MEECE
Marine Ecosystem Evolution in a Changing Environment

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MEECE Fact Sheet: MSFD Descriptor 5. Eutrophication

Ecosystem modelling in support of the MSFD Eutrophication Descriptor

MEECE is an EU FP7 project which has developed regionally-focused ecosystem models. The new European Marine Strategy Framework Directive (MSFD) provides a transparent, legislative framework to apply an ecosystem-based approach to the management of human activities in the marine environment. The Directive aims to achieve 'Good Environmental Status' (GES) across Europe's regional seas by 2020. The MEECE Descriptor fact sheets highlight how MEECE science can be used in support of the MSFD.

Eutrophication and the MSFD

Eutrophication refers to the processes related to discharge of macronutrients in the marine environment that stimulate the rapid growth of microalgae and lead to disruptive effects on the marine environment. These range from potential production changes, biodiversity loss, oxygen deficiency in bottom waters, development of Harmful Algal Blooms, and impacts to goods and services such as aquaculture and fisheries.

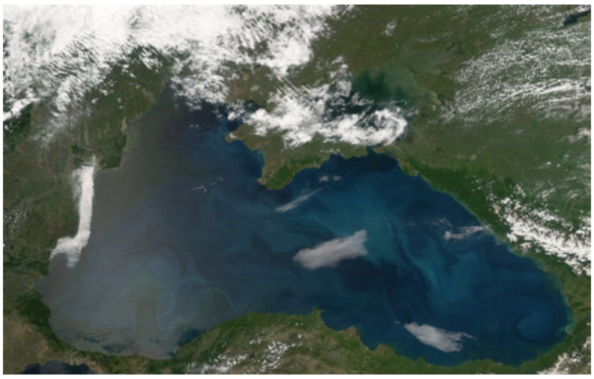
The MSFD descriptor for eutrophication focuses on both anthropogenic and natural causes (i.e. human induced increased river nutrient loads, and coastal nutrient increases due to climate effects), and their direct (increased phytoplankton blooms or decrease in transparency) and indirect (decrease of benthic plants) effects. Eutrophication has broad reaching impacts and can have negative impacts on other MSFD descriptors such as biodiversity, non-indigenous species, food webs and commercial fish.

How MEECE science can support this descriptor

MEECE has produced a number of tools that can be used in decision making and management around eutrophication in European regional seas. The MEECE model library is particularly suitable to study this descriptor as it includes a suite of biogeochemical models providing state of the art tools to understand the impacts of eutrophication, and how climate change and policy management could affect this descriptor. Current models are able to provide estimates for recent trends and future forecasts for several of the indicators for eutrophication. Although each model has different structures and characteristics, indicators relevant to this descriptor that can be addressed by MEECE biogeochemical models include:

- nutrient concentration in the water column (5.1.1)
- chlorophyll concentration (5.2.1) or phytoplankton biomass
- dissolved oxygen (5.3.2)

Some models can also provide more detailed information on nutrient ratio and phytoplankton community composition. All this information can be provided either as time series of data for a particular location or area, or as synoptic maps which provide information over regional areas and can be viewed through the MEECE Model Atlas.



Black Sea shows swirling blooms of phytoplankton coloring the surface waters blue and green. Image by Jesse Allen, NASA Earth Observatory.

MEECE has also collated a large dataset on discharge of European and non-European rivers integrating information from other European and global projects like globalNEWS and Waterbase. The database contains a huge amount of field data and model outputs on rivers flow and chemistry (for example nutrients), useful for analysing the impact of past policies on riverine nutrient loads and to force biogeochemical models such as those used in MEECE.

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Science in support of policy

MEECE models can be used to assess the potential consequences of the implementation of different policy decisions. For example figure 1 shows the potential reduction in phytoplankton biomass as a consequence of a number of socio-economic assumptions (increased economic globalisation combined with increasing environmental awareness, the "Global Community" scenario) compared to a Business as Usual socio-economic scenario. The map shows how the implementation of green policies would lead to a reduction in eutrophication in most of the Adriatic Sea, except in the NE coast. In this region, nutrient loads from rivers are due to increase as a result of increased economic activity driven by population growth and global demand for food.

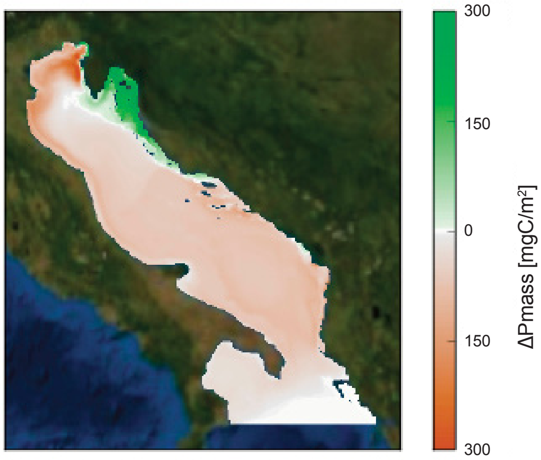

Figure 1: Change in phytoplankton biomass in the Adriatic Sea as a consequence of policy implementation.

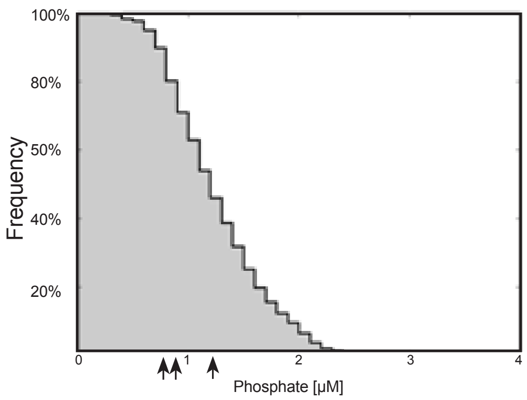

Figure 2: Frequency of phosphate concentration higher than an increasing value in different coastal areas of the southern North Sea: e.g. the plot shows that there is about 45%. The arrows on the x-axis show the "elevated levels" for coastal areas as defined in the OSPAR Common Procedure 2005-03.

The models developed during MEECE can also provide information on the frequency of critical events, i.e. when the indicators of Good Environmental Status exceed threshold values. Figure 2 shows the frequency with which winter phosphate exceeded thresholds in the coastal area of southern North Sea (ICES area IVc, salinity between 30 and 34) during the period 1990-2004. This curve can be compared with the "elevated levels" defined by the OSPAR common procedure to assess how many times the limits have been exceeded in parts of this area. Repeating this approach with the outcomes of models driven by different policy scenarios will inform policy makers and managers on the potential impact of the different strategies for achieving GES, providing crucial information to feed into a more complete Decision Support Tool.

Model Confidence

It should be bore in mind that uncertainties related to the coarse resolution of models and process formulations of growth, respiration, mortality and regenerative production in state of the art biogeochemical models are responsible for large model spread in eutrophication risk assessments. Such uncertainties currently limit the applicability of single model approaches to eutrophication management problems, looking at the outputs from a number of biogeochemical models could provide a more robust assessment.

MEECE Links

The full suite of models developed in MEECE can be viewed through the Model Library with accompanying user guides. Outputs from the models applied across European regional seas during MEECE are available through our web based Model Atlas. This interactive website allows visitors to view and compare model projections per region for different variables affected by a range of scenarios including future climate and human induced drivers of change.

www.meece.eu/Library.aspx | www.meeceatlas.eu

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