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Integrating Unmanned Aerial Vehicles (UAVs) for the Assessment and Monitoring of Vegetation in the Panama Sand Dune, Sri Lanka

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Abstract

Drones are widely used in photogrammetric surveys worldwide for environmental monitoring research since they provide high-resolution and real-time images. Therefore, drone mapping can effectively study dune vegetation consisting of various flora types such as shrubs, creepers, climbers, herbs, and trees. Hence, this study mainly focuses on identifying the vegetation cover of the Panama sand dunes area, between the Panakala lagoon on the Eastern coast, by using Unmanned Aerial Vehicles (UAVs). The DJI Phantom 4 Pro V2.0 drone was utilized to capture images at 50 m altitude, and the image overlapping threshold was set to 90% when creating the GPS path using the PIX4D Capture Pro software. The drone imagery underwent the creation of orthomosaic maps using Drone Deploy software. Two orthomosaic maps were generated according to the limitation of image uploading capacity. The maximum likelihood supervised classification was performed by ArcGIS 10.8 software to distinguish the area of the vegetation patches and sand separately. Vegetation coverage was estimated as 63.6% of the total study area (110,231 m^2) on map 01, and vegetation coverage was estimated as 15.75% of the total study area (171,539 m^2) on map 02. Using 300 reference points separately, the accuracy assessment showed an overall accuracy of 91% with the Kappa coefficient of 82% and an overall accuracy of 96% with the Kappa coefficient of 79% in maps 01 and 02, respectively. 50×50 m grids (11 of the grids created from ArcGIS 10.8 with 100 m of intervals) were used to obtain the vegetation diversity of the selected area. According to the result, *Casuarina equisetifolia* was the most abundant tree (43%), and next was a creeper called *Spinifex littoreus* (10%) at the selected location. The overall accuracy and the Kappa coefficient indicate a strong agreement between the classified map and reference data, suggesting that the classification method is reliable for such environmental studies. Vegetation coverage variation in dunes results from the interplay of soil nutrients, moisture availability, wind exposure, sand dynamics, and human disturbances, shaping distinct plant communities adapted to specific environmental conditions. *Casuarina equisetifolia* and *Spinifex littoreus* dominate the coastal dune ecosystem due to their adaptations to saline conditions and roles in stabilizing sandy substrates, facilitating the establishment of diverse plant communities. This research could inform coastal conservation management and guide future studies on dune vegetation dynamics in Sri Lanka and beyond.

Keywords: *Coastal dune ecosystem, Dune vegetation, Panama, Photogrammetric surveys*