



Operationalising marine and coastal ecosystem services

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1. Introduction

The ecosystem services concept has been increasingly adopted to assess nature's contributions to people and to understand feedbacks within social-ecological systems. Yet, to be useful in decision-making, the scientific knowledge developed around the ecosystem services concept and its frameworks needs to be operationalised and taken up by policy-makers and practitioners (Primmer and Furman 2012). To help overcoming this critical challenge, IPBES, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services was established in 2012 by national governments to set an interface between scientists, policy-makers and practitioners, and help setting the foundations for the incorporation of ecosystem services science into policy formulation (Díaz et al. 2015, 2018).

For marine and coastal ecosystems, dedicated classification systems (e.g., Beaumont et al. 2007; Carollo et al. 2013), indicator sets (e.g., Böhnke-Henrichs et al. 2013; Lillebø et al. 2016), a series of literature reviews (e.g., Liqueste et al. 2013; Garcia Rodrigues et al. 2017), newly defined research priorities (Rivero and Villasante 2016), and sectoral analyses (e.g., Lillebø et al. 2017) have advanced the theoretical underpinnings of marine and coastal ecosystem services (MCES). However, attempts to operationalise and put MCES into practice remain remarkably scarce. To address this research gap, this Special Issue compiles papers in which findings and recommendations resulting from MCES assessments were taken up by policy-makers and practitioners, and used in decision-making. In addition, several papers also provide insights on how scientific outcomes can better inform decision-making and have positive impacts on the marine environment.

This Special Issue is a result of a joint collaboration between the International Council for the Exploration of the Sea Working Group on Resilience and Marine Ecosystem Services and the Ecosystem Service Partnership (ESP) Marine Biome Working Group. We received contributions from participants of the European ESP Conference Session *Informing marine and coastal policy using ecosystem service assessments: evidence from real world applications*, convened by the ESP Marine Biome Working Group in Antwerp, Belgium, on 22 September 2016.

2. Lessons learned and key recommendations to operationalise MCES

Based on findings from the six papers included in this Special Issue, we provide an overview of the main lessons learned and key recommendations for scientists, policy-makers and practitioners who intend to operationalise MCES and apply ecosystem services science in environmental decision-making.

In the opening paper of this Special Issue, Verutes et al. (2017) describe a science-policy process in Belize that led to the country's first integrated coastal zone management plan, which was approved by the Belizean government in 2016. The authors provide details about the four crucial steps of the process, namely, (1) project scoping and stakeholder engagement, (2) compiling knowledge to quantify ecosystem services and map coastal and marine ecosystems and human activities, (3) developing future zoning and management options, and (4) conducting an ecosystem service assessment. The integrated coastal zone management plan was co-developed with local stakeholders, who contributed with data, participated in the development of management scenarios, and reviewed and refined the final scientific outputs. The spatial plan considered the needs of multiple stakeholders, advanced environmental management, and accounted for nature's contributions to people. This science-policy process is an example of how science can successfully inform marine planning decisions worldwide.

The inclusion of ecosystem services into the Latvian marine spatial planning is reported by Veidemane et al. (2017). The authors map and assess MCES, and evaluate different uses of Latvian marine waters. The process involves a diverse set of stakeholder groups who use MCES maps to visualise the marine areas providing the most significant social benefits, and to discuss the potential impacts caused by different uses of the sea. Including ecosystem services into the country's marine spatial planning was not without challenges. The authors had to overcome data scarcity issues on marine ecosystem structures and processes, difficulties in MCES mapping due to the multidimensional character of the marine environment, challenges to define suitable spatial units, budget limitations, and time constraints. To overcome methodological challenges, the authors combined benthic habitat maps as a proxy for mapping MCES, expert knowledge to identify the poten-

tial distribution of several services, and data from landings of fish to assess the pelagic zone. They consider this spatial explicit MCEs approach as a useful strategy for stakeholders and policy-makers to address competing uses and benefits provided by the marine environment.

Trégarot et al. (2017) assess the indirect-use value of several MCEs provided by coral reefs, seagrass meadows and mangroves in Mayotte, a small archipelago of the Indian Ocean. The authors use production functions, replacement cost, and benefit transfer methods to assess the monetary value of coastal protection, fish biomass production, water purification, and carbon sequestration. The analysis shows a lower economic value for the MCEs provided by the ecosystems negatively impacted by human activities as compared to the value of MCEs provided by the same ecosystems in a pristine state. Although concluding that conserving coral reefs, seagrass meadows, and mangroves in Mayotte would make sense from an economic perspective, the authors identify a paradox: a higher monetary value can be attributed to a deteriorating ecosystem as a production function can increase in a degraded ecosystem state. This is the case for water purification and carbon sequestration provided by degrading coral reefs in Mayotte. As the coral reefs degrade, algae overgrow and the production functions of water purification and carbon absorption increase. This paradox highlights the limits of economic valuation, whose estimations need to be carefully interpreted and accompanied with other elements when environmental decisions are taken (Gómez-Baggethun and Muradian 2015).

The pathways of MCEs co-production are explored by Outeiro et al. (2017). The co-production concept highlights the role of humans in ecosystem services delivery (Reyers et al. 2013). Ecosystem services are *co-produced* by a combination of natural capital and different forms of non-natural capital such as human, social, financial, and technological capital (Palomo et al. 2016). Accordingly, Outeiro et al. (2017) analyse the relationships and trade-offs between MCEs in three shellfisheries from Galicia, Spain, and two small-scale fisheries from Northern Portugal, with different levels of non-natural capital inputs. Based on their results, the authors hypothesise that property rights regimes, and associated management practices that favour the privatisation of common-pool resources seem to increase non-natural capital inputs in the co-production of MCEs. This suggests that as MCEs delivery becomes more reliant on non-natural capital inputs, the generation of ecosystem disservices and trade-offs may increase. These findings may have implications for the regulation of human activities that rely on MCEs, such as fisheries, aquaculture, or seaweed harvesting.

Drakou et al. (2017) take stock of 11 European case studies to understand how MCEs assessments have been operationalised and taken up by decision-makers. To that end, the authors provide an overview of the main conceptual and methodological challenges in MCEs operationalisation from a researcher and practitioner's perspective, indicate observed impacts of such challenges, and specify applied solutions that contributed to solving those challenges. The authors also provide recommendations for researchers and practitioners to maximise the impact of MCEs research in policy and decision-making. They recommend that 'end users' of MCEs assessments should be engaged throughout the research process; scientists and practitioners should collaborate and share knowledge to fill disciplinary and knowledge gaps; civil society needs to be aware of the importance of the coasts, seas, and oceans to their own wellbeing to better comply with new policies and regulations; and that policy-making should consider plural views, social knowledge, and cultural and ethical values to increase the legitimacy of environmental decisions. The paper ends with the authors' 'wish list' for future MCEs research to reach and influence policy and decision-making.

In the closing paper of this Special Issue, Beaumont et al. (2017) detail their application of the Ecosystem Service Approach (ESA) at six marine and coastal sites across South West England and North West France. The sites varied in their ecology, scale, issues and uses. However, to enable comparisons of the ESA, the interdisciplinary teams at all sites followed a collectively agreed approach. In all cases, the ESA was undertaken in close collaboration with local environmental managers and provided a wealth of results and data, which in many cases directly influenced the management of the sites. In addition, given the variability of the sites and the methods used it was possible to draw six generally applicable recommendations for the future application of the ESA: (1) invest resources in collective planning of ESA; (2) apply dynamic and connected approaches including multiple ecosystem services; (3) undertake ESA at a local scale; (4) employ interdisciplinary research; (5) work proactively and transparently with data gaps and uncertainty; (6) record ESA and resultant impact. A key finding was that the primary barriers to successful ESA were organisational and communication-based issues, which if recognised and acknowledged can be relatively easily overcome.

The six papers included in this Special Issue provide a useful contribution to address the challenges and opportunities of operationalising MCEs. The inclusion of MCEs research findings and recommendations in policy and practice is still in its infancy, but is gaining momentum. The marine systems play an important role in major high-level

policy instruments, from the Paris Climate Agreement, in which the oceans are mentioned as critical systems to be managed, to the United Nations Sustainable Development Goals. Those instruments require robust and complete MCES assessments that will help to better inform policy and decision-making. Only if the challenges of operationalising MCES are addressed, MCES assessments can be thoroughly put into practice and fulfil their potential of supporting evidence-based environmental decisions that protect, conserve and restore marine and coastal ecosystems around the world.

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