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Ship traffic and shoreline erosion in the Lagoon of Venice

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Maritime traffic is the most important human activity in the world oceans. Some of the ship related impacts, like underwater noise, oil spills and release of ballast waters, litter and sewage disposal, gaseous and particulate emissions have direct effects on the marine environment. Pollution is not the only undesiderable effect of marine traffic. A considerable amount of energy is in fact introduced in the sea in form of wake waves as vessels move along their routes with major consequences in coastal and shallow water areas. In confined or semi confined navigation channels depression wakes may cause extensive drawdown in the water level [1], propagate far from the channel [2] or play the largest role in sediment resuspension [3]. A research based on the analysis of a historical sequence of aerial photographs and satellite images combined with in situ measurements revealed an unprecedented shoreline regression on the side of a major waterway in the Venice Lagoon, Italy (Figure 1).

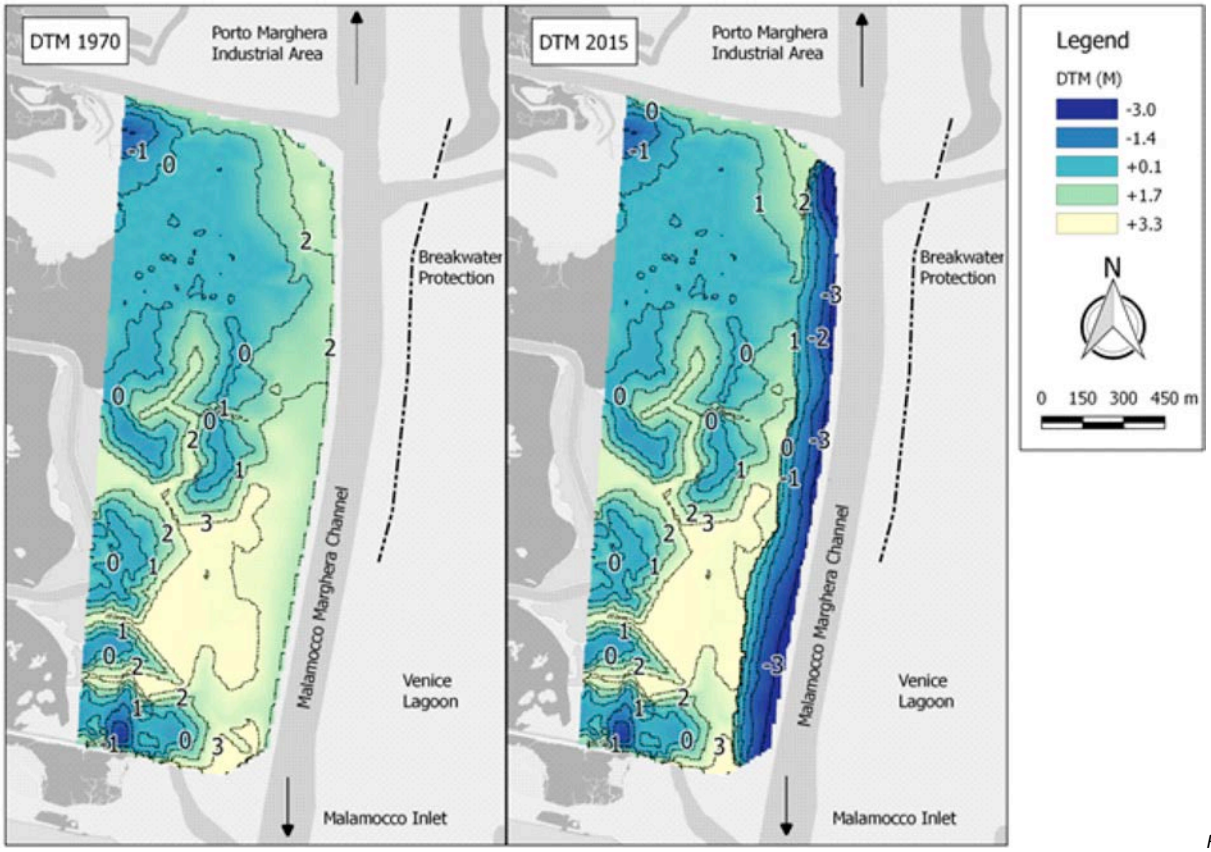

Fig. .1 DTM (Digital Model Terrain) for "Cassa di Colmata B" in 1970 (A) and in 2015 (B). Contour lines are also shown for each case.

The study considered long and short-term recession rates caused by ship-induced depression wakes in an area which was reclaimed at the end of the ’60 for the expansion of the nearby Porto Marghera Industrial Zone and never used since then. The GIS analysis performed with the available imagery shows an average retreat of about 4 m yr^{-1} in the period between 1965 and 2015. Field measurements carried out between April 2014 and January 2015 also revealed that the shoreline’s regression still proceed with a speed comparable to the long term average regardless of the distance from the navigation channel and is not constant through time. Periods of high water levels determined by astronomical tide or storm surges, more common in the winter season, are characterized by faster regression rates. The retreat is proceeded by the collapse of slabs of the reclaimed muddy soil after erosion and removal of the underlying original salt marsh sediments and is a discontinuous process in time and space depending on the morphology, the intrinsic properties and the vegetation cover of the artificial deposits. Digitalization of historical maps and new bathymetric surveys made in April 2015 enabled the construction of two digital terrain models for both past and present situations. The two models have been used to calculate the total volume of sediment lost during the period between 1970 and 2015. The results of this study shows as ship-channel interactions can dominate the morphodynamics of a waterway and its margins and enable a better understanding as to how this part of the Venice Lagoon reacted to the pressure of human activities in the post-industrial period. Evaluation of the temporal and spatial variation of the shoreline position is also crucial for the development of future scenarios and for the management of the lagoon and its ecosystem.

References

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