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Surface and sub-surface anatomy of the landscape: integrating Unmanned Aerial Vehicle Structure from Motion (UAV-SfM) and Ground Penetrating Radar (GRP) to investigate sedimentary features in the field. – an example from NW Australia

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Geomorphology is confronted by the challenge of reconstructing landscape features at appropriate scales, resolution and accuracy, that allows meaningful analysis of environmental processes and their implications. Field geomorphology offers a discrete snapshot (i.e. one or two field campaigns) to reconstruct how features have changed, evolved or responded over time. We explore the application of an emerging photogrammetry technique called Structure-from-Motion (SfM), which uses multiple photographs of the same feature (but taken at different locations) to create high-accuracy three-dimensional models of surface of sedimentary fans formed by extreme wave events. This approach is complimented by investigation of the sub-surface morphology using Ground Penetrating Radar (GPR).

Using an UAV "octocopter", we captured 1208 photos with a DSLR camera (Canon EoS-M) at the height of 50m with a ground pixel resolution of 9mm, above a cyclone wash-over fan in the Exmouth Gulf (Western Australia) that measured about 500m inland by 300m wide. Based on 38 ground control point targets (with between 4 and 45 individual photographs per target) the SfM surface had an absolute total (XYZ) accuracy of 51mm (39mm X, 29mm Y and 14mm Y), based on RTK-DGPS surveying from a local ground reference station (with an absolute AUSPOS accuracy of 57mm X, 6mm Y, 50mm Z to AHD) and an overall relative point accuracy of 7mm. A sparse point cloud of over 5.5 million data points was generated using only points with a reconstruction accuracy of <50mm, before spectral unsupervised classification (RGB colour of each XYZ pixel) using K-Means clustering within Python. The output was then manually classified into ground and non-ground points, and the geostatistical analyst functionality of ArcGIS used to produce a final bare-earth DEM. This approach has allowed the study team to economically collect an unprecedented high-resolution and accuracy topographic model of this feature to compliment on-ground sediment, geophysics and dating work to analyse the complex evolution structure of the wash-over sequence and the implications of this feature for reconstructing the paleotempestology of the Australia NW coast. This has allowed insight into the backwater heights associated with the depositional environment of the contemporary fan, areas of the fan surface in preferential connection to the wash-up channel and the relationship between topography and vegetation and GPR transects that has allowed for targeting of Field trenches and OSL dating.