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Morphological characterization of extremely shallow environments through spectral and textural analysis of high resolution bathymetric and backscatter data

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Transitional environments like lagoons, deltas and estuaries often undergo strong natural and human-induced actions that need constant monitoring. The changes of these environments can be assessed using acoustic bathymetric surveys: bathymetric data are not only important for navigational purposes but they are also employed for geomorphologic studies, habitat mapping and modelling of evolution trends of the highly dynamical coastal areas. Among the coastal systems, transitional environments, are often extremely shallow (of the order of 1 m deep or less) and morphologically complex. This kind of environment represents a challenge for acoustic bathymetric surveys. To assess the potentiality and the limits of acoustic surveys in extremely shallow environments, we carried out two surveys in the Lagoon of Venice, Italy, with an interferometric sonar and a multibeam echosounder system.

As a case study we focused on a natural channel in the northern part of the lagoon combining the data from the different surveys. In particular we carried out a two-dimensional (2D) spectral and textural analysis of the high resolution bathymetric and backscatter data collected. As a result of the 2D spectral analysis on the elevation data, we were able to identify and parameterize the geometrical characteristics of the main morphological features of the channel, like dunes, scours, crests and troughs and sedimentation areas and to extract the channel bottom roughness. We then performed an unsupervised classification of the backscatter data. As a result, we were able to identify different backscatter areas where several grab samples were collected for ground truthing. With the help of this sampling we calibrated a textural analysis and obtained a classification of the different kinds of substrate.

Within this multidisciplinary approach, we set up and successfully tested a combined method to quantitatively characterize an extremely shallow water dynamical environment. Using this method, we could map the main morphological and sedimentological features of the seabed and relate them to the hydrodynamic conditions provided by an high resolution 3D numerical model.