High-Resolution UAV Derived Orthomosaics of Shallow Water Coral Reefs: A Tool for Benthic Habitat Mapping and Monitoring

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Coral reefs are unique ecosystems characterised by high biodiversity and their ability to survive under highly variable, monsoon-driven environmental conditions. However, coral reefs, especially in very shallow areas (<5 m), are naturally exposed to various natural and anthropogenic stressors, including climate change, temperature - induced coral bleaching, and marine pollution, raising great concern over their future. As such, accurate and ecologically informative coral reef maps are important for their management and conservation. Our study aimed to assess the benthic habitat composition and coral reef condition at two selected shallow water fringing reef sites, Madiha and Dondra, along the southern coast of Sri Lanka using Unmanned Aerial Vehicle (UAV) based photogrammetry. A DJI Air 2S consumer-grade drone was operated at 20 m altitude with 85% forward and 80% side image overlap to acquire very high-resolution imagery. Orthomosaics were processed using Agisoft Metashape Pro, achieving ground resolutions between 5 and 7 mm/pixel. Then, in situ reef surveys were conducted using 10 underwater video transects (20 m each) per site, analyzed with CPCe (Coral Point Count with Excel extensions). Benthic classification was performed within Object-Based Image Analysis (OBIA) using a Support Vector Machine (SVM) classifier in ArcGIS Pro. High classification accuracies were obtained for key substrate types, based on accuracy assessments conducted in ArcGIS Pro, with overall accuracies of 94% and 88% and Kappa coefficients of 90% and 72% for Madiha and Dondra, respectively. Dondra exhibited moderate coral cover with relatively lower diversity, while Madiha showed clear signs of reef degradation with a shift from coral to algal- dominated area. These findings highlight the potential of UAV -based photogrammetry combined with supervised classification for benthic habitat mapping in shallow waters, a promising but still underutilized approach for future monitoring and conservation efforts.

Keywords: *Coral reef, Benthic habitat mapping, Unmanned Aerial Vehicle, Photogrammetry, Object-Based Image Analysis, Sri Lanka*