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# Low-Altitude Coastal Aerial Photogrammetry for High-Resolution Seabed Imaging and Habitat Mapping of Shallow Areas

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This paper explores the application of Kite Aerial Photography at the coastal environment along with digital photogrammetry for seabed geomorphological mapping. This method takes advantage of sea-water clearance that allows the transmission of sunlight through the water column and backscatter of seabed reflection under certain conditions of sunlight, weather and sea state. We analyze the procedure of acquisition, processing and interpretation of kite aerial imagery from the sub-littoral zone up to 5 meters depth. Using a calibrated non-metric digital compact camera we managed to acquire several vertical aerial images from two coastal sites in the Attica Peninsula (Greece) covering an area of approximately 200x100 meters. Both sites express significant geomorphological variability and they have a relatively smooth slope profile. For the photogrammetric processing we acquired topographic and bathymetric survey simultaneously with Kite Aerial Photography using a portable GPS of sub-meter accuracy. In order to deal with bottom control measurements we developed Bottom Control Points which were placed on the seabed. These act like the Ground Control Points and they can be easily deployed in the marine environment. The processing included interior and exterior orientation as well as ortho-rectification of images. This produced final orthomosaics for each site at scales 1:500 – 1:1500 with a resolution of a few centimeters. Interpretation of the seabed was based on color and texture features of certain areas with explicit seabed reflectivity and was supported by underwater photographs for ground truthing. At the final stage of image analysis, we recognized the boundaries (contrasting reflectivity) between different bottom types and digitized them as 2D objects using GIS. Concluding, this project emphasizes on the advantages and physical restrictions of Kite Aerial Photography in mapping small-scale geomorphological features in coastal, estuarine and lagoonal environments. Furthermore, this study appoints the suitability of the KAP method for mapping shallow water habitats such as soft/hard substrates, coastal reefs and sea grass meadows. Consequently, the application of low altitude digital photogrammetry is proposed for shallow water surveying as an alternative or supplementary to the side scan sonar and backscatter recorder until a maximum depth of 10 meters. It is suggested that very dense DEMs produced by LiDAR bathymetry may be utilized for ortho-rectification of high-resolution aerial imagery acquired by UAVs or remotely controlled platforms.