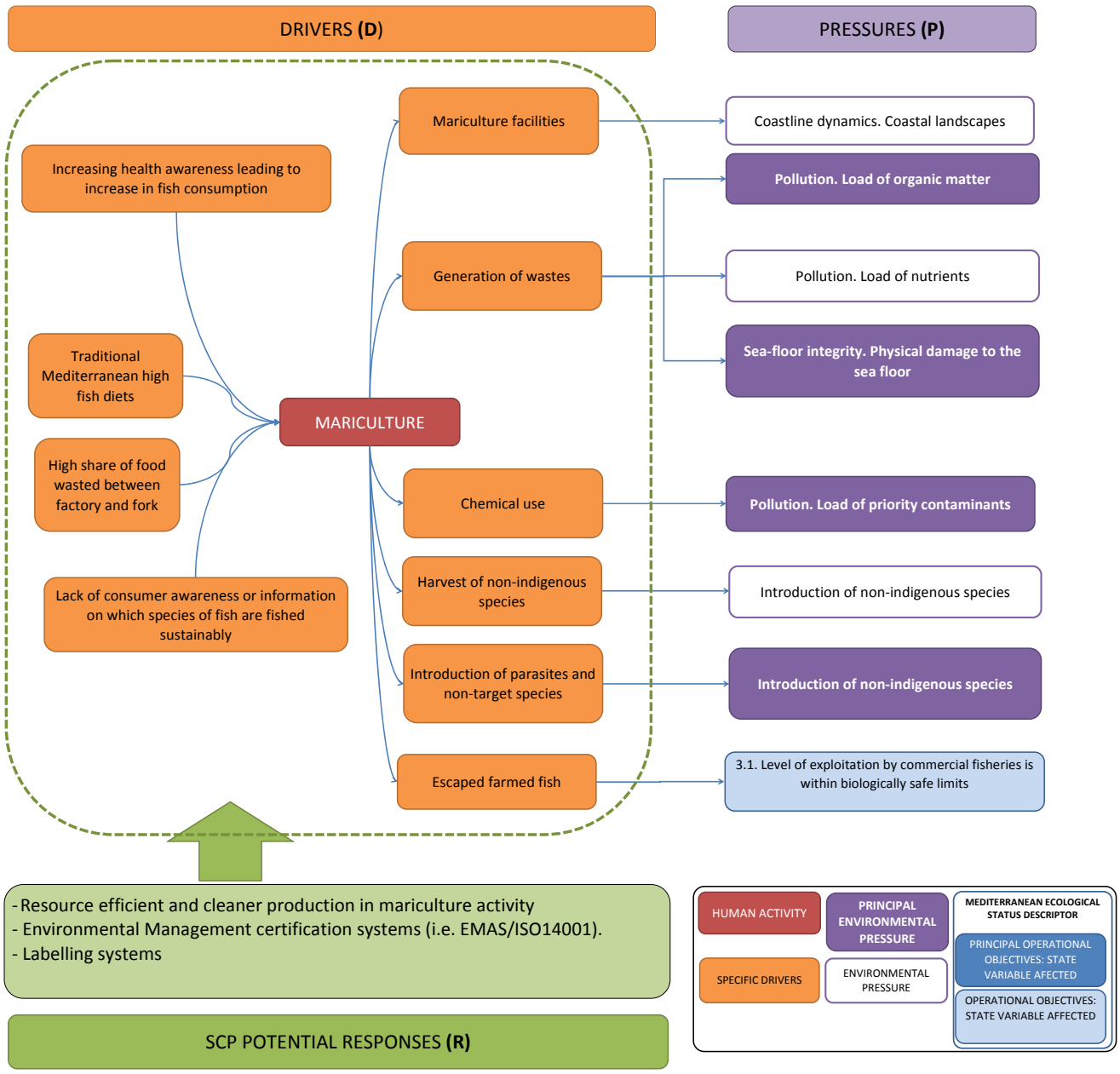

Fig. 28 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Mariculture

Extraction of Non-Living Resources

As in the previous case, Fig. 17 in Chapter 3 shows the most relevant Drivers-Pressures-State relations related to the extraction of non-living resources as a human activity in the Mediterranean. In the same Figure the ecological and operational objectives directly affected by the pressures caused by the extraction of non-living resources are presented. In this case, the following ecological objectives are those most affected (drawn in dark blue): 6. Sea-floor integrity, 8. Coastal ecosystems and landscapes, and 9. Contaminants.

This Figure is complemented with the SCP tools applicable for mitigating the pressures of the extraction of non-living resources.

The more conventional intervention in this area is the regulation of the extraction sites and conditions, including the partial or total prohibition of the extraction activities for some of the non-living resources in some marine areas.

A better regulation of the extraction industries supplemented by encouraging the industries to accept more responsibility for their activities could mitigate their impacts. However, a reduction in the demand for fuels for households, transport and industry and aggregates for construction would also have a significant mitigating effect.

The SCP tools can have a high potential relevance, as a complementary subset of tools for mitigating the pressures on the marine environment. The most relevant potential SCP-type responses identified related to the extraction of non-living resources are (seeF Fig. 29):

- Encouraging Corporate Social Responsibility and certification under EMAS/ISO14001 in the extractive industries
- Market instruments, voluntary agreements, minimum standards and labelling to encourage the design and demand for more fuel-efficient vehicles
- Market instruments for encouraging a switch from private cars to collective forms of transport
- Increasingly stricter building energy standards to reduce energy demand
- Increasing landfill charges for demolition waste to encourage greater recycling and reuse of aggregates
- Promotion of new types of community housing for single people, pensioners etc. to reduce demand for new housing and demand for aggregates.

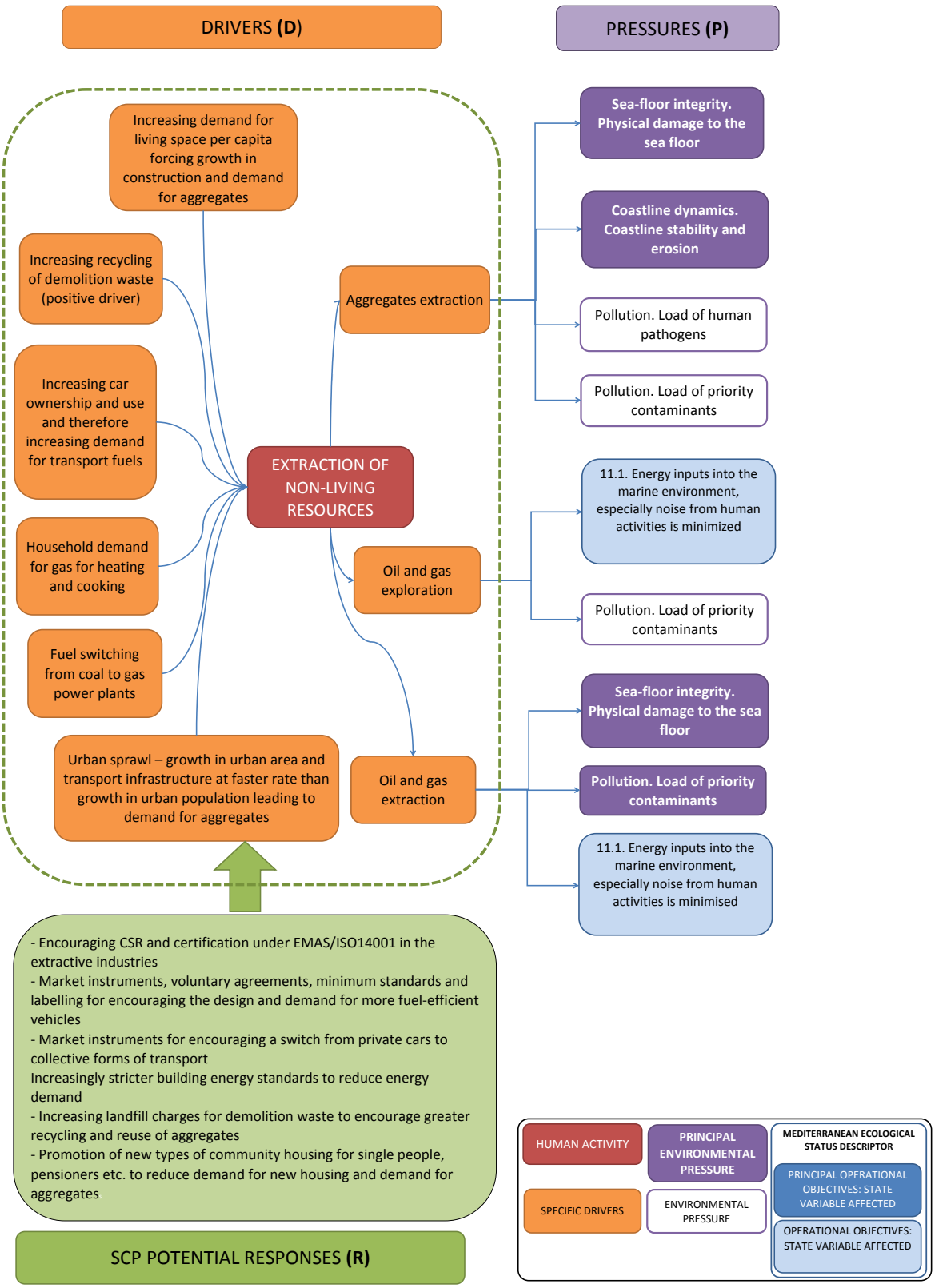

Fig. 29 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Extraction of Non-Living Resources

Placement of Infrastructures

In relation to the placement of infrastructures in the Mediterranean, the conventional interventions are related to planning conditions regarding the erection of infrastructures, Environmental Impact Assessment (EIA) regulations and the protection of marine areas where structures are not permitted.

A better regulation of more sensitive placements of infrastructures via better use of EIA and stricter planning permission conditions is probably the most important aspect here.

SCP tools could have some potential relevance in relation to the reduction of the consumption of some goods and services that are upstream drivers of the placement of infrastructures (i.e. reduction of energy consumption that demands extraction and distribution of gas and petrol). Nevertheless, the potential incidence of SCP tools in relation to the placement of infrastructures can be considered to be low. Therefore, the policies should focus on the increase and improvement of the conventional interventions.

Maritime Transport

Fig. 19 in Chapter 3 shows the most relevant Drivers-Pressures-State relations related to maritime transport. Maritime transport is a very important human activity in the Mediterranean. As described in detail in Chapter 3, it is estimated that approximately 30% of the volume of international sea-borne trade originates in or is directed to Mediterranean ports or passes through the Mediterranean Sea, and that some 20-25% of the world's sea-borne oil traffic transits the Mediterranean.

In Fig. 19 the ecological and operational objectives directly affected by the pressures caused by maritime transport in the Mediterranean are also shown. The most relevant objectives are: 1. Biological diversity; 2. Non-indigenous species 7. Hydrography; 8. Coastal ecosystems and landscapes; 9. Contaminants; and 10. Marine and coastal litter.

Some of the conventional interventions to mitigate the pressures of maritime transport are the establishment of International Maritime Organization (IMO) standards for noise from ships engines, the implementation of Ballast Water Management Convention, the designation of Particularly Sensitive Sea Areas (PSSA) and Special Areas under MARPOL by IMO, and the bans on antifouling chemicals.

The general policy area of SCP may act to reduce the consumption of consumer goods and also the demand for transport fuels. However, in terms of focussed policy, these problems can probably be better mitigated via improved regulation of shipping by the IMO and national governments. Nevertheless, since the enforcement of regulation on shipping operations is difficult to police, increasing self-management via Corporate Social Responsibility (CSR) and EMAS might have an important role to play.

Therefore, SCP would have a medium, or even a low potential impact on the mitigation of the pressures on the environment associated with maritime transport. This potential influence is quite indirect in some cases (i.e. a reduction in the consumption of goods imported) or with low capacity for implementation from the public policies (i.e. CRS and environmental management certification in the shipping industry). Some of the identified potential SCP responses would be(see Fig. 30):

- Encouraging CSR and environmental management certification under EMAS/ISO14001 in the shipping industry
- Market instruments etc. encouraging the design and demand for more fuel-efficient vehicles to reduce the demand for transport fuels
- Market instruments for encouraging a switch from private cars to collective forms of transport to reduce the demand for transport fuels
- Social innovation projects on eating local (seasonal food) to reduce the demand for imported food.

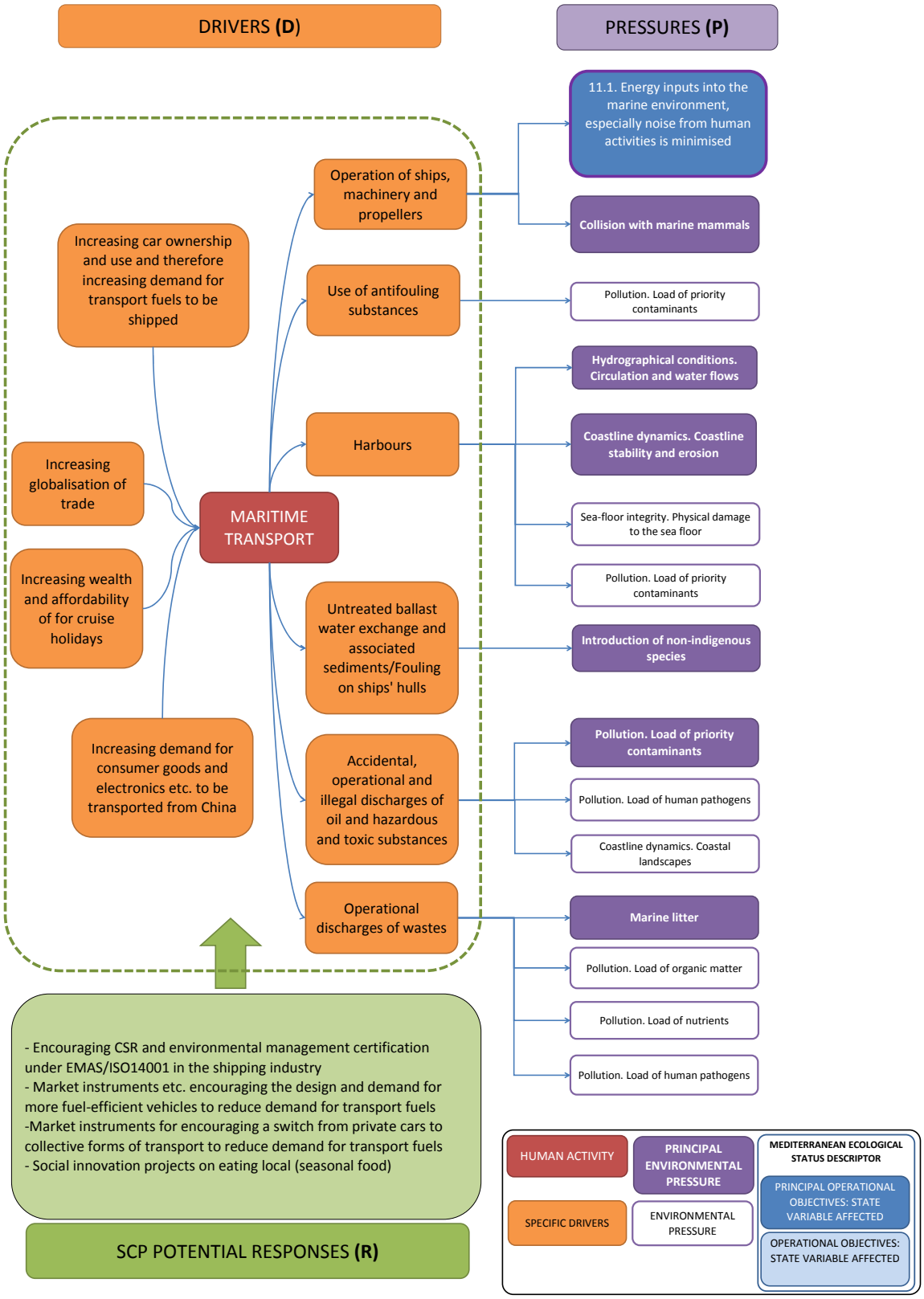

Fig. 30 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Maritime Transport

Tourism and Recreational Activities

Fig. 20 in Chapter 3 show the most relevant Drivers-Pressures-State relations related to tourism and recreational activities. The same Figure shows the ecological and operational objectives directly affected by the pressures caused by these activities. It must be pointed out that tourism, due to its transversal nature, has an impact on almost all the ecological objectives. However, the most relevant ones are: 1. Biological diversity; 5. Eutrophication; 6. Sea-floor integrity; 7. Hydrography; 8. Coastal ecosystems and landscapes; and 10. Marine and coastal litter.

With regard to the tourism and recreational activities, the most commonly used conventional interventions are the Environmental Impact Assessment of large tourist developments, the urbanisation plans/zoning plans and the extension of systems of protected natural areas.

Tourism is of particular importance to the economy of southern European countries and eastern Mediterranean countries. Therefore, actions to reduce the numbers of tourists would not be a desired solution.

Thus, better planning, zoning and regulation of tourism developments may limit their proximity to sensitive ecosystems, while measures to increase the awareness of tourists to their impacts and change their behaviour during their visits may also have some important benefits.

Taking into consideration this entire framework, SCP tools could be considered to have a medium relevance for mitigating the pressures of tourism and its specific impact on the ecological objectives. The most relevant SCP tools identified are (see Fig. 31):

- Encouraging environmental management certification in the tourist industry, and increased environmental labelling of more sustainable hotels, resorts and other facilities, for example via Green Globe.
- Information tools for awareness raising among tourists and leisure boat operators.

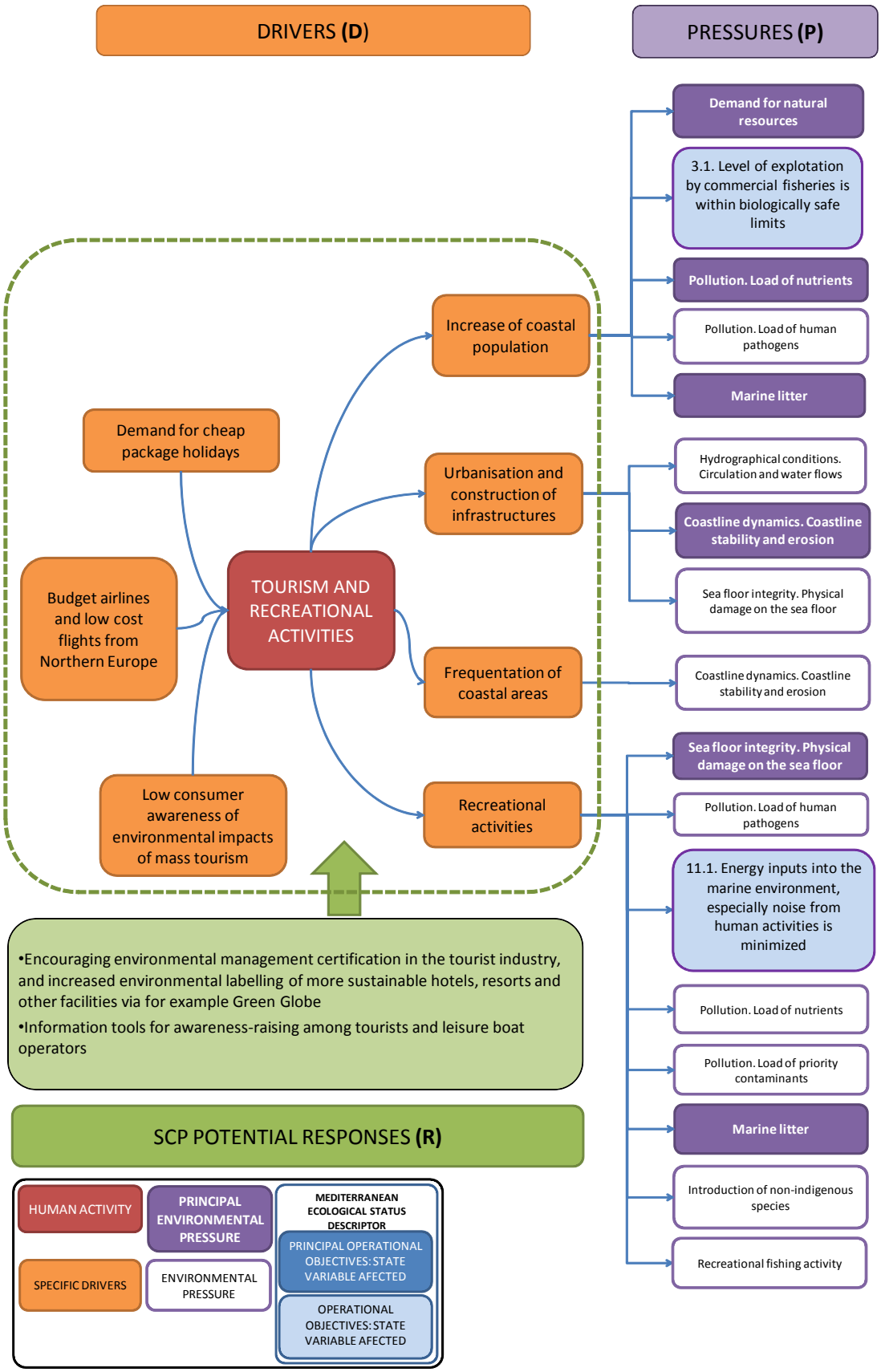

Fig. 31 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Tourism and Recreational Activities

Discharges from Land-based Sources and Activities

Fig. 21 in Chapter 3 shows the most relevant Drivers-Pressures-State relations related to the Discharges from Land-based Sources and Activities in the Mediterranean.

The danger presented to the marine environment's living resources and to human health by pollution from land-based sources and activities is primarily due to the release of untreated, insufficiently treated or inadequately disposed of domestic or industrial discharges.

The discharges from Land-based Sources and Activities have a direct influence over several ecological status descriptors, particularly relevant for ecological objectives associated with: 1. Biological diversity; 5. Eutrophication; 9. Contaminants; and 10. Marine and coastal litter.

There is a very important intervention related to the mitigation of pressures over the Mediterranean caused by the discharges from land-based sources and activities. In fact, it is one of the issues more tackled in the framework of MAP.

The most relevant conventional interventions are those associated with integrated pollution prevention and the regulation of industries, the regulation of the management of wastewaters, the public investments in wastewater facilities and advice and regulations for farmers on the application of fertilisers close to watercourses.

These conventional interventions have a major impact on the prevention of pressures in the ecosystem. However, it should also be pointed out that most of them are very much based on end-of-pipe type solutions.

Therefore, there is a high and considerable potential for supplementing these through SCP-type approaches aimed at: 1) encouraging cleaner production via technological innovation in factories and plants, reducing waste emissions through closed loop processes; 2) the control of certain chemicals in agricultural products, in washing powders and other cleaning products; and 3) increasing consumer demand for ecolabelled products, which lead to lower emissions to water during production processes and during use etc.

Taking into consideration this potential role of SCP-type approaches, the most relevant SCP-type responses identified would be (see Fig. 32):

- Environmental Management certification systems (i.e. EMAS/ISO14001) for industries aimed at constant improvements in environmental performance, compliance and reductions in waste and emissions

- Capacity-building schemes to show companies economic and environmental benefits in investing in new innovative production processes
- Environmental tax reforms aimed at taxing products with high environmental impacts
- Consumer awareness-raising and Ecolabel schemes aimed at constant improvements in key products the production or use of which lead to harmful emissions to water
- Taxes on products the production or use of which lead to harmful emissions to water
- Banning specific damaging compounds from agricultural pesticides
- Organic farming certification and labelling schemes for food products
- Integrated Crop Management certification and labelling schemes for food products
- Reducing the demand for fresh water through water metering in households and pay by use, raising water prices for all users to encourage the use of water-saving products, encouraging re-use of water etc. (i.e. to reduce the need for desalination plants)

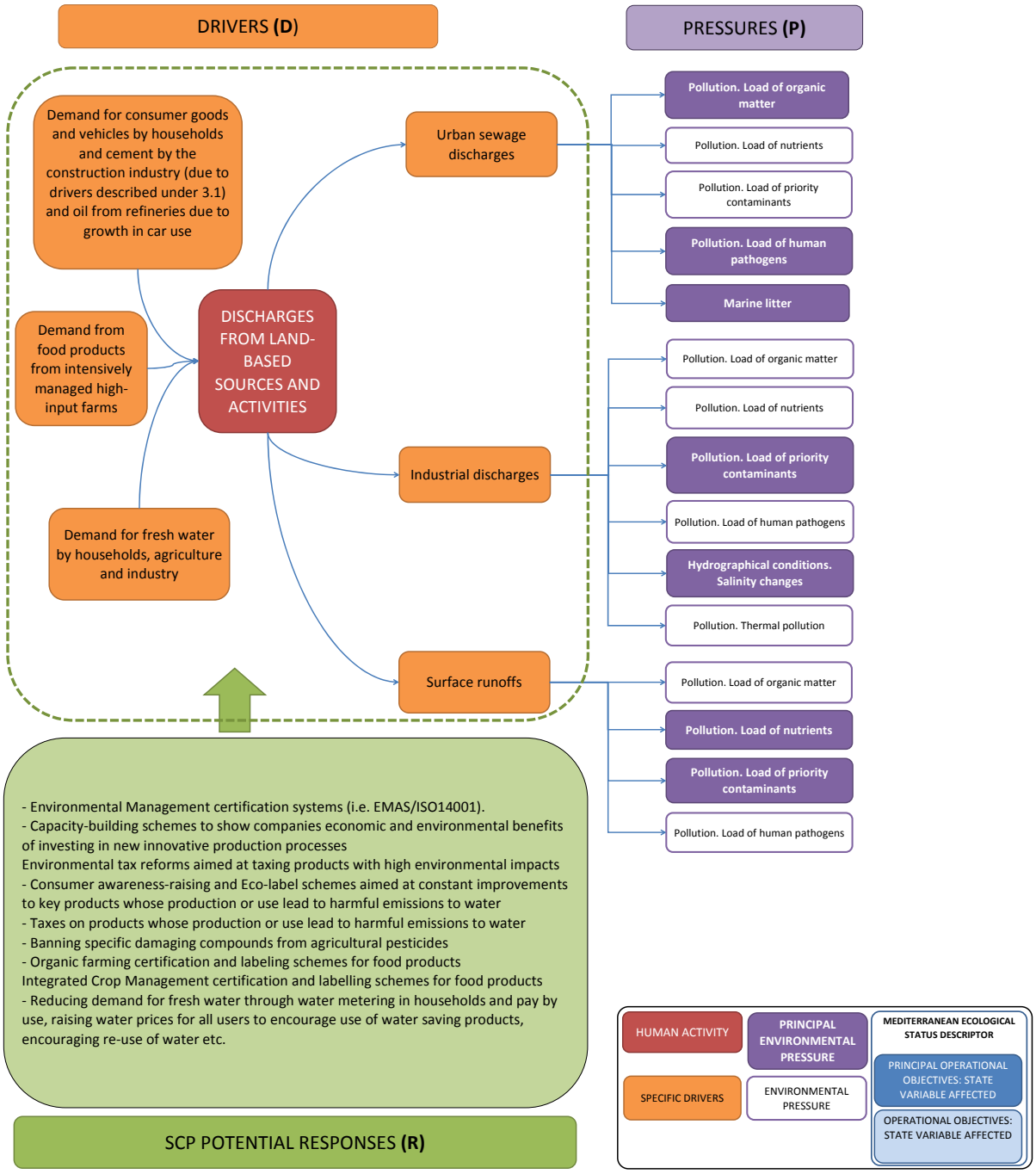

Fig. 32 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Discharges from Land-based Sources and Activities

Dumping of Wastes

Fig 22 in Chapter 3 shows the most relevant Drivers-Pressures-State relations related to the Dumping of Wastes.

Dumping as defined by the Barcelona Convention protocol is any deliberate disposal or storage of wastes or other matter on the seabed or in the marine subsoil from ships or aircraft.

Dumping of wastes in the Mediterranean is mainly due to the increase of maritime transport and demand for navigation waterways, increased activity of factory ships and the industrialisation of fishing, the presence of oil drilling platforms, demand for construction materials and mining activities.

Fig. 22 also shows the ecological and operational objectives directly affected by the pressures caused by the dumping of wastes in the Mediterranean. The most relevant objectives are the ones related to: 6. Sea-floor integrity; 9. Contaminants; and 10. Marine and coastal litter.

The most usual conventional interventions are related to the regulation of the dumping of wastes by different human activities such as fishing activities, oil extraction, shipping, and military action.

In the Mediterranean, dumping is highly regulated, and the dumping of wastes and other matter is prohibited with the exception of: dredged material; fish waste or organic materials resulting from the processing of fish and other marine organisms; platforms and other man-made structures at sea, provided that material capable of creating floating debris or otherwise contributing to pollution of the marine environment has been removed to the maximum extent; and inert uncontaminated geological materials the chemical constituents of which are unlikely to be released into the marine environment. Dumping of these wastes requires a prior special permit from the competent national authorities.

The potential relevance of the SCP approach in this issue is low. The main SCP approach (see Fig. 33) is via encouraging corporations to take on responsibility for preventing dumping of waste via Corporate Social Responsibility (CSR) and other measures. This could be useful for activities that are otherwise difficult to police by authorities. However, this would only be useful for large company operations and not for most fishing fleets, etc.

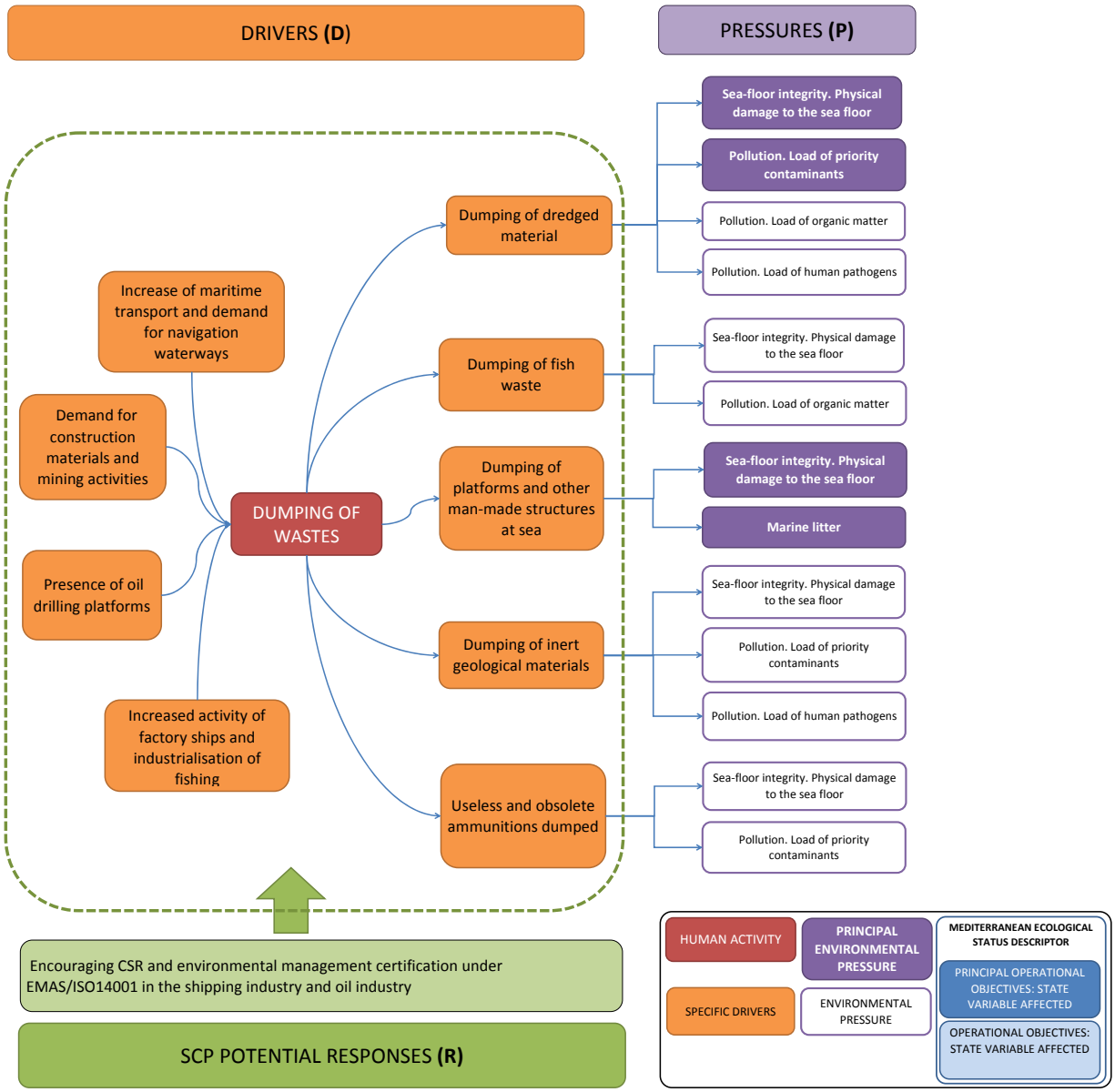

Fig. 3314 Identification of potential SCP responses to apply in key drivers affecting ecological objectives: Dumping of wastes

5.2 Example of the application of SCP measures in fisheries

This chapter provides an example of the application of SCP measures in fisheries. Fisheries represent the greatest use of marine resources in the Mediterranean and they are relevant activities in the Mediterranean, which affect many people in the basin. Furthermore, fisheries have been chosen as a human activity, which SCP tools can have a notable effect on, and as a relevant activity that has a direct impact on the ecological and operational objectives established within the framework of the MAP Ecosystem Approach roadmap. Moreover, being a human activity of an intuitive nature, fisheries facilitate the explanation and presentation of both production and consumption tools.

As indicated above, there are many inter-related issues affecting the sustainability of fisheries, including overcapacity in fishing fleets and a related increase in illegal, unregulated and unreported (IUU) fishing, a failure to take into consideration the ecosystem effects of fishing in management plans (e.g. by-catch, discards, destructive fishing practices), the lack of incentives-based management, weak monitoring, control and surveillance capacity and inability and/or unwillingness to accept short-term costs for long-term benefits, etc.

The continuing contribution of fisheries to sustainable development depends on the health of functioning, productive ecosystems and on their optimal utilisation.

Traditionally, for the achievement of sustainable fisheries, conventional measures and ecosystem-based tools have been applied. Conventional measures include limits on fishing effort, regulations for the selectivity of catches and protection of the seabed communities against harmful fishing practices. Regulations and guidelines for fishery sustainability and Ecosystem Approach management have been set by national fishery authorities and international bodies as the Food and Agriculture Organisation (FAO) and Regional Fishery Management Organisations (RFMO).

In general, fishing effort is defined as fishing capacity exerted for a given time in a given area. Therefore, **fishing effort** can be limited directly by (1) reducing fishing capacity through measures such as reduction in the size of the fishing fleet, reduction of the Horsepower of the trawlers' fleet and for the fishing gears, decreasing the number of hooks or increasing hook size for longline vessels or decreasing the fishing gear surface for gillnets; and (2) reducing fishing time (trawling time, setting time, time spent in fishing area or period between leaving and entering port). Also, fishing effort can be limited in an indirect way by reducing fish catches and landings, e.g. Total Allowable Catches (TACs) and quotas in EU countries.

Selectivity of catches for the achievement of sustainable fisheries has conventionally been implemented through the regulation of the mesh sizes of nets, the regulation of

hooks size and type, the use of square mesh and by-catch excluder devices, etc. Spatio-temporal management and even closure of areas prohibiting non-selective fishing gears are also commonly used tools

In the Mediterranean, for instance, specific measures related to the **protection of the seabed communities** are carried out, prohibiting the use of harmful fishing gears below a certain depth, e.g. bottom trawling was forbidden at depths of over 1,000 metres in 2005 in order to protect Mediterranean seabeds and vulnerable deep sea fauna.

With regard to ecosystem-based tools, we might highlight the **"FAO Code of Conduct for Responsible Fisheries and its four associated International Plans of Action"**[12] established in 1995 as a voluntary framework for increasing the contribution of fisheries to sustainable development.

This Code provides the conceptual basis and institutional requirement for, *inter alia*, ecosystem and habitat protection; accounting for environmental factors and natural variability; reducing the impacts of fishing and other activities; biodiversity conservation; multispecies management; the protection of endangered species; accounting for relations between populations; reducing land-based impacts and pollution; achieving integration in coastal area management; eliminating ghost fishing; reducing waste and discards; a precautionary approach; delimitating ecosystem boundaries and jurisdictions, as well as adapted institutions and governance.

On the other hand, the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem in 2001 adopted the **"Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem"**, directly and specifically addressing the issue of introducing more ecosystem considerations into conventional fisheries management.

The Reykjavik Declaration called for, *inter alia*: (1) the immediate introduction of management plans with incentives for sustainable use of ecosystems; (2) strengthening of governance; (3) prevention of the adverse effects of non-fisheries activities on the marine ecosystems and fisheries; (4) advances in the scientific basis for incorporating ecosystem considerations in management (including the precautionary approach); (5) monitoring of interactions between fisheries and aquaculture; (6) strengthening of international collaboration; (7) technology transfer; (8) removal of trade distortions; (9) collection of information on management regimes, and (10) development of guidelines.

Later, in 2002, the **Ecosystem Approach to Fisheries** (EAF) was adopted by the FAO Technical Consultation on Ecosystem-based Fisheries Management. The purpose was to

[12] International Plans of Action for: i) Reducing Incidental Catch of Seabirds in Longline Fisheries; ii) Conservation and Management of Sharks; iii) Management of Fishing Capacity; and iv) Prevent, Deter, and Eliminate Illegal, Unreported and Unregulated Fishing.

plan, develop and manage fisheries in a manner that addresses the multiplicity of societal needs and desires, without jeopardising the options for future generations to benefit from a full range of goods and services provided by marine ecosystems. Therefore, an Ecosystem Approach to fisheries strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries.

The EAF established the following principal operational objectives:

- Rebuilding ecosystems
- Maintaining Reproductive Capacity of Target Resources
- Maintaining Biological Diversity
- Protecting and Enhancing Habitats
- Protecting Selected Marine Areas
- Reducing By-catch and Discards
- Reducing Ghost Fishing
- Reducing Uncertainty and Risk
- Improving the Institutional Set-up
- Matching Jurisdictional and EAF Boundaries
- Improving the Decision-making Framework
- Improving Statistics and Inventories
- Monitoring and Indicators
- Improving Research Capacity
- Management Planning
- Certification of management systems

Under the auspices of the UN, several agencies have drafted a document under the name of **"A blueprint for ocean and coastal sustainability"** developed in preparation of the next UN Conference on Sustainable Development Rio+20 (IOC/UNESCO *et al.*, 2011). This document includes a proposal to increase efforts for responsible fisheries and aquaculture for the achievement of the objective related to the promotion of sustainable ocean[13]. In this respect, the document notes that green practice changes in the ocean include the consideration of institutional responses such as fishing capacity and effort reduction where required, the adoption of responsible governance of tenure of fisheries, greater enforcement of existing regulations including the use of technologies to assist enforcement, greater collaboration between regional and national

[13] Objective 2: "Actions that support the Green Economy concept leading to alleviation of poverty and promotion of sustainable ocean sectors and livelihoods including actions to improve implementation at local levels through participatory processes".

fisheries bodies, capacity building, and the protection and restoration of key habitats and species that provide the basis for the fisheries value chain.

These conventional measures and ecosystem-based tools could be complemented with SCP tools for the achievement of the ecological objectives established by MAP as shown in Fig. 34.

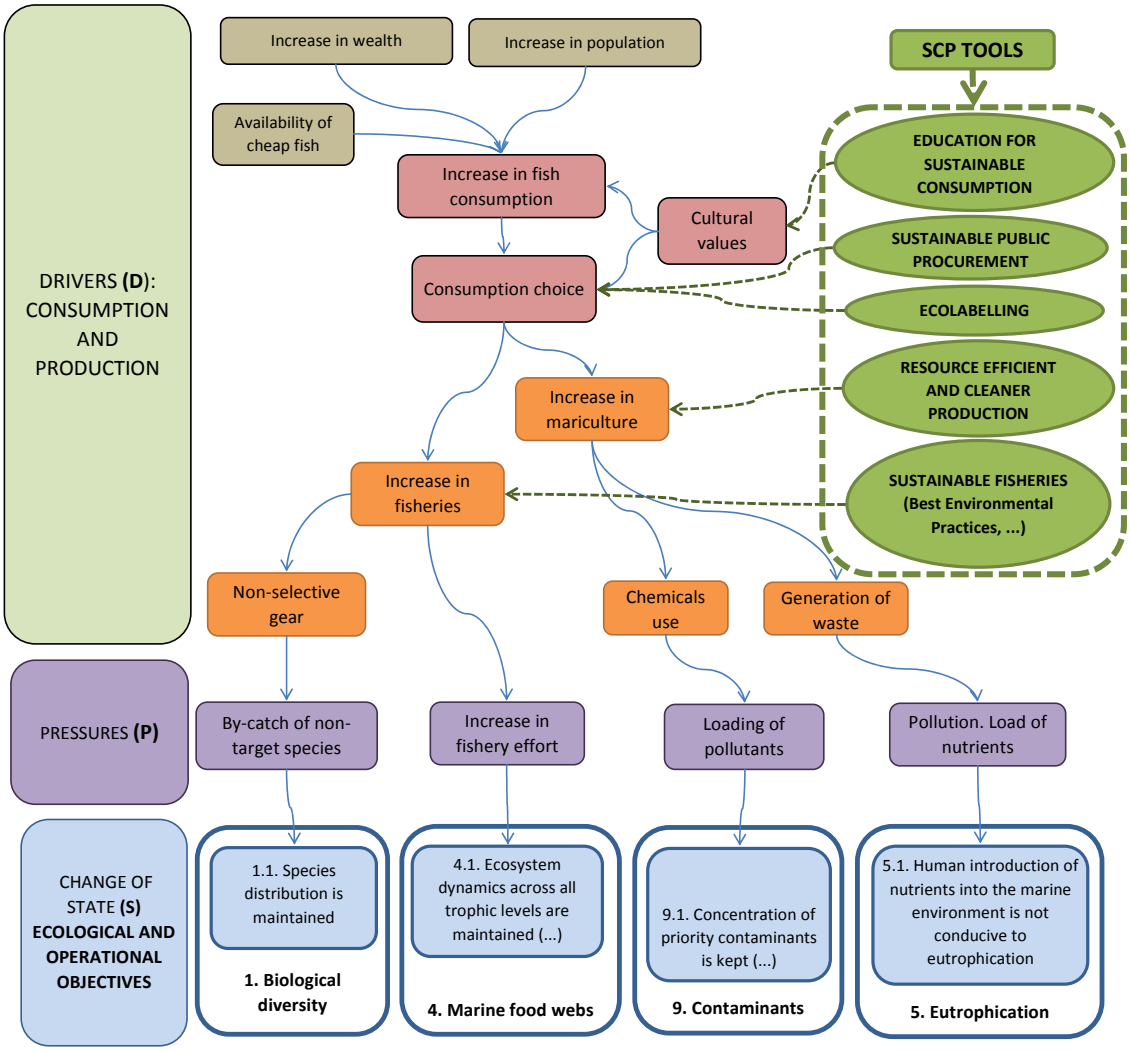

Fig. 34 Simplified map of relations between consumption and production Drivers linked to fish consumption, Pressures and Change or State (Ecological objectives) and example of SCP tools to be considered

Some experiences and initiatives of SCP tools applied to fisheries and focusing on end consumers, our first drivers, are presented below as an example of how they can complement conventional measures.

Education for sustainable consumption

- Monterey Bay Aquarium Seafood Watch programme[14] (California, USA)

  The Monterey Bay Aquarium Seafood Watch programme helps consumers and businesses make choices for healthy oceans. The recommendations indicate which seafood items are "Best Choices," "Good Alternatives," and which ones you should "Avoid."

  Seafood Watch raises consumer awareness through pocket guides, website, mobile applications and outreach efforts. They encourage restaurants, distributors and seafood purveyors to purchase from sustainable sources.

  Its recent achievements include the bill to ban the trade in shark fins in California. As published by Seafood Watch on its web site: "A ban on fins here will have a significant impact on the global trade in shark fins and protect shark populations around the world".

- Marine Conservation Society (MCS)[15] (UK)- *Good Fish Guide* and *Fishonline*

  The MCS *Good Fish Guide* and *Fishonline* are designed to help identify the fish species that are the most resilient to fishing pressure, from well-managed sources and caught using methods that minimise damage to wildlife and habitats, allowing the best seafood choices to be made.

  Their many successes and campaigns to date include the introduction of Marine Acts to give better protection to the seas and marine life, and influencing sustainable seafood choices by major retailers and consumers through the *Good Fish Guide*. They have also brought together thousands of volunteers in *Beachwatch* to clean beaches of litter, and campaigned for "*Marine Reserves Now!*" to create safe havens for wildlife and fish populations to recover.

[14] http://www.montereybayaquarium.org/cr/seafoodwatch.aspx
[15] http://www.mcsuk.org

- www.fish2fork.com

  This is the world's first website to review restaurants according to whether their seafood is sustainable.

- Slow Fish Campaign[16]

  The international Slow Fish campaign is launching initiatives that promote artisanal fishing and neglected fish species, inspiring a reflection on the state and management of the sea's resources. To have any chance of success, this reflection must start at a local level.

  The *Slow Fish event*, held every two years in Genoa (Italy) attracts over 50,000 visitors; it aims to promote good practices for the responsible consumption of high-quality fish and seafood. A large space is dedicated to information for consumers, awareness raising for children and encounters between people involved in sustainable fishing. During the 2009 event, Slow Food presented *Fare's Fair*, a practical guide for Mediterranean consumers wishing to know more on the subject of sustainable fishing, along with an entertaining and educational version of the guide, *Bare Bones*, for children.

  The *Slow Food Foundation for Biodiversity* is playing a key role. In recent years it has launched 23 Presidia projects with *Terra Madre* fishing communities.

Sustainable public procurement

- Good Food on the Public Plate project[17] (London's public procurement)

  Since 2009 the project has provided a wide range of assistance to a diverse cross-section of London's public sector organisations including local authorities, hospitals, universities and care homes, to enable them to use more sustainable food in their catering. The project is fully funded by the Greater London Authority (GLA) and their services are delivered free of charge.

[16] http://www.slowfood.com/slowfish/
[17] http://www.sustainweb.org/goodfoodpublicplate/

GLA Group has made a commitment to ensuring that all its members purchase sustainable food, modelled on the London 2012 Food Vision, and including a commitment to 100% demonstrably sustainable seafood.

Good Food on the Public Plate awards recognise and celebrate the best of London's public sector caterers and food procurement staff for increasing the sustainability of the food and drink they serve. Awards will range from incorporating higher animal welfare, sustainable fish, food with a reduced environmental impact and real bread.

- UNEP recommendation on serving only sustainable fish[18]

  In March 2011 the United Nations Environment Programme (UNEP) issued guidance on serving sustainable fish in catering for UN canteens. The procurement guidelines are intended to help UN agencies around the world use natural resources in a responsible way, and to stimulate and accelerate a change in production towards more sustainable methods.

  Only consuming fish that comes from demonstrably sustainable sources is an important way in which the UN can take immediate and practical action to demonstrate its commitment to sustainable development.

  The UN's new food guidelines include a commitment to buying only sustainable fish, by:

  - Excluding the worst: not buying threatened species - defined in Europe as those on the Marine Conservation Society's "fish to avoid" list
  - Buying the best: for wild caught, Marine Stewardship Council certified; for farmed fish, Soil Association organic certified

Ecolabelling

- Dutch *Good Fish Guide*[19] (set up in 2004 by the North Sea Foundation)

  The initiative has improved the level of communication and social interaction between different stakeholders, particularly NGOs and fishermen, who may have conflicting priorities.

[18] http://www.sustainweb.org/sustainablefishcity/united_nations_sustainable_fish_commitment/
[19] http://www.goedevis.nl

The primary consumer tool produced by the Guide is a small wallet-sized card, which indicates the sustainability status of different species with a traffic light system (red = over-exploited, green = environmentally sustainable). The card is now reportedly used by 25% of all Dutch consumers.

On advice from the Guide, two large supermarket chains removed the threatened North Sea cod, plaice and sole from their shelves. At the time, this triggered a negative response from fishermen as it opposed their fishing practices and portrayed them as "destroyers of the ecosystem".

- Marine Stewardship Council (MSC) Fishery Standard[20]

This is an ecolabelling system for capture fisheries ("Certified sustainable seafood"). The MSC standard has 3 overarching principles that every fishery must prove that it meets:

- Principle 1: Sustainable fish stocks. The fishing activity must be at a level that is sustainable for the fish population. Any certified fishery must operate so that fishing can continue indefinitely and is not over-exploiting the resources.
- Principle 2: Minimising environmental impact. Fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which the fishery depends.
- Principle 3: Effective management. The fishery must meet all local, national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability.

So far, 269 fisheries are engaged in the MSC program (135 are certified fisheries and 134 fisheries are in assessment), another 40 to 50 fisheries are in confidential pre-assessment.

Regarding seafood in the MSC programme:

- Together, fisheries already certified or in full assessment record annual catches of close to 9 million metric tonnes of seafood. This represents over 10% of the annual global harvest of wild capture fisheries.
- The fisheries already certified catch over 5 million metric tonnes of seafood. This is close to 6% of the total wild capture harvest.
- Worldwide, more than 12,000 seafood products, which can be traced back to the certified sustainable fisheries, bear the blue MSC ecolabel.

[20] http://www.msc.org

Resource efficient and cleaner production

- Cleaner production in Danish fish processing[21]

  The experiences with cleaner production, from the late 1980s until today, among leading Danish industries producing pickled herring and canned mackerel reveal that significant environmental improvements have been obtained for the analysed companies, especially concerning reductions in water consumption, wastewater emissions, and utilisation of fish "waste" for valuable by-products. Still, more focus could be placed on the reduction of energy consumption, change of packaging types, and environmental impacts in other stages of the products' life cycle.

Best environmental practices

- 2001 Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem

  Encourages FAO to work with scientific and technical experts from different regions to develop technical guidelines for best practices with regard to introducing ecosystem considerations into fisheries management.

- MITIGA FISHERIES Lab – SW Mediterranean

  As part of the LIFE+ project "Inventory and designation of marine Natura 2000 areas in Spain", an interesting case study can be found in the SW Mediterranean where cooperation between the artisanal fisheries and researchers of the NGO Alnitak and KAI Marine Services has tackled a series of sustainability issues of international relevance.

  With regard to surface longline fisheries targeting swordfish, Atlantic bluefin tuna and albacore, cooperation was initiated as early as 1986 after the detection of extremely high loggerhead turtle (*Caretta caretta*) by-catch rates (estimates of over 20,000 turtles per year). Research conducted by Alnitak, KAI, IEO (Spanish Oceanographic Institute) and NOAA NMFS (National Marine Fisheries Service of the US National Oceanic and Atmospheric Administration) scientists together with fishermen have, since 2005, allowed for the identification and testing of 5 measures that have virtually eradicated the risk of by-catch (95% reduction in by-catch rate).

  Currently collaboration work is focusing on developing the fishery's capacity to optimise the selling of the target catch in support of an initiative by the fishermen's association CARBOPESCA, which has achieved the certification of the

[21] THRANE, M. *et al.* (2009). *Cleaner production in Danish fish processing – experiences, status and possible future strategies.* Journal of Cleaner Production 17 (2009) 380–390.

catch of these fisheries as a sustainable product with a "geographical appellation of origin" label.

With regard to the artisanal gillnet fisheries around the coastal waters of the Marine Reserve of Cabo de Gata – Níjar, a similar cooperation process focused on the risk of by-catch and depredation interactions with the bottlenose dolphin (*Tursiops truncatus*). Cooperation has allowed for the mitigation of negative interactions between the fishery and protected species. Furthermore, an important capacity development effort has been made to help fishermen organise themselves creating an association of artisanal fisheries; PESCARTE. Through this organisational structure, fishermen are trying to ensure their future by optimising their business and playing an active role in initiatives from the Spanish Central Administration, the Regional Government of Andalusia (Spain) and initiatives like the IUCN Alboran Initiative or the CP/RAC Workshops on the Dissemination of Best Practices in Fishing in the Mediterranean.

These workshops are integrated in the CAMP Levante project[22] and they are coordinated by the Regional Activity Centre for Cleaner Production (CP/RAC). CAMP Levante is a project that, following a methodology established by the United Nations, seeks to promote in this stretch of coastline a change in the management model implementing Integrated Coastal Zone Management.

So far, two workshops have been carried out (June and September 2011). In the first workshop, training in sustainable fishing operations was be given to the members of the artisanal fleet in the area and to associations and groups involved in the fisheries sector. In order to achieve this, the event counted on the contribution of the Lonxanet Foundation for Sustainable Fisheries, which presented its experiences in the field of fisheries management.

The second event, attended by 25 people, dealt with topics such as: the role of the Mediterranean Platform for Traditional Fishing in the current Common Fishing Policies reforms, the Co-Management of Fishing Reserves in Andalusia, the new regulations regarding sport fishing, direct sales mechanisms, energy saving measures and the diversification of the fishing sector, among others.

Attending fishermen also took part in a survey assessing their knowledge of the marine environment. The results of the survey will be included in the sector regulation proposals that are currently being studied by AGAPA (the Agriculture and Fisheries Management Agency for Andalusia), a public company attached to the Regional Government of Andalusia.

[22] http://www.camplevantedealmeria.com

6. CONCLUSIONS: CHALLENGES AND NEXT STEPS IN THE APPLICATION OF THE SCP APPROACH

6.1 Challenges presented in the application of SCP measures within the framework of the MAP Ecosystem Approach roadmap

The Pressures of the human activities on the marine ecosystem, and their consequences for the achievement of the ecological objectives associated to the State of the ecosystem, are linked with the consumption and production models.

Therefore, the improvement of the patterns of consumption and production in the Mediterranean costal countries can contribute substantially to the achievement of Good Environmental Status (GES), defined by the ecological objectives and targets established by MAP.

The Sustainable Consumption and Production (SCP) approach focuses on the assessment of the interactions between consumption demand and production activities, and also between consumption-production and the environmental pressures. The knowledge of these interactions can help define of more accurate and effective policies to facilitate the achievement of the GES.

The SCP approach also includes policies and management tools aimed at reducing environmental pressures at both consumption and production levels.

SCP offers a new set of response types that can act further up the causal system and thus supplement more traditional responses, which are mainly aimed at managing the State of the environment in the Mediterranean. The SCP tools introduce a more global and systemic view to the process, attempting to make an impact on the whole production supply chain, and also the drivers furthest upstream, such as citizens' consumption options.

Sustainable Consumption and Production (SCP) tools, albeit complementary to conventional measures and interventions that have been applied to alleviate the pressures of human activities at sea, appear important for reducing the pressures on the marine and coastal environment for some of the human activities analysed, while in other cases, the potential effect is lower.

The SCP approach could make a significant contribution to mitigating the pressures on the Mediterranean ecosystem caused by discharges from land-based sources and activities, the extraction of non-living resources, in addition to Fisheries and mariculture. The mitigation of these pressures would help achieve the ecological

objectives linked firstly to eutrophication and contaminants, and secondly to the sea-floor integrity, biological diversity and marine food webs.

However, SCP would not have relevance in relation to human activities in the Mediterranean such as urbanisation, the placement of infrastructures, marine transport or dumping of wastes, while would have a medium relevance in relation to the Tourism and recreational activities.

In summary, the main opportunities of the application of SCP in the framework of the MAP Ecosystem roadmap are listed below. All of them are directly linked to Step 7 of the MAP Ecosystem Approach roadmap: *Development and review of the relevant action plans and programmes*.

- Help create knowledge for decision-makers on the links between the patterns of consumption and production and the environmental degradation of the Mediterranean region, specifically with regard to the key environmental pressures related to ecological objectives.
- Facilitate information about the environmental pressure of the different economic option models for the Mediterranean countries.
- Help prioritise and focus the policies aimed at achieving the GES targets and improve their effectiveness.
- Facilitate specific tools for the reduction of impacts of lifestyle and consumption patterns aimed at achieving the ecological objectives, particularly in the European countries.
- Facilitate the conceptual framework and specific tools for reducing the impact of key production activities in the Mediterranean in order to achieve the ecological objectives.

On the other hand, several relevant limitations in some of the potential applications of the SCP can be identified within the framework of the ecosystem approach roadmap. These limitations are listed below:

- Limitations in the application of SCP assessment tools (EE-IOA and LCA) caused by the lack of information at the Mediterranean ecosystem level. Firstly, the geographical scope of the data is limited due to the lack of availability of regularly updated input/output accounts and satellite environmental accounts for all Mediterranean countries, especially the southern countries. Secondly, there is a scarcity of environmental pressure data in the available environmental satellite accounts.

- Limitation of the locational Information, due to the fact that EE-IOA usually provides information about environmental pressures occurring within the country as a whole, and information associated with the coastal areas and affecting the ecological objectives established by MAP would be required.
- The non-locational nature of SCP can introduce limitations in its potential for focused location-specific mitigation i.e. reducing environmental impacts on the Mediterranean, especially with growing international trade.

6.2 Proposed next steps for the application of the SCP in the MAP Ecosystem Approach roadmap

Future assessment of management and policy actions that could result from a better understanding of the state of the Mediterranean marine and coastal environment will have to focus more strongly on the level of pressures caused by the human activities, and, therefore, linked to the models of production and consumption.

Thus, taking into account different phases of the MAP ecosystem approach roadmap, indicated in blue, there are proposals for the following actions listed below to be considered:

Integrated Monitoring Programme

Preparing the regional integrated monitoring programme

- Definition of economic and environmental data required for the assessment of environmental pressures for consumption and production affecting the ecological objectives useful for policy-making (economic activities and national economic accounts, consumption, environmental impacts of production activities, etc.)
- Evaluate the potential of Environmental Extended Input-Output Analysis (EE-IOA) and the Life Cycle Analysis (LCA) methods for providing useful information for SCP policy-making within the framework of the Mediterranean.
- Reporting of economic and environmental data for the application of EE-IOA (National Environmental Accounts)
- Pilot applications of EE-IOA in some countries

UNEP/MAP policies under development for the incorporation of the Ecosystem Approach application progress

- Introduction of SCP approach and tools in *Preparing an Action Plan on Marine Litter*

Review and development of Action Plans and Programmes for measures to take into account regarding progress made with the application of the Ecosystem Approach

- Design, ex ante impact assessment, and adoption of SCP tools for influencing consumption and production patterns relevant to achieving ecological targets.
- Incorporation of SCP national strategies to address the achievement of ecological objectives

Public awareness raising regarding the Ecosystem Approach

- Incorporation of SCP tools to raise public awareness on sustainable consumption to help achieve the ecological objectives: Education for sustainable consumption and production (ESCP), Environmental Labelling and Certification, Sustainable Public Procurement / Green Public Procurement.

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ANNEXES

ANNEX 1: PROPOSED ECOLOGICAL OBJECTIVES

PROPOSED ECOLOGICAL OBJECTIVES

This set of ecological objectives, operational objectives and indicators was agreed during the third meeting of Government-designated Experts on the Application of the Ecosystem Approach by MAP held in Durres (Albania) in June 2011

1 Biodiversity

Ecological Objective	Operational Objectives	Indicators
Biological diversity is maintained or enhanced. The quality and occurrence of coastal[1] and marine habitats[2] and the distribution and abundance of coastal[3] and marine species[4] are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.	**1.1 Species distribution is maintained**	1.1.1 Distributional range
		1.1.2 Area covered by the species (for sessile/benthic species)
	1.2 Population size of selected species is maintained	1.2.1 Population abundance
		1.2.2 Population density
	1.3 Population condition of selected species is maintained	1.3.1 Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/ mortality rates)
	1.4 Key coastal and marine habitats are not being lost	1.4.1 Potential / observed distributional range of certain coastal and marine habitats listed under SPA protocol
		1.4.2 Distributional pattern of certain coastal and marine habitats listed under SPA protocol
		1.4.3 Condition of the habitat-defining species and communities

[1] By coastal it is understood both the emerged and submerged areas of the coastal zone as considered in the SPA/BD Protocol as well as in the definition of coastal zone in accordance with Article 2e and the geographical coverage of Article 3 of the ICZM Protocol

[2] Regarding benthic habitats currently, sufficient information exists to make a prioritization amongst those mentioned in the UNEP/MAP - RAC/SPA list of 27 benthic habitats and the priority habitats in areas beyond national jurisdiction following CBD decisions VIII/24 and VIII/21 paragraph 1 . These could include from shallow to deep: biocoenosis of infralittoral algae (facies with vermetids or trottoir), hard beds associated with photophilic algae, meadows of the sea grass Posidonia oceanica, hard beds associated with Coralligenous biocenosis and semi dark caves, biocoenosis of shelf-edge detritic bottoms (facies with Leptometra phalangium), biocoenosis of deep-sea corals, cold seeps and biocoenosis of bathyal muds (facies with Isidella elongata). Amongst pelagic habitats upwelling areas, fronts and gyres need special attention and focus.

[3] By coastal it is understood both the emerged and submerged areas of the coastal zone as considered in the SPA/BD Protocol as well as in the definition of coastal zone in accordance with Article 2e and the geographical coverage of Article 3 of the ICZM Protocol

[4] On the basis of Annex II and III of the SPA and Biodiversity Protocol of the Barcelona Convention

2 Non-indigenous species

Ecological Objective	Operational Objectives	Indicators
Non-indigenous[5] species[6] introduced by human activities are at levels that do not adversely alter the ecosystem	**2.1 Invasive non-indigenous species introductions are minimized**	2.1.1. Spatial distribution, origin and population status (established vs. vagrant) of non-indigenous species
		2.1.2 Trends in the abundance of introduced species, notably in risk areas
	2.2. The impact of non-indigenous particularly invasive species on ecosystems is limited	2.2.1 Ecosystem impacts of particularly invasive species
		2.2.2 Ratio between non-indigenous invasive species and native species in some well studied taxonomic groups

[5] The term non-indigenous refers to an organism that may survive and subsequently reproduce, outside of its known or consensual range. Non-indigenous may be further characterized as un-established or vagrant, established, invasive and noxious or particularly invasive. Occhipinti-Ambrogi and Galil (2004). Marine Pollution Bulletin 49 (2004) 688–694. doi:10.1016/j.marpolbul.2004.08.011

[6] The list of priority (indicator) species introduced by human activities will be derived by consensus, based on information from the CIESM Atlas of Exotic Species in the Mediterranean and the DAISIE project (European Invasive Alien Species Gateway) a database tracking alien terrestrial and marine species in Europe

3 Harvest of commercially exploited fish and shellfish

Ecological Objective	Operational Objectives	Indicators
Populations of selected commercially exploited fish and shellfish[7] are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock	**3.1 Level of exploitation by commercial fisheries is within biologically safe limits**	3.1.1 Total catch by operational unit[8]
		3.1.2 Total effort by operational_unit
		3.1.3 Catch per unit effort (CPUE) by operational unit
		3.1.4 Ratio between catch and biomass index (hereinafter catch/biomass ratio).
		3.1.5 Fishing mortality
	3.2 The reproductive capacity of stocks is maintained	3.2.1 Age structure determination (where feasible)
		3.2.2 Spawning Stock Biomass (SSB)

[7] The choice of indicator species for collecting information for Ecological Objective 3 should be derived from fisheries targeting species listed in Annex III of Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (species whose exploitation is regulated) and the species in the GFCM Priority Species list (http://www.gfcm.org/gfcm/topic/166221/en). Choice of indicators should cover all trophic levels, and if possible, functional groups, using the species listed in Annex III of SPA and/or, as appropriate the stocks covered under regulation (EC) No 199/2008 of 25 February 2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy

[8] Operational unit is "the group of fishing vessels which are engaged in the same type of fishing operation within the same Geographical Sub-Area, targeting the same species or group of species and belonging to the same economic segment"

4 Marine food webs

Ecological Objective	Operational Objectives	Indicators
Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability	**4.1 Ecosystem dynamics across all trophic levels are maintained at levels capable of ensuring long - term abundance of the species and the retention of their full reproductive capacity**	4.1.1 Production per unit biomass estimates for selected trophic groups and key species, for use in models predicting energy flows in food webs
	4.2 Normal proportion and abundances of selected species at all trophic levels of the food web are maintained	4.2.1 Proportion of top predators by weight in the food webs
		4.2.2 Trends in proportion or abundance of habitat-defining groups
		4.2.3 Trends in proportion or abundance of taxa with fast turnover rates

5 Eutrophication

Ecological Objective	Operational Objectives	Indicators
Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.	**5.1 Human introduction of nutrients in the marine environment is not conducive to eutrophication**	5.1.1 Concentration of key nutrients in the water column
		5.1.2 Nutrient ratios (silica, nitrogen and phosphorus), where appropriate
	5.2 Direct effects of nutrient over-enrichment are prevented	5.2.1 Chlorophyll-a concentration in the water column
		5.2.2 Water transparency where relevant
		5.2.3 Number and location of major events of nuisance/toxic algal blooms caused by human activities[9]
	5.3 Indirect effects of nutrient over- enrichment are prevented	5.3.1 Dissolved oxygen near the bottom, i.e. changes due to increased organic matter decomposition, and size of the area concerned*[10]

6 Sea-floor integrity

Ecological Objective	Operational Objectives	Indicators
Sea-floor integrity is maintained, especially in priority benthic habitats[11]	**6.1 Extent of physical alteration to the substrate is minimized**	6.1.1 Distribution of bottom impacting activities[12]
		6.1.2 Area of the substrate affected by physical alteration due to the different activities[14]
	6.2 Impact of benthic disturbance in priority benthic habitats is minimized	6.2.1 Impact of bottom impacting activities[14] in priority benthic habitats
		6.2.2 Change in distribution and abundance of indicator species in priority habitats[13]

[9]The connection between eutrophication and toxic algal blooms is subject of devoted research at the moment. The connection between the two is not clearly established as not all the ecosystems react in the same way. In fact recent surveys in UK/Ireland in the framework of OSPAR have allowed concluding on the lack of relation between the them and therefore the number and location of major events of nuisance/toxic algal blooms should always be regarded cautiously as an indicator of a direct effect of nutrient over-enrichment.

[10]Monitoring to be carried out where appropriate

[11] e.g. coastal lagoons and marshes, intertidal areas, seagrass meadows, coralligenous communities, sea mounts, submarine canyons and slopes, deep-water coral and hydrothermal vents

[12] e.g bottom fishing, dredging activities ,sediment disposal, seabed mining, drilling, marine installations, dumping and anchoring, land reclamation, sand and gravel extraction

[13]Indicator species to be used to assess the ecosystem effects of physical damage to the benthos could refer to disturbance-sensitive and/or disturbance-tolerant species, as appropriate to the circumstances, in

7 Hydrography

Ecological Objective	Operational Objectives	Indicators
Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.	**7.1 Impacts to the marine and coastal ecosystem induced by climate variability and/or climate change are minimized**	7.1.1 Large scale changes in circulation patterns, temperature, pH, and salinity distribution
		7.1.2 Long term changes in sea level
	7.2 Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimized	7.2.1. Impact on the circulation caused by the presence of structures
		7.2.2 Location and extent of the habitats impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures
		7.2.3 Trends in sediment delivery, especially in major deltaic systems
		7.2.4 Extent of area affected by coastal erosion due to sediment supply alterations
	7.3 Impacts of alterations due to changes in freshwater flow from watersheds, seawater inundation and coastal freatic intrusion, brine input from desalination plants and seawater intake and outlet are minimized	7.3.1. Trends in fresh water/sea water volume delivered to salt marshes, lagoons, estuaries, and deltas; desalination brines in the coastal zone
		7.3.2. Location and extent of the habitats impacted by changes in the circulation and the salinity induced by the alterations
		7.3.3 Changes in key species distribution due to the effects of seawater intake and outlet

line with methodologies developed to assess the magnitude and duration of ecological effects of benthic disturbance.

8 Coastal ecosystems and landscapes

Ecological Objective	Operational Objectives	Indicators
The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved	**8.1 The natural dynamic nature of coastlines is respected and coastal areas are in good condition**	8.1.1. Areal extent of coastal erosion and coastline instability
		8.1.2 Changes in sediment dynamics along the coastline
		8.1.3 Areal extent of sandy areas subject to physical disturbance[14]
		8.1.4 Length of coastline subject to physical disturbance due to the influence of manmade structures
	8.2 Integrity and diversity of coastal ecosystems, landscapes and their geomorphology are preserved	8.2.1 Change of land-use[15]
		8.2.2 Change of landscape types
		8.2.3 Share of non-fragmented coastal habitats

[14] Physical disturbance includes beach cleaning by mechanical means, sand mining, beach sand noursihment

[15] Land-use classess according to the classification by Eurostat-OCDE, 1998: http://unstats.un.org/unsd/environment/q2004land.pdf

9 Pollution

Ecological Objective	Operational Objectives	Indicators
Contaminants cause no significant impact on coastal and marine ecosystems and human health	**9.1 Concentration of priority[16] contaminants is kept within acceptable limits and does not increase**	9.1.1 Concentration of key harmful contaminants in biota, sediment or water
	9.2 Effects of released contaminants are minimized	9.2.1. Level of pollution effects of key contaminants where a cause and effect relationship has been established
	9.3 Acute pollution events are prevented and their impacts are minimized	9.3.1 Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution
	9.4 Levels of known harmful contaminants in major types of seafood do not exceed established standards	9.4.1. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood[17]
		9.4.2. Frequency that regulatory levels of contaminants are exceeded
	9.5. Water quality in bathing waters and other recreational areas does not undermine human health	9.5.1 Percentage of intestinal entorococci concentration measurements within established standards
		9.5.2. Occurrence of Harmful Algal Blooms within bathing and recreational areas

[16] Priority contaminants as listed under the Barcelona Convention and LBS Protocol
[17] Traceability of the origin of seafood sampled should be ensured

10 Marine litter

Ecological Objective	Operational Objectives	Indicators
Marine and coastal litter do not adversely affect coastal and marine environment[18]	**10.1 The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized**	10.1.1 Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source
		10.1.2 Trends in amounts of litter in the water column, including microplastics, and on the seafloor
	10.2 Impacts of litter on marine life are controlled to the maximum extent practicable	10.2.1 Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles[19]

11 Energy including underwater noise

Ecological Objective	Operational Objectives	Indicators
Noise from human activities cause no significant impact on marine and coastal ecosystems	**11.1 Energy inputs into the marine environment, especially noise from human activities is minimized**	11.1.1 Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals
		11.1.2 Trends in continuous low frequency sounds with the use of models as appropriate

[18] A policy document on marine litter strategy, taking fully into account the activities envisaged for the implementation of the EA roadmap, is being prepared by MEDPOL and will be submitted to the MAP Focal Point for approval. The approved document will be used as the basis for the formulation of an action plan for the reduction of marine litter.

[19] Marine mammals, marine birds and turtles included in the regional action plans of the SPA/BD Protocol.

ANNEX 2: APPLICATION OF EE-IOA TO CALCULATE SPAIN'S CARBON FOOTPRINT

The CP/RAC carried out a study analysing Spain's carbon footprint between 1990 and 2005. This study included the following::
- An in-depth analysis of Spain's carbon footprint for 1995 and 2000, and an estimated carbon footprint for 1990 and 2005.
- A carbon footprint analysis segmented into 71 categories of goods and services included in the Spanish economy, as well as direct household combustion, and according to 11 groups of final household consumption.
- A global and country-specific analysis of GHG emission flows due to Spain's exports and imports of goods and services.

The study included an Input and Output Analysis of the Spanish economy for emissions of all greenhouse gases, as well as an in-depth analysis of Spain's international trade flows, in physical and monetary units, with each of the 224 countries for more than 15,000 product categories.

The aim of the study was to calculate the GHG emissions caused by the Spanish household consumption, taking into consideration the entire life cycle of the products and services consumed, irrespective of the location of the emissions produced (Spanish territory or rest of the world territory). This is the information provided by the carbon footprint.

Fig. 1 summarises the scope of the GHG emissions considered in the study: (1) the direct GHG emissions in households (emissions by private cars and combustion of fuels in houses), (2) the GHG emissions produced in the entire life cycle of the products and services consumed along all the supply chain.

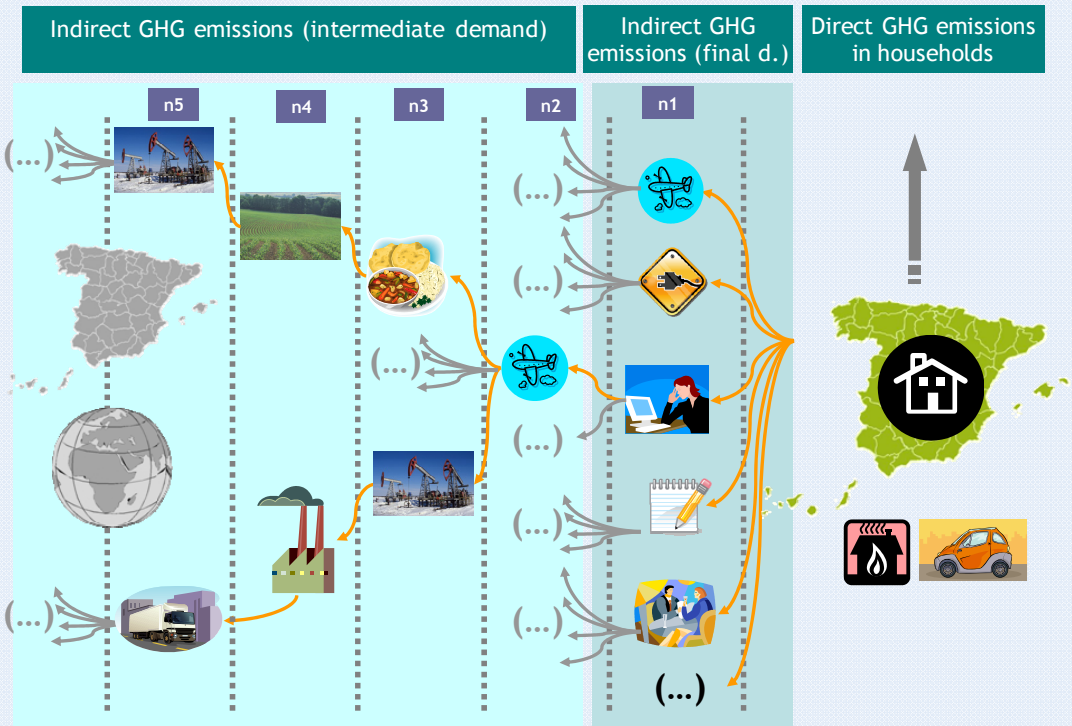


Fig. 1 Application of Environmental Extended-Input Output Analyses to calculate Spain's carbon footprint

Consumption vs. production approach regarding GHG emissions

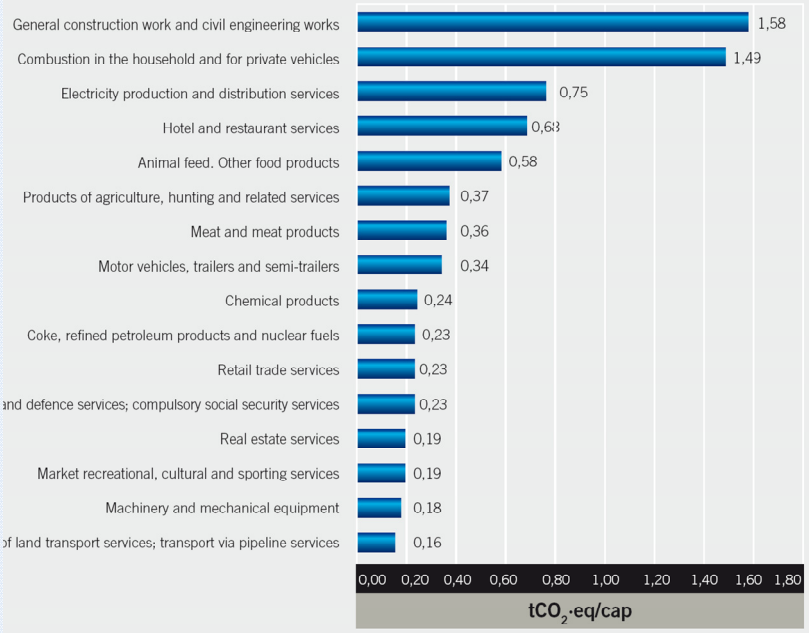
Spain's carbon footprint in 2005 rose to 515.38 MtCO2•eq (11.68 tCO_2•eq/cap). This is 16.9 % higher than Spain's domestic emissions for the same year according to the Spanish GHG inventory. This difference is due to the greenhouse gases emitted by other countries during the production of goods and services imported into Spain for final consumption.

Although some of these emissions are offset by those generated by Spanish production processes for goods that are exported, the levels of these emissions are lower than those embodied in imports, with the overall balance between imported and exported emissions being 1.68 tCO_2•eq/cap. It is important to note that a net import of a climate footprint is a characteristic shared by most European countries, and is especially noticeable in smaller countries.

Case study: Application of EE-IOA to calculate Spain's carbon footprint

Construction is the productive category with the greater carbon footprint

The category consisting of construction and civil engineering works is the main climate footprint generator taking into account direct emissions (only 3% of the total emissions) and those induced by the intermediate demand from the other sectors (for example cement manufacturing). This is a good reflection of the relevance of the construction sector in recent years, as well as the importance of the physical flows resulting from it, in the form of the input of construction materials and their energy intensity (tCO_2>eq/t).



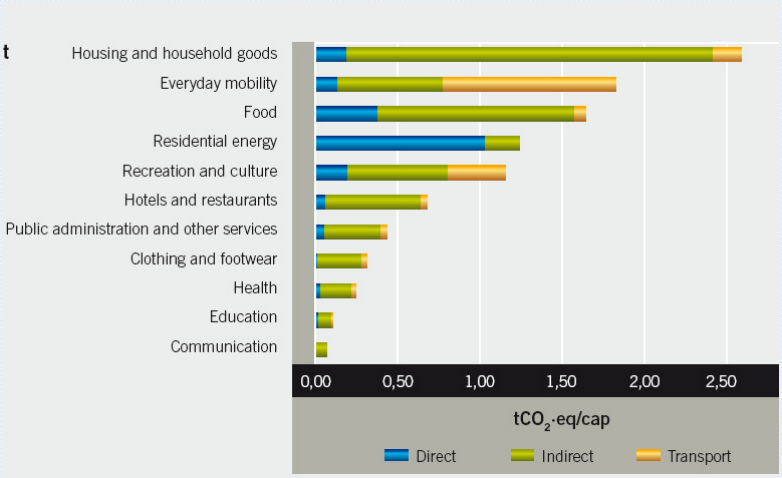
In second place is combustion in households and, to a greater extent, combustion in private vehicles, which underwent marked growth in the period studied.

The importance of energy products — electricity and oil — is also remarkable, with production processes resulting in very intensive GHG emissions.

The climate footprint embodied in the hotel and catering trade and prepared foods is also worthy of note. This reflects the importance of the tourism sector in the country, as well as the increasing relevance of energy intensity in the food and agriculture industry and the growth of a diet based on animal protein (both meat and fish).

Housing, mobility and food as consumption categories with the greatest impact on climate change

Consumption related to housing and household goods is quite clearly the most important component of the climate footprint of Spanish households. Other influencing factors include the high intensity of the carbon footprint produced by the construction of housing, as well as the increased demand for both first and second homes during the analysed period.



Day-to-day mobility (which does not include leisure activities) is the second largest component of the carbon footprint. Mobility not only results in the direct consumption of fuels, instead it also produces emissions linked to the entire vehicle manufacturing process and to the fuel industry itself, from fuel extraction to its sale to the end user.

Food is also a key factor, as a result of emissions linked to the production, distribution and sale of foodstuffs, especially those derived from animals

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