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Use of texture analysis techniques for digital mapping of underwater environments: The case of a submerged karstic landscape offshore Malta.

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We present a quantitative, semi-automated GIS-based technique to map the distribution of seafloor facies and morphology using high-resolution multibeam echosounder data.

Data collected from the shallow coastal areas to the north of the main island of Malta, central Mediterranean Sea, are used to test the technique. The acoustic data were acquired on board the RV Hercules using a hull-mounted Simrad Konsberg EM3002D multibeam system operating at a frequency of 300 kHz. The multibeam echosounder data were processed with CARIS HIPS and PRISM to derive bathymetric and backscatter data sets, respectively. A high resolution digital elevation model (DEM) of the seabed was generated using these data. High-definition digital video was also acquired from eleven stations using a SeaEye Panther Plus Remotely Operated Vehicle.

The DEM and the associated backscatter data were analysed using Grey Level Co-occurrence matrices and second-order statistical analyses. Parameterisation of the techniques is very important; for example the number of grey levels used and the size of the kernel sample. Homogeneity (also known as inverse difference moment) gives a good measure of local similarities within a window, whereas entropy measures the lack of spatial organisation. The inertia and uniformity indices, on the other hand, provide quantitative measures of contrast and roughness. Most of the textures in the backscatter data could be characterised and analysed using only a few indices (e.g. Homogeneity and entropy). Correlation of these indices was carried out to classify the landscape and map seabed composition and morphology. The video samples are analysed visually to ground-truth the resulting map.

The data sets and classification map reveal an outstanding and spectacular underwater landscape comprised of limestone, sands and silt. It consists of an uncharted submerged Quaternary coastal landscape characterised by advanced solution weathering landforms, in the form of limestone pavements and solution subsidence structures. Many of these structures have now been documented for the first time, one being nearly 250 m wide. Intricately shaped sediment bedforms, on the other hand, provide information on the current oceanographic regime and terrestrial sources of sediment.

The technique can have wide-ranging applications, such as the reconstruction of submarine landscapes and the identification of geological processes responsible for their development, as well as quantitative seabed mapping, which has become a critical tool for the effective management of marine systems.