

Ecosystem modelling in support of the MSFD Contamination 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.

Contamination and the MSFD

Good Environmental Status for Contaminants under the MSFD states that "concentrations of contaminants are at levels not giving rise to pollution effects". Pollution effects are defined as "direct and/or indirect adverse impacts of contaminants on the marine environment, such as harm to living resources and marine ecosystems, the hindering of marine activities, impairment of the quality for use of sea water and reduction of amenities or, in general, impairment of the sustainable use of marine goods and services". Consequently, chemical pollution is closely linked to other GES descriptors, such as biodiversity, integrity of food webs and sea-floor ecosystems.



The list of existing potentially toxic substances of the American Society of Chemistry includes more than 296,000 compounds thus rendering impossible a complete screening of contaminants in assessing environmental quality. In this light, the direct estimation of pollution-induced biological effects (i.e. through ecotoxicological and ecological analyses) and the use of modelling to assess potential impacts at population and community level are key tools for supporting the management of environmental pollution in marine ecosystems.

How MEECE science can support this descriptor

Impacts of contamination have been considered in several tasks of the MEECE project. In particular, project activities were focused on target contaminants such as heavy metals, alkylphenols, antibiotics and herbicides. Available scientific information about the fate of key-pollutants and the biological effects on marine organisms were collected and collated into structured databases. A set of multi-driver experiments was then carried out in order to parameterise biological responses induced by key-pollutants and other climate change relevant drivers.

MEECE has developed a range of decision support tools: using the MSFD approach contamination was included in the generic framework for the integrated assessment of marine resources. A specific expert Decision Support System (DSS), focused on managing contamination in marine coastal areas (fig 1.), calculates the pollution-related environmental risk on a scale from 0 (no risk) to 1 (maximum risk) integrating a complex set of chemical (concentration of target contaminants) and biological data (ecotoxicological effects on model organisms), thus supporting environmental managers in the estimation of environmental quality.

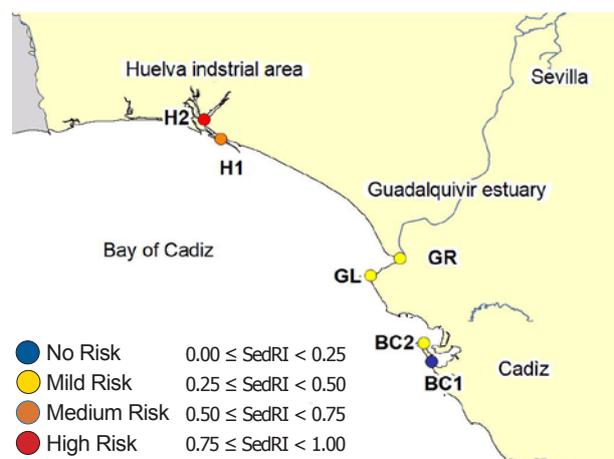


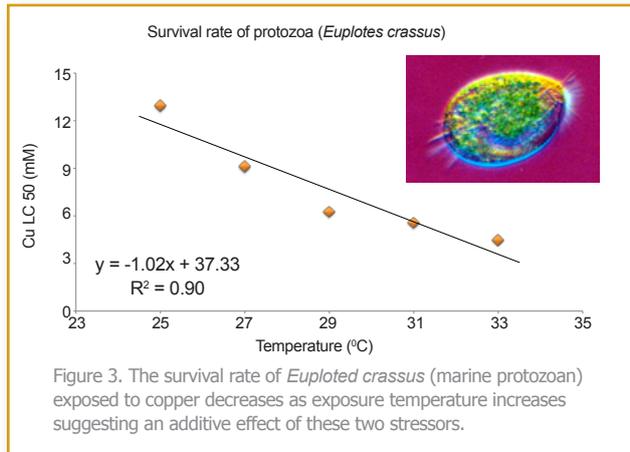
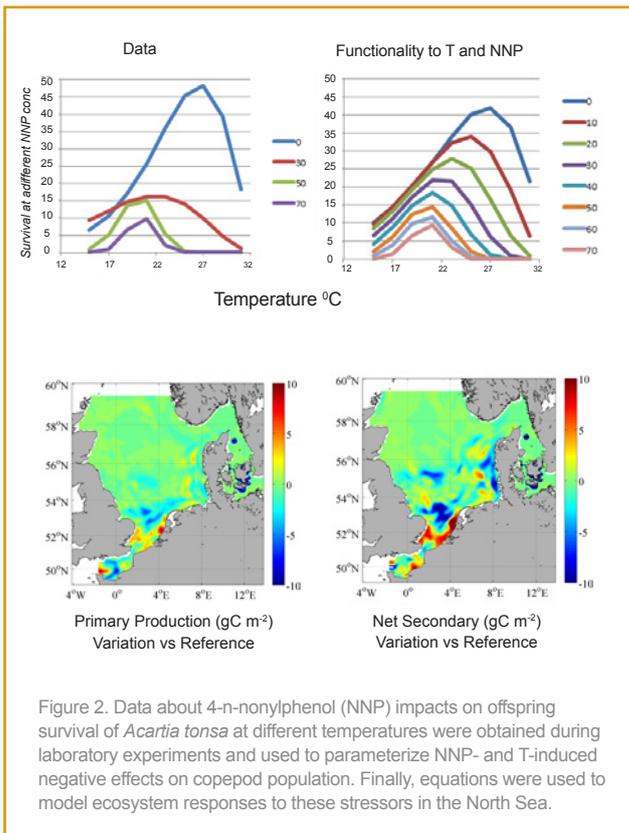
Figure 1. The levels of contamination and the results of ecotoxicological tests reported on sediments from the Bay of Cadiz (Riba et al 2004) were fed to the expert decision support system and a sediment risk index (SedRI) was calculated to classify sites in risk categories.

Science in support of policy

MEECE researchers have selected contamination as one of the stressors to be included in modelling of marine community response. In particular, laboratory experiments were planned to obtain data to allow the parameterization of some variables used in model simulations. An interesting example concerns the laboratory analyses of the responses in copepods (*Acartia tonsa*) exposed to a range of concentration of nonylphenol at different temperatures; obtained data were utilized to model the impacts on marine communities in the North sea (figure 2).

Moreover, the expert DSS was applied to determine sediment-related risk in a Copper-polluted area along the Gulf of Cadiz, Spain (data from Riba et al 2005). Chemical and ecotoxicological data were integrated into a sediment risk index, called SedRI. SedRI values have been compared to safety thresholds and sampling sites classified into 4 risk categories: no risk, mild risk, medium risk and high risk (figure 1) useful to address priorities in an environmental management perspective.

Finally, data from MEECE experiments demonstrated that marine organisms, such as mussels and protozoa, are more vulnerable to pollutants (i.e. Cu and Ni) at higher temperatures (figure 3) suggesting a direct impact of climate change in determining pollutant-induced risks. From a management perspective, these findings indicate that future shifts in parameters related to climate change should be considered in determining of environmental quality standards to manage pollution in marine ecosystems.



Model Confidence

The framework of the expert DSS is mainly based on the integration of heterogeneous (chemical and biological) data, through a weight of evidence approach, into risk indexes useful in improving the decision-making process. With this objective, the quality and quantity of input data are key factors in determining reliability of results obtained.

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