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# Close-range airborne photogrammetry: an effective tool for high-resolution sandy beach morphometric surveys. Examples from embayed beaches in French Guyana.

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Photogrammetric techniques are at a turning point in their history with the development of new algorithms, such as SIFT (Lowe, 1999) for automatic camera alignment and point cloud densification (Furukawa, 2010) integrated in user-friendly end-products. These innovations facilitate the utilization of this technique to study objects with low to mild morphological contrasts at low cost and by non-specialists. It is now possible to produce high-resolution 3D morphometric models, and derived products such as Digital Surface Models (DSM) and Orthophotographs.
We conducted three photogrammetric experiments on the embayed beach of Montjoly (4 km long, 100-200 m wide) in Cayenne, French Guyana, in order to quantify morphological changes. The beach is affected by rotation induced by westward migration of mud banks from the Amazon that generate spatio-temporal changes in wave refraction and incident wave angles. The current rotation involves massive erosion of the northern part of the beach (50 m retreat between October 2013 and March 2014) and deposition in the southern sector (50 m advance). We acquired subvertical aerial photographs from a microlight aircraft using a full frame DSLR sensor with a 50 mm lens synchronized with an onboard DGPS, and flew alongshore at low elevation (900 ft). The flight plan included several parallel flight axes with a 50 m interband distance. Meanwhile on the ground, we placed around 30 square targets of 40 cm width georeferenced by RTK-DGPS with centimetre accuracy. These targets served in producing the georeferenced output 3D model. Third, we measured the topography of random points and cross-shore profiles to validate our results and assess the process accuracy. We produced the model and its derived products with user-friendly Agisoft Photoscan© software.
We obtained three morphometric models realized in October 2013, March 2014 and October 2014 covering the entire beach. These models were produced at a resolution of 10 cm per pixel and have a mean vertical accuracy less than +/- 5 cm compared to the GPS control points, with a maximum of 20 cm in marginal sectors near vegetation and in the swash zone in low-water conditions. To our knowledge, this is the first time a poorly textured surface composed of sand is reconstructed by photogrammetry, contrast in the studied object being necessary for this method. Our highly accurate photo resolution and pre-processing permitted imaging enough texture to proceed.
Morphological features in the upper surf zone such as rip channels, and subaerial features, such as erosion scarps and aeolian forms, clearly appear. The comparison between the DSM validates the estimation of sediment transfers and the rotation process on this beach, unlike traditional beach monitoring with GPS, which involves large uncertainty linked to sparse point acquisition.
It can be claimed that photogrammetry is low-cost, user-friendly, and offers new perspectives for non-specialist users in geomorphology and other fields recquiring high-resolution topographic data. It combines the advantages of the reproducibility of GPS topographic surveys and the high density and accuracy of LIDAR, but at very advantageous cost compared to the latter.