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# Marine spatial planning and oil spill risk analysis: Finding common grounds

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ABSTRACT

A flow of key information links marine spatial planning (MSP) and oil spill risk analysis (OSRA), two distinct processes needed to achieve true sustainable management of coastal and marine areas. OSRA informs MSP on areas of high risk to oil spills allowing a redefinition of planning objectives and the relocation of activities to increase the ecosystem's overall utility and resilience. Concomitantly, MSP continuously generates a large amount of data that is vital to OSRA. The Environmental Sensitivity Index (ESI) mapping system emerges as an operational tool to implement the MSP–OSRA link. Given the high level of commonalities between ESI and MSP data (both in biophysical and human dimensions), ESI tools (both paper maps and dynamic GIS-based product) are easily developed to further inform MSP and oil spill risk management. Finally, several other benefits from implementing the MSP–OSRA link are highlighted.


## 1. Introduction

Marine spatial planning (MSP) is commonly defined as "a process (...) of analyzing and allocating the spatial and temporal distribution of human activities in marine areas" (from coastal areas to entire exclusive economic zones) (European Commission, 2010) that takes the ecosystem-based approach to the management of such activities as its overarching principle (Douvere, 2008; European Commission, 2008). Ecosystem-based management (EBM) is characterized by: (1) encompassing the biophysical, human and institutional dimensions of a given ecological–economic system; (2) recognizing the connectivity amongst all of its elements; and (3) ensuring the necessary trade-offs to achieve sustainability. MSP is increasingly being developed and implemented around the world due to its potential and relevance for coastal and ocean management and the development of corresponding policies. Encompassed in this spatial planning process is the need to identify and analyze existing conditions within a target area, as well as to map and quantify the impacts of human activities on its biophysical ecosystems (Ehler and Douvere, 2009). In order to do so, suitable data and assessment methods must be available, and MSP implies the development of a strong data and knowledge base.

Risk analysis is also a requirement for a proper spatial planning process (Greiving and Fleischhauer, 2006), and in this context MSP is no exception. Hence, instruments such as hazard potential, vulnerability, and risk profiles/maps are crucial to support contingency planning, as well as decision-making and risk management (Abascal et al., 2010; Castanedo et al., 2009). Because oil spills can cause significant impacts to coastal/marine environments and resources, and in view of the international policies and guidelines pertaining to the reduction of marine pollution and its subsequent impacts (e.g. OSPAR Convention, MARPOL Convention), the existence of related preparedness and response tools is crucial for a sustainable management (IPIECA, 2008; Frazão Santos and Andrade, 2009).

In spite of their different purposes and contexts, oil spill risk analysis (OSRA) and MSP share a need for spatial information on key coastal and marine resources and habitats, as well as processes identification. To make the best use of spatial data collected, and given the relevance of both MSP and OSRA for a truly sustainable management of coastal and marine spaces, finding common ground between them and further combining their development and application are challenges of paramount importance. The pres-

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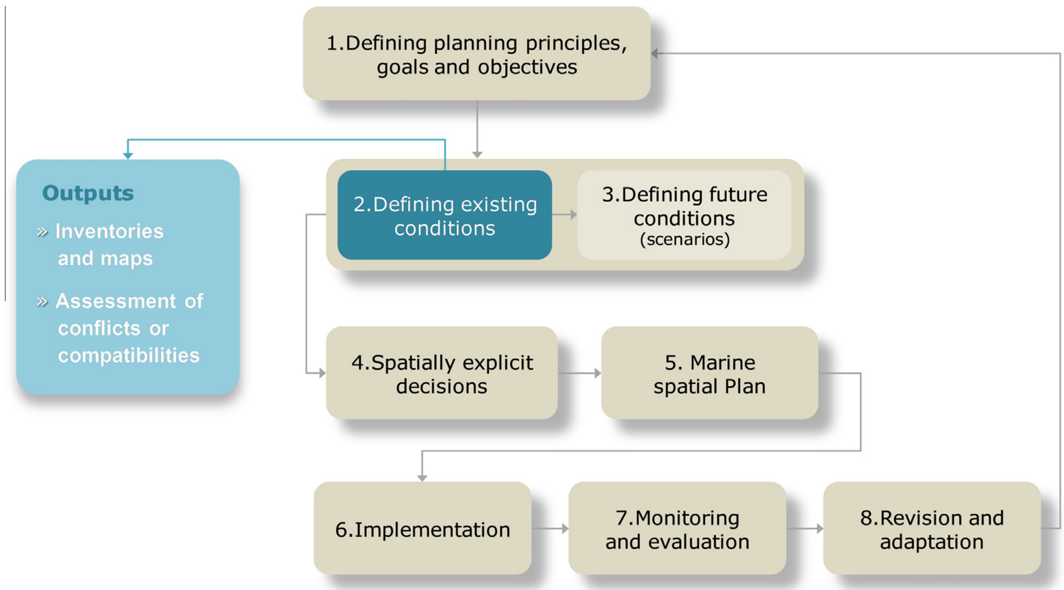


**Fig. 1.** Main steps in a full marine spatial planning process. Highlight is given to the expected outcomes from step 2 – 'defining existing conditions'.

ent work highlights the link between MSP and OSRA by: (1) analyzing both processes' frameworks and identifying commonalities between them and (2) proposing an operational model to implement the MSP–OSRA link.

## 2. Methods: analyzing MSP and OSRA frameworks

### *2.1. Marine spatial planning: data on existing conditions*

As a planning process, MSP involves a group of steps that must be implemented to ensure its proper development (Ehler and Douvere, 2009; Foley et al., 2010). It starts with the definition of planning principles, goals and objectives for a management area (step 1 in Fig. 1), followed by the analysis of present environmental, socio-economic, and political conditions (step 2). Based on the latter information, scenarios are built to predict/define potential future conditions (step 3), and management alternatives are established and spatially explicit decisions are made (step 4). When a management alternative is selected, a spatial plan is then developed (step 5), implemented (step 6) and the results of both the plan and its implementation are monitored/evaluated (step 7). Finally, the plan is revised so that the entire planning process can be adapted in light of learned lessons (step 8 in Fig. 1).

The definition and analysis of existing conditions (step 2 in Fig. 1) is a key step of MSP because management scenarios/alternatives will build on such initial information. According to Ehler and Douvere (2009) there are two major outcomes from this step: (1) the development of 'inventories and maps' and (2) an 'assessment of potential conflicts and/or compatibilities', both among existing human uses and between them and the environment (effects that may risk or promote good environmental quality). Although the assessment of conflicts/compatibilities has a major relevance in MSP since it ultimately determines the need for a management plan[1], within the context of this paper special attention is given to the first outcome.

Because collecting, compiling and mapping spatial data tend to be high-cost and time-consuming processes yet constitute key components of planning and management activities (Beck et al., 2009; Ehler and Douvere, 2009), proper development of 'inventories and maps' is of paramount importance. MSP inventories/maps commonly pertain to the identification and mapping of two main types of information[2]: (1) important biological and ecological areas – i.e. areas to conserve/protect, as well as areas compatible with human activities – and (2) existing human activities and pressures – i.e. the spatial/temporal distribution and density of important human activities within an area. Data on important biological/ecological areas may be mapped using either qualitative or quantitative methods, depending on established goals and data constrains. In either case, however, entities involved in MSP (both decision-makers and stakeholders) must bear in mind that marine ecosystems 'move', although sometimes at imperceptible speeds, and that their boundaries are more difficult to perceive and establish than terrestrial ones (Norse et al., 2005). For these reasons, there is a need for dynamic mapping (and planning) to encompass the diversity of marine species and habitats in space and time (Crowder and Norse, 2008).

For data on human activities/pressures, the MSP process must recognize the complexity of human dimensions, as it does with the biophysical ones, and acknowledge that the set of existing processes and practices in place is "complex, integrated, and multiscalar" (St. Martin and Hall-Arber, 2008). In fact, besides considering activities that directly take place in marine areas, MSP must consider effects from, or effects in, activities located 'upstream' (land) and 'downstream' (international waters) from the management area – e.g. links between offshore marine activities and onshore communities and economies (Ehler and Douvere, 2009). Nevertheless, some direct activities (and areas) are always more relevant to identify and display than others, due to their social, economic or political value – e.g. fishing, energy production (Ehler and Douvere, 2009).

For both types of data, a key rule is that information must be "up-to-date, objective, reliable, relevant and comparable" (Ehler and Douvere, 2009) and should cover most of the planning area, instead of only small sub-areas (fine-scale data) that have little

[1] If no spatial overlaps are found among human activities/pressures, or between them and important biological/ecological areas, conflicts and compatibilities will not exist, and a management plan will (in fact) not be necessary; this situation is, however, very rare (Ehler and Douvere, 2009).

[2] A thorough list on information that can be included in MSP inventories and maps is found in Section 3 (Table 2).