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Mathematical models to support the different stages of the environmental impact assessment of the coastal works : the case study of Civitavecchia harbour

Marco Marcelli, Viviana Piermattei, Francesco Paladini de Mendoza, and Simone Bonamano

Laboratory of Experimental Oceanology and Marine Ecology, University of Tuscia, DEB, Department of ecological and biological sciences, Civitavecchia, Italy (marcomarcell@unitus.it)

Mathematical models represent the only tools to forecast the future environmental conditions connected to the realization of the projects and plans significantly affecting Natura 2000 sites. For this reason they are increasingly used in the various stages of environmental impact assessment: from potential effects prediction on protected species and habitats to assessment of mitigation and compensation measures. Moreover, the model results can provide a fundamental contribution for the economic evaluation of the ecosystem services, considered as the basis for a correct quantification of the compensation activities.
The costal zone of Civitavecchia (Latium, Italy) was chosen as pilot study area due to the presence of important biodiversity hotspots and multiple human activities. In particular, the works of expansion scheduled for the Port of Civitavecchia, one of the largest in Europe in terms of cruise and ferry traffic, could impact on two Sites of Community Importance (IT6000005 and IT6000006), for the presence of priority habitats (Posidonia oceanica meadows and reefs of rocky substrates and biogenic concretions) and species (Pinna nobilis and Corallium rubrum).
In the early stages of the project the mathematical models were used to evaluate the indirect effects produced by the resuspended sediment during dredging activities. The results show that the SCI located at the north of Civitavecchia port is affected by the highest impacts due to the high sedimentation rate and the low transparency of the water column. Part of the impacts is mitigated through an Early Warnig system, based on mathematical model predictions, that will warn preventively the operator if a high risk to the health of protected species and habitats occurs. Another part of the impacts is compensated by the restoration of the ecosystem functions and services of the potentially damaged habitats that will be carried out through the restoration of P.oceanica and the positioning of artificial substrates suitable for colonization and restocking of coralligenous species. Since the greatest probability of success of these measures strictly depends on the environmental conditions, the mathematical models are used in this phase to estimate the marine currents, water column turbidity and sedimentation rate at a high spatial resolution in order to support the identification of suitable areas for the compensation activities.
This work demonstrates that a correct use of mathematical models can minimize the damage on marine ecosystems by improving the estimation of indirect impacts and increasing the probability of success of mitigation and compensation measures.