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Modeling expert judgment to assess cost-effectiveness of EU Marine Strategy Framework Directive programs of measures

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ABSTRACT

The EU Marine Strategy Framework Directive (MSFD) requires all Member States to establish a program of measures to achieve or maintain Good Environmental Status (GES) of their marine waters, which should be justified on economic grounds. So far, however, only limited efforts exist to support, from a scientific perspective, marine policy- and decision-makers to this direction. This paper describes a first effort towards closing this gap and improving existing marine policymaking processes as regards the prioritization and selection of measures and policies towards coastal and marine resources management. More specifically, the paper presents an expert judgment-based weighting framework named '*MeTaLi*'. The tool provides a cost-effectiveness ranking algorithm of alternative measures (e.g. command-and-control, economic, etc.) within the framework of MSFD by means of fuzzy and stochastic analysis. A pilot application of '*MeTaLi*' in Greece for three selected MSFD descriptors is also discussed, aiming to evaluate the tool and allow drawing conclusions for real conditions. Finally, the paper concludes with a discussion of research findings and methodological challenges related to marine policy issues.

1. Introduction

It is widely acknowledged that the EU Marine Strategy Framework Directive (MSFD) is strongly framed within the economic logic. MSFD includes economic requirements either explicitly (i.e. areas where economic analysis is clearly demanded) or implicitly (i.e. areas where economic analysis may be beneficial in meeting the requirements although this is not a prerequisite) [1]. For instance, Art 8(1c) of the MSFD requires all Member States to undertake "*an economic and social analysis of the use of those waters and of the cost of degradation of the marine environment*" within their Initial Assessment reports. The economic linkages are even more intense in Article 13 of the MSFD, which expects the Member States to design and implement a program of measures to achieve good environmental status in their marine waters. These measures, implemented at different spatial levels (local/national/regional or global), may include a number of different instruments [2]:

- Traditional command and control (CAC) or regulatory instruments (e.g. regulation, norms and standards, bans) that have a direct influence on the behavior of actors by imposing rules that limit or prescribe the actions of the target group.
- Economic instruments (e.g. fees, subsidies, liability and compensation regimes, trading systems) that modify the behavior and decisions of actors by changing the cost or price of a market good (e.g. plastic bags), service (e.g. waste collection), activity (e.g. waste dumping), input (e.g. materials), or output (e.g. pollution).
- Social instruments, which are based on voluntary aspect of actions and influence the behavior of actors and individuals indirectly. For instance, polluters are stimulated to take actions through awareness raising campaigns.
- Technical, technological and research-oriented measures, e.g. removal of man-made constructions, monitoring activities, etc. If there is an obligation to imply a certain technical measure, it should be regarded as a regulatory instrument. If the implementation of a technical measure is encouraged by subsidies, it should be regarded as an economic instrument. If an information campaign promotes the application of the technical measure, it should be regarded as a social instrument. Thus, it is sometimes difficult to categorize a measure as a technical measure or as a regulatory or economic measure.

Regardless of the measures selected for achieving or maintaining Good Environmental Status (GES) of marine waters, decision-makers

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have to define the costs of measures and to estimate the potential benefits in order to evaluate the proposed program and the proportionality of costs by means of cost-effectiveness or cost-benefit analyses [3]. In general, cost-benefit analysis is suitable when the targets have not yet been set because it can be used to determine if the benefits of the possible targets are higher than the costs, thereby informing what the target should be [1]. Cost-effectiveness, on the other hand, is a more suitable approach to use when the objective has been established and the analysis focuses on the best way to meet the target. The latter seems to be the most relevant methodology in the context of Article 13 of the MSFD, where the objectives have already been established [1].

Considering that the MSFD sets out eleven qualitative descriptors covering broad topics, there are many challenges ahead towards achieving GES of the European marine environment. There is therefore a need for further scientific understanding for the criteria and indicators determining the descriptors. A major challenge is certainly the development of appropriate tools and approaches that would make use of best available scientific knowledge and would facilitate the implementation of the MSFD within the prescribed timeline. Among them, tools that will help Member States to draw up their Program of Measures to achieve GES are of particular importance provided that these programs are scheduled to be developed by 2015 at the latest.

To this end, this paper presents and discusses '*MeTaLi*', a tool developed within the EU funded MERMAID project (*Marine Environmental targets linked to Regional Management schemes based on Indicators Developed for the Mediterranean*). The MERMAID aims to provide scientific understanding for assessing GES in a coherent and holistic manner. The project will develop a state-of-the-art methodology that will be tested for five selected MSFD descriptors, namely commercial fisheries and shellfish (D3), hydrology (D7), chemical pollution of the environment (D8), contaminants in fish and seafood (D9) and marine litter (D10), in three study sites of the Mediterranean Sea (i.e. the Gulf of Lions, the Saronikos Gulf and the Cilician basin). *MeTaLi* specifically aims at bridging the existing gap in marine policy- and decision-making related to the selection and prioritization of measures and policies towards coastal and marine ecosystem protection. For this purpose, *MeTaLi* provides a cost-effectiveness ranking algorithm of selected command-and-control, economic, social and technological measures using estimates that are based on expert judgment.

The rest of the paper is structured as follows: Section 2 first describes in brief the theoretical framework, i.e. the expert judgment approach and then the methodological development of *MeTaLi*. Section 3 presents the pilot application of *MeTaLi* in Greece and provides, for illustrative purposes, a cost-effectiveness ranking of policy measures for three selected descriptors. Finally, Section 4 concludes and discusses policy implications.

2. Development of the *MeTaLi* tool

2.1. Methodological background

Expert judgment is an approach for soliciting informed opinions from experts, i.e. those who have knowledge of an issue at an appropriate level of detail and who are capable of communicating this knowledge [4], or those whose opinion might be of interest [5]. Expert judgment can provide useful insights for policy- and decision-makers when scientific research is not available or is ongoing [6,7]. Moreover, it can be useful when current research needs to be made directly useful to policy- and decision-makers but comprehensive empirical information is lacking [8]. In this sense, experts can be relied on to consolidate and synthesize new or existing qualitative and/or quantitative information into a framework suitable for decision-making [9–11].

Nevertheless, whether or not expert judgment has the potential to provide accurate, reliable and uncontested data is still debatable. Some researchers argue that experts are sensitive to a number of heuristics (e.g. representativeness, availability, anchoring and adjustment, overconfidence, etc.) and may be subject to cognitive and motivational biases that impair their abilities to accurately report their true beliefs [4,11]. On the other hand, other researchers claim that experts have superior recall of information and improved abilities to abstract knowledge to new situations and, thus, they are able to think critically about data and methods in their domain [12].

Expert judgment approaches have been used extensively in marine policy and science issues. This is not surprising considering that marine science is characterized by data unavailability, large uncertainties, and costly research and monitoring, which, if combined with conflicting interests and values about governance practice, complicate marine decision-making [13]. For instance, Halpern et al. [14] devised a method for collecting expert opinion on how threats affect marine ecosystems. They surveyed 135 experts from 19 different countries who were asked to assess the functional impact, scale, and frequency of a threat to an ecosystem; the resistance and recovery time of an ecosystem to a threat; and the certainty of these estimates. Teck et al. [8] applied an expert judgment approach to the California Current region in order to evaluate the relative vulnerability of 19 marine ecosystems to 53 stressors associated with human activities, i.e. a total of 1007 stressor-by-ecosystem combinations, using surveys from 107 experts. In order to gain more understanding into the role of scientific information in marine management and policy-making, van Haastrecht and Toonen [13] asked policy makers and scientists for their expert judgment in cases where crucial information for policy decisions was missing. The experts acted both as information producers and users describing the selection process of Marine Protected Areas (MPAs) in the Dutch part of the North Sea. Thus, at times they were asked to speak from their gut, or to voice opinions that consisted of a mix of both scientific and managerial considerations. Carollo et al. [15] contacted via email more than 2000 experts working with coastal and ocean issues in the Gulf of Mexico asking them to rank 12 data categories (e.g., benthic habitats, human uses, coral reef, oyster reef, temperature, etc.) and score the relevance of four qualifiers (spatial resolution, temporal resolution, age of data, and level of detail) using a discrete choice approach. In total 348 surveys were completed and the results were used to identify data gaps and consequently identify priority areas where money should be invested for future data collection. Furthermore, Carollo et al. [16] used expert opinion at the first Gulf of Mexico Ecosystem Services Workshop (2010) in order to: (a) identify and classify the Gulf of Mexico habitat types based on the Coastal and Marine Ecological Classification Standard (CMECS); (b) link ecosystem services to the Gulf of Mexico habitat types; and (c) prioritize ecosystem services. Ban et al. [17] involved 21 experts, using the Great Barrier Reef as case study, in order to construct a framework where management options can be evaluated; to obtain estimates of outcomes associated with a variety of scenarios; and to better understand the interaction of multiple stressors and related management options where data about the effects of these interactions were incomplete. Cook et al. [18] used integrated conceptual ecosystem models of the coastal marine environment developed as part of the Marine and Estuarine Goal Setting for South Florida (MARES) project in conjunction with a modified DPSIR model, expert opinion and matrix-based analyses to explore the direct and indirect relative impact of 12 ecosystem pressures on 11 ecosystem states and 11 ecosystem services (i.e. 34 components) identified through MARES project. More specifically, among these 34 components 193 unique interactions were identified and 25 experts