Sustainable sediment management in coastal infrastructures through an innovative technology: final results of the MARINAPLAN PLUS LIFE project

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Introduction: More than 90% of global trade is carried by waterborne transport, constituting by far the most important means of transport of goods. Therefore, global trade is critically dependent on adequate ports and waterways navigation status (navigability). Preservation of a good port navigability is a challenging issue, since port access and waterways are often hampered, as the vast majority of 10,000s of ports worldwide suffer from sedimentation. Traditionally, the sediment that causes the problem is excavated, removed and relocated through maintenance dredging. Nevertheless, dredging is not effective in keeping navigability over the time. This objective may be reached through a higher frequency of dredging operations, but would result in higher costs and complex authorization/permit procedures. Maintenance dredging also has considerable environmental impacts, since dredging operations can: i) destroy or greatly modify underwater habitats and resident flora and fauna, ii) resuspend sediments and contaminants already present in the seabed, thus increasing the Suspended Solid Concentration (SSC) in the water column with negative effects for the ecosystem, iii) impact locally on greenhouse gas (GHG), pollutants and noise emissions, iv) generate a waste to be disposed, i.e. the dredged material. There is an increasing expectation for infrastructure projects to add value beyond the economic dimension since sustainability issues are of growing importance. The "*ejectors plant*" technology has been developed as a sustainable alternative to maintenance dredging and has been tested by Trevi SpA and University of Bologna in the first demo application in the Marina of Cervia (Italy) [1]. The demo plant operated from June 2019 to September 2020 with the final aim of keeping water depth at the Marina entrance over 2.5 meters.

Methods: During the 15 months of operation the demo plant of Cervia has been monitored to assess i) water depth, ii) energy consumption, iii) maintenance costs, iv) seabed features and species diversity, v) equivalent CO_2 emissions through LCA, vi) underwater noise impact. Water depth and energy consumption have been assessed by the Municipality of Cervia through, respectively, bathymetry surveys and energy bill. The other parameters have been monitored by the University of Bologna in collaboration with Trevi SpA. In particular, the impact on seabed features and species diversity was assessed by analyzing the characteristics of the sediment (organic matter and grain size) and the composition of the benthic and fish assemblages, in the two areas of possible impact and in control areas located both to the south and north of the port, in the periods before (2018) and after (2020) the installation of the system.

Results: After 15 months of continuous operation of the demo plant in Cervia the minimum water depth of 2.5 meters was guaranteed. Monitoring actions revealed that seabed features and species diversity were improved and that the impact on underwater noise was absent. Ejectors plant operation resulted in a reduction of the muddy fraction and of the organic matter content present in the sediment in the areas affected by the plant, compared to the initial values that were affected by previous dredging. The species richness of benthic macro-invertebrates, initially reduced near the port, probably as a result of the previous repeated dredging, significantly increased eight months after the demo plant was put into operation. Underwater noise assessment in the port and periport environment showed that the contribution of hydraulic pumps and ejectors to the increase in underwater noise is not significant. It is therefore believed that the ejectors plant does not constitute an impact for the marine fauna near the port of Cervia. Based on energy consumption, it was also demonstrated that an optimized ejectors plant, if fed by renewable power, could cut more than 80% of GHG emissions and guarantee near-zero pollutants emissions in comparison with traditional dredging.
Discussion: The results suggest that the technology is effective and efficient, and that the demo plant operation is accompanied by an improvement in several parameters related to the ecological status of the marine ecosystem in the area affected by ejectors within one year.

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References: [1] Pellegrini et al. (2020) *J Soils Sediments* **20**:6.