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

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Introduction: The water field around ports is an area where intense currents and sediment transport rates are usually present and can be affected by low water velocities that take place close to the entrance and inside the port basin. Consequently, sediment can be entrained and accumulated in such areas, creating problems to navigation. The result is that harbour basins and approaches are frequently silted and require ordinary maintenance dredging. The dredging process involves the removal of sediment in its natural deposited condition by using either mechanical or hydraulic equipment. Dredging is a consolidated and proven technology, but involves considerable drawbacks, like notable environmental impact on marine flora and fauna, the increasing of mobility and diffusion of contaminants and pollutants already present on the seabed, the obstruction of navigation and the relatively high and low predictable costs. Moving towards a sustainable sediment management in harbor areas requires the adoption of innovative technologies able to reduce the environmental impacts and to minimize and standardize costs. The paper shows the preliminary results of the MARINAPLAN PLUS LIFE project, which aims to develop and test an innovative sediment by-passing plant alternative to dredging.

Project description: The MARINAPLAN PLUS LIFE project foresees the realization of a sediment by-passing plant in the harbor channel inlet of Cervia (Italy). Cervia is located on the Adriatic Sea and it can be considered as a representative siltation case study for Middle-North Adriatic Sea harbours and marinas. Through the analysis of the last 5 years bathymetries it has been possible to identify a natural sand transport moving from North to South direction that is interrupted by the docks of the harbor channel. This fact produces two negative drawbacks: i) the harbor channel inlet is affected by sand siltation and ii) the beach located near the southern dock suffers from erosion. The consequence is that the harbor inlet requires frequent dredging, with high concerns regarding costs, environmental sustainability and navigation safety.

A demo plant for sediment by-passing is under realization in Cervia (to be completed by April 2019). The technology is under development since 2001 and has been already applied in two experimental plants in Italy [1,2]. The main element of the plant is the *ejector*, an open jet pump (i.e. without closed suction chamber and mixing throat) with a converging section instead of a diffuser and a series of nozzles positioned circularly around the ejector. The ejector works on a limited circular area created by the pressurized water outgoing from the central nozzle, whose diameter depends on the sediment characteristic such as, for example, the angle of repose. By ejector integration in series and in parallel it is possible to create or to maintain a seaway. The demo plant is made by ten ejectors and includes also a fully automated and remotely accessible pumping station equipped with auto-purging filters. Monitoring activities are fundamental in the MARINAPLAN PLUS LIFE project, since reliable data are crucial to evaluate the impact of the demo plant and to design a sustainable sediment management: bathymetries, chemical-physical characterizations, impact on marine flora and fauna, underwater noise and energy consumption will be measured before and after the demo plant operation start.

Preliminary results: On July 2017 on-field test were carried out by the University of Bologna to evaluate the working conditions of the ejectors at the harbor channel inlet of Cervia. The ejector reached a mean sand flowrate at the discharge pipeline (characterized by 60 meters length) of about 2 m^3/h through a primary water feeding flowrate of about 32.5 m^3/h and an energy consumption of 3 kW. So, one ejector consumes 1.5 kWh per cubic meters of sand moved.

References: [1] Amati and Saccani (2005) *Proceedings of the XXXII National Conference on Italian Plant Engineering*; [2] Bianchini et al. (2014) *Proceedings of the International Symposium on Sediment Management I2SM*.