Ecological Indicators 96 (2019) 336–350

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Using a holistic ecosystem-integrated approach to assess the environmental status of Saronikos Gulf, Eastern Mediterranean

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ARTICLE INFO

Keywords:
NEAT
Good Environmental Status
Marine Strategy Framework Directive
Ecological Indicators
Chemical Indicators
Sewage
Eutrophication
Pressure Index

ABSTRACT

The holistic Nested Environmental status Assessment Tool (NEAT), developed for the integrated assessment of the status of marine waters, was applied to Saronikos Gulf, in the Eastern Mediterranean. We used different spatial and decadal time series data covering 9 biological and chemical ecosystem components, 24 indicators and 8 descriptors of the Marine Strategy Framework Directive (MSFD), to test its performance under different ecosystem approaches. The results were evaluated in relation to the anthropogenic pressures affecting the study area as well as the management measures taken, and compared to the results from previous studies. NEAT has shown clear spatial gradients differentiating the impacted and slightly-impacted areas, as well as the response of the ecosystem towards the management measures taken, demonstrating the most responsive and early warning ecosystem components. The application of NEAT to Saronikos Gulf classified the whole basin into good status, with the pelagic habitat components (fish, water column and phytoplankton ecosystem components) contributing strongly to the overall environmental status of the gulf. Sediment, benthic fauna and vegetation, mammals and alien species were the most impacted ecological components in Saronikos Gulf. The most affected areas, Elefsis Bay and Psittalia (wastewater submarine outfall), were assessed as in poor and moderate status, respectively. We conclude that: (i) it is possible to integrate data from different sources, spatial and temporal scales; (ii) this integration has permitted to undertake a real ecosystem assessment; (iii) there is no loss of information, allowing full tracking of problems and cases in no good status that should be addressed at lower levels (e.g. species or species groups); (iv) the results are related with the pressures identified; (v) the assessment demonstrates the recovery of the system and the time needed to recovery; and (vi) these results could be very useful for managers, policy makers and scientists when deciding the method to use in assessing the environmental status under the MSFD.

1. Introduction

Anthropogenic pressures (resource depletion, habitat degradation, pollution) on the seas and their services may lead to significant degradation of marine ecosystems and threaten their integrity, structure and functioning, compromising the potential to deliver essential ecosystem services on which human wellbeing depends (Liquete et al., 2013; Borja, 2014; Halpern et al., 2015; Reker et al., 2015). The EU Marine Policy and Regional Seas Conventions provide a framework for a coherent approach to the sustainable protection, use and management of marine and coastal resources (Boyes and Elliott, 2014). This policy has adopted an Ecosystem-Based Management (EBM) framework for human activities in the marine environment (Borja et al., 2010a): the 2008 Marine Strategy Framework Directive (MSFD, 2008/56/EC), the 2014 Marine Spatial Planning Directive (MSPD) and the Common Fisheries Policy (last modified in 2014), are three of the main EU

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https://doi.org/10.1016/j.ecolind.2018.09.007
Received 14 June 2018; Received in revised form 1 September 2018; Accepted 5 September 2018
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Fig. 1. The Saronikos Gulf case study, showing the spatial assessment units and the stations used.

marine policies that adopt EBM. These three Directives are combined with others, including the Biodiversity Strategy to 2020 and the Habitats and Birds Directives (Directives 92/43/EEC and 2009/147/EC), in ways capable of handling multiple environmental objectives.

All these instruments will play a central part in addressing the sustainability challenges faced by EU marine ecosystems, since implementing effective coastal and marine management policies remains a key environmental policy challenge linked to biodiversity, eutrophication, climate change, chemical pollution and other threats from various socioeconomic activities (Reker et al., 2015). Traditionally, different sectors and different aspects of marine ecosystems have been considered separately, therefore, a step towards better integration could come from current developments at the science-policy interface (Borja et al., 2016b).

Focusing specifically to MSFD, this Directive aims to implement an integrated approach in order to manage anthropogenic activities and achieve Good Environmental Status (GES) of the marine environment within all Member States (MSs), by 2020. It can be expected that achieving GES will primarily be accomplished through reductions in pressures (from human activities) and their impacts on the marine environment (Loizidou et al., 2017), resulting in an increase of the delivering of ecosystem services (Mee et al., 2008).

The Mediterranean countries have committed themselves to implement the EBM in the framework of Barcelona Convention in full synergy with the MSFD implementation (UNEP, 2013). However, more efforts are urgently needed in order to ensure consistency and to allow for comparison between marine regions or subregions of the extent to which GES is being achieved because of the significant gaps found in data availability, indicators, targets and assessment methods (Palialexis et al., 2014). Apparently, it became clear that MSs approaches are different and regional coordination was lacking in ensuring sufficient coherence and comparability.

Given these shortcomings and to ensure that the next cycle of implementation of the MSFD (2018 and beyond) yields greater benefits, the European project MEDCIS (Support **MED**iterranean Member States towards coherent and **C**oordinated **I**mplementation of the second phase

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