Benthic morphologies and sediment distribution in a shallow highly human impacted tidal inlet

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1. Introduction

Transitional environments like lagoons, deltas and estuaries are extremely shallow, dynamic and highly valuable in terms of biodiversity and productivity. Therefore, they require constant monitoring, but at the same time they represent a challenge both for optical (aerial- satellite) observations because of their turbidity and for swath bathymetry because of their shallowness.

In this study, we present results from a high resolution multibeam echosounder (MBES) survey carried out in 2013 in a highly human impacted tidal inlet in the, Venice Lagoon, Italy. The Venice Lagoon has an average water depth of about 1 m and it is connected to the open sea by three inlets (Lido, Malamocco and Chioggia) that since 2006 have been strongly modified by the construction of mobile barriers (MoSE Project) to protect the historical city of Venice from high water. These works could influence the lagoon hydrodynamic and morphological configuration (Ghezzo et al, 2010). This study focuses on the Chioggia inlet with the aim of describing the inlet benthic morphological and habitat characteristics highlighting the main changes on the seafloor induced by the anthropogenic interventions.

2. Methods

In 2013, we mapped a seafloor area of 10 km^2 in the Chioggia Inlet with a resolution of 0.5 m thanks to a high resolution MBES. MBES data (bathymetry and acoustic backscatter intensity) and a total of 45 in-situ samples (bottom sediment samples and underwater images), were collected to describe the territory, in terms of seafloor geo-morphology and grain size distribution. The main bedforms (scour holes, dune fields, pools, etc.) were identified both manually and with the Benthic Terrain Modeller in ArcGIS 10.2. Different automatic algorithms were tested to classify the acoustic backscatter intensity and checked against the sedimentological analysis in order to obtain the seafloor sediment and habitat distribution.

3. Results

The depth of the study area ranges between 2 m and 30 m, with a mean of 10.9 m (Figure 1). The maximum depth was registered inside a big scour hole located close to the artificially stabilised landward side of the Chioggia inlets. Other 2 smaller scour holes were observed around the artificial breakwater located on seaside. Moreover, we mapped 32 dune fields in the study area with a high variability in terms of wavelength and height.

The Folk classification of 45 grab samples shows 7 different classes, ranging from coarse gravels to sandy muds, with a strongly predominance of slightly gravelly sands. By comparing the result of the sedimentological analysis and the seabed photos with the acoustic backscatter distribution, we obtained the seafloor sediment distribution with four main sediment classes with an overall accuracy of 75%.

The sediment distribution seems to be directly linked to MoSE construction, in particular to the presence of the breakwater, that constrain in a small section the water fluxes: this factor causes an upgrade of the bottom shear stress and the consequent increase in grain size distribution. The presence of breakwater induced the forming of the two main erosive features due to increased vorticity.

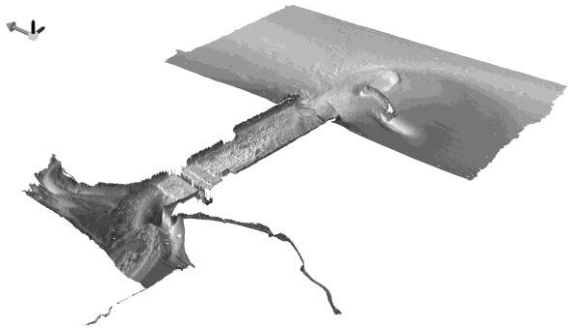

Figure 1. 3-D digital benthic model of the Chioggia inlet (0.5 m resolution, 5 times vertical exaggeration).

4. Conclusions

Whereas a vast literature is available on MBES studies in deep waters, very few papers has been made in shallow tidal environments. This research shows with unprecedented detail the Chioggia inlet morphologies and shows the unknown alterations induced by the anthropogenic structures, like scour holes excavation and different bottom sediment distribution.

The results were compared with previous literature and with the results of a high resolution hydrodynamic model, which helped to explain the distribution of seafloor sediments and the recent evolution of the tidal inlet.

References

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