

Human activities and pressures for key European marine habitats; a catalogue of map resources for the restoration project MERCES

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Abstract – Human activities crisscross the urban and coastal fabric, and expand into the off shore and deep sea, deriving numerous associated pressures often impacting marine habitats. A main goal of the ongoing MERCES project (<http://www.merces-project.eu/>) is to produce a catalogue of available maps for existing activities and pressures in the European Seas. To this end, we compiled a catalogue with mapping sources for maritime activities, as well as endogenous and exogenous pressures that could potentially drive key-habitat changes. It currently includes more than 250 entries covering several key coastal and deep sea habitats, comprising published records, web resources, and grey literature. Fisheries, coastal marine infrastructure and transport are the most featured activities at the broad scale maps. Aquaculture and tourism rank high at the sublittoral habitats maps and research/conservation at the deep-sea records. Chemical pressures and biological invasions rank high at the broad scale followed by litter, abrasion and extraction of species. These last 3 pressures seem to be the most mapped pressures in deep-sea records. Mapping the location and intensity of marine activities has been steadily increasing, and could be valuable when overlaid on key habitats, aiding spatial planning and conservation by linking pressures to mitigation and restoration efforts.

Keywords: mapping, habitat, pressures, restoration, meta-data

1. Introduction

Human activities and the resultant pressures they place on the marine environment have been widely demonstrated to contribute to habitat degradation (e.g. Halpern *et al.*, 2008), therefore, their quantification is an essential step towards any meaningful restoration effort. One of the main goals of the Horizon 2020 MERCES (Marine Ecosystem Restoration in Changing European Seas) project is to review current knowledge regarding the major marine pressures placed upon marine ecosystems in EU waters and the mechanisms by which they impact habitats to determine potential restoration pathways. Although a multitude of data linked to marine activities and pressures are available, understanding of their geographical distribution is critical for any local assessment of degradation, as well as for planning conservation and restoration actions. A great deal of work has been undertaken recently to understand and categorise activities and pressures for policy implementation. Within the Marine Strategy Framework Directive, which aims to achieve or maintain good environmental status (GES) in European waters by 2020, standardised activity and pressure lists have been defined (EC, 2008). These have been refined further in the last few years in various research initiatives at the European level (e.g. DEVOTES project, Smith *et al.* 2016). To effectively restore a degraded habitat, actions need to be taken to remove

impacting pressures or at least reduce their severity and intensity through management of activities. To this end, the scope of this work is to inventory and assess available activity and pressure maps across the European regional seas, as well as to perform a review identifying limitations and gaps.

Methodology

The MERCES Activities and Pressures Catalogue was compiled from a semi-structured literature internet search using keywords and keyword combinations (related to mapping, regional seas, specific habitats, activities and pressures) applying to European marine ecosystems. The first 100 search results were scanned, (a) in order of relevance (browser derived) and (b) ranked by year (2016 - most recent). Specific web resources were also searched (including downloadable reports) of international organizations, commissions and agencies dealing with habitat conservation (e.g. EEA, IUCN, UNEP-MAP-RAC/SPA, HELCOM, OSPAR, FAO, OCEANA, MarLIN) and European projects registered in the European Marine Spatial Planning platform (e.g. MEDTRENDS, CoCoNet, MESMA, PERSEUS, ADRIPLAN, THALCHOR, BALANCE). In addition, MERCES participants provided entries based on their thematic and regional knowledge.

2. Results and discussion

The MERCES Activities and Pressures Catalogue consists of 264 entries, out of which 194 (73.5%) map activities, 147 (55.7%) map pressures, and 101 (38.3%) map both. Most of the information (49%) came from peer-reviewed journals, followed by project reports (27%) and web resources (19%) which consisted mainly of map viewers and other online inventories. The majority of maps are simple images (86%) with a further 9% relating to online map viewers, which often allowed multiple pressure and habitat layers to be viewed together, thereby facilitating inferences in relation to their spatial relationships. Only 5% of the entries were shapefiles, which represent the most useful sources of information for further work. Geographically, most entries are from the Mediterranean Sea (39%) and the North-East Atlantic (27%), with the Baltic Sea and Black Sea represented to a much lesser extent (16% and 14%, respectively)

3.1. Assessment of Activities

The hierarchical ranking of mapped activities according to number of records is illustrated in Figure 1, while the main features of the most prominent ones are described below. "Extraction of living resources" was the most frequently cited activity. It refers to commercial fisheries in general, but also includes recreational fishing in some instances, in which case it is also relevant to tourism/recreation. "Coastal and marine structure and Infrastructure" is a diverse category incorporating any man-made structures on the seashore or seabed. Activities relating to "Transport" are related to maritime traffic and routes, accidents, as well as dumping and waste placement. The "Production of

living resources" category refers to aquaculture (finfish and shellfish). "Research and conservation" is a rather under-represented category that could be possibly expanded to include locations where regulations and restrictions apply. "Carbon sequestration" and "agriculture" are the least represented categories in the Catalogue. The first is restricted to sources citing offshore CO₂ storage and underground coal gasification, while the latter relates to mapped agricultural land coverage proximal to the coast, or coastal population employed in agriculture.

3.2 Assessment of Pressures

Mapped endogenous pressures (manageable pressures from within the system) that are reported in more than 15% of the total records are hierarchically ranked in Figure 2. Chemical pressures rank high in the list, with "nitrogen and phosphorous enrichment", "introduction of other substances", and "input of organic matter" occupying the three first positions. Out of the remaining endogenous pressures present in more than 15% of the relevant entries, "abrasion" (a physical pressure most commonly related to fishing activities), and marine "litter" are the most mapped physical pressures in most habitats including the deep sea, while "introduction of non-indigenous species" is a well-mapped biological pressure. Out of the 264 entries of the pressures catalogue, 52 (20%) included mapped exogenous pressures (unmanageable pressures from outside of the system, e.g. tectonic events affecting seabed morphology). Most frequently mapped exogenous pressures are related to thermal and emergence regime change (in 62% and 42% of the records including mapped exogenous pressures, respectively). No maps of exogenous pressures were found among the queried sources to specifically address deep-sea habitats. The Mediterranean and the Baltic Sea have some maps of various exogenous pressures, but this type of information is under-represented for the North-East Atlantic while missing for the Black Sea.

3. General Conclusions

The comprehensive review undertaken as part of the MERCES project highlights several traits and limitations concerning available marine activity and pressure maps:

Format: A clear majority of the available activities/pressure maps are simple images greatly reducing any further usability since they cannot be accurately overlaid with other complimentary maps nor can the underlying data be easily extracted. **Scale:** Available activities/pressure maps are usually broad-scale and low-resolution. While low resolution may be sufficient for setting conservation priorities (see Giakoumi *et al.*, 2015) it cannot be considered appropriate for actual conservation and for restoration actions.

Coverage: Geographic under-representation is an issue (e.g. Black Sea, Eastern Mediterranean) reflecting differences in research efforts or reduced accessibility to information for some areas.

Accuracy: several available maps may contain a high level of modelled data (using a variety of data proxies) with a high degree of interpolation between actual data points. This leads to high levels of uncertainty and the limitation of broad scale map utilisation only for broad scale use.

Accessibility: Grey literature (e.g. technical and project reports) is a significant source for useful activities/pressure maps; however, these sources are not directly visible or searchable through standard literature platforms (e.g. SCOPUS, WoS).

4. Acknowledgements

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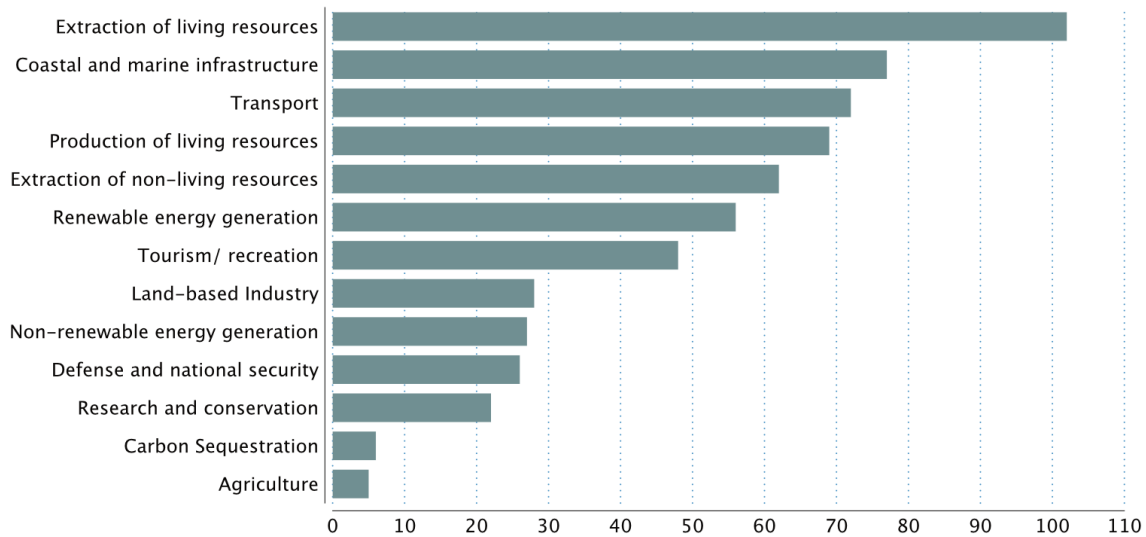


Figure 1. Mapped activities in the MERCES Activities and Pressures Catalogue, ranked in order of number of records.

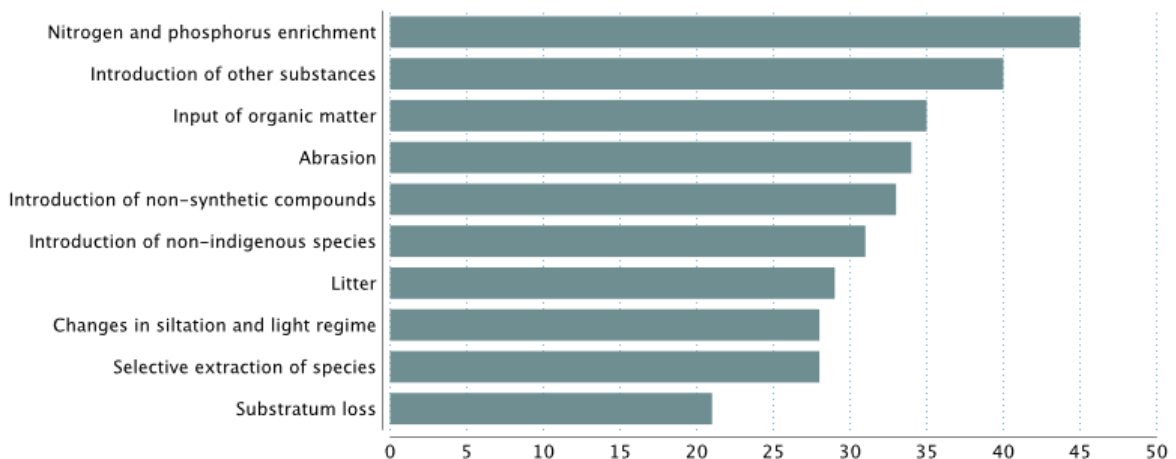


Figure 2. Mapped endogenous pressures reported in more than 15% of the total relevant records in the MERCES Activities and Pressures Catalogue, ranked by number of records.

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