



Assessment of the effects of port structure changes on water quality through the development of a new predictive index.

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Harbours can be considered as semi-enclosed areas where water stagnation leads to physical and chemical alterations due to anthropogenic activities. These features affect the quality of the port waters as well as the environmental health of coastal ecosystems in the surrounding areas. According to the Water Framework Directive (WFD), harbours are classified as heavily modified water bodies and they must reach or maintain the “good ecological potential” (GEP). In order to understand the potential degradation of water quality within the harbour area it is essential to evaluate the hydrodynamic behaviour of the system.

In this study, the water renewal time was evaluated within the port of Civitavecchia (Northern Latium, Italy) by the use of a numerical model. In particular, the flushing time (FT), which represents the time required for the total mass of a conservative tracer originally within the water body to be reduced to a factor $1/e$, was examined. To test the reliability of the calculated water renewal time within the harbour basins, the relation between the FT and the enrichment factor (EF) due to trace metals in marine sediments was assessed. Since port of Civitavecchia has been and will be subjected to new major structural changes (breakwater extension, the construction of new docks, the realization of a new entrance), a new flushing efficiency index (FEI) was developed to evaluate the effects of these modifications on harbour water quality and, consequently, to prevent the occurrence of potential user–environment conflicts, as prescribed by marine spatial planning (MSP) directive.

The increase in the harbour basin size due to the embankment extension result in high values of FT, particularly in the inner part of the port, in accordance with the highest values of the enrichment factor of the trace metals found in the sediment. The deterioration of water quality is confirmed by negative FEI values. Otherwise, the index assumes positive values after the realization of a second entrance in the southern part of Civitavecchia port, highlighting a drastic improvement in harbour water renewal.

This study provides a predictive tool to correctly address the environmentally sustainable management of port activities, thereby contributing to the development of career opportunities in the blue economy.