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Integrating a drone's DEM and orthomosaic enhances performance of Object-Based Image Analysis for habitat mapping of shallow coral reefs

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Shallow coral reefs are biodiverse ecosystems currently severely at risk from anthropogenic disturbance and climate change. To ensure their survival through the Anthropocene, ecologically informative maps of these areas, that can guide ecosystem-based management, are necessary. In recent years, Unmanned Aerial Vehicles (UAVs) have emerged as a new tool to obtain spatially explicit data of the benthic community in very shallow habitats (<3.5 m deep), where acoustic survey techniques used in deeper water become challenging or unfeasible. Structure-from-Motion (SfM) processing allows the conversion of separate images into high-resolution orthomosaics and Digital Elevation Models (DEM), spanning several hundred metres. The orthomosaic is commonly used to create a habitat map. Object-Based Image Analysis (OBIA), in which an image is first segmented into homogeneous segments before classification, provides an effective method to work with such high-resolution data. In this study we investigated the possibilities to enhance habitat classification by also using the DEM in the OBIA. Therefore, we surveyed three shallow reef areas on the central Saudi-Arabian coast with a consumer-grade UAV and processed the imagery with SfM. We then separately assessed the impact of adding the DEM's three-dimensional information on the image segmentation and automatic classification steps in the OBIA. Integrating both the 3D model and spectral information into the segmentation greatly reduced the amount of oversegmentation. The addition of DEM-derived variables into a Random Forest classifier increased overall classification accuracy up to 11%. Thus, this study demonstrates the previously untapped potential of a drone's DEM to improve the accuracy of semi-automated OBIA for habitat mapping in shallow tropical marine ecosystems.