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High-resolution topography using SfM-photogrammetry from UAV for coastal mudflat geomorphic surveys

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The coast between the Amazon and the Orinoco river mouths comprises mud banks formed from the large muddy discharge of the Amazon and migrating westward under the influence of waves and currents. These banks are highly dynamic and strongly affected by complex hydro-bio-geochemical interactions that are also important in mangrove colonization of bare mudflats in the upper intertidal zone of these banks. The surface topography of these mud banks is further affected by physical and biological processes such as tidal channel incision and bioturbation. Surveying the morphology of these mudflats over large areas and at a high-resolution without perturbing their surface is a real challenge that cannot be accomplished using classical survey methods such as RTK-GPS or Total Stations.

To overcome this hurdle, we conducted a SfM(Surface from Motion)-photogrammetry experiment over 1 ha of a large intertidal mudflat colonized by pioneer mangroves at the mouth of the Sinnamary estuary in French Guiana. We developed a topographic data acquisition system based on sub-vertical aerial photography from a UAV flying at low altitude (15 m), in order to produce images at 3 mm resolution. A light DJI F550 drone was used, with an automatic flight programming using GPS navigation and a flight plan designed on photogrammetric criteria. The payload was a lightweight (250 grams) Ricoh GR camera with an APS-C sensor of 16.2 Megapixel and including an intervalometer triggering function. The drone had a flight autonomy of 12 minutes thus covering entirely the surrounding mudflat platform. The landing procedure was conducted manually in order for the drone to land safely on a very narrow artificial ground base set up for our experiment. 3D-models and derived products were generated using Agisoft Photoscan Professionnal software. We produced a gridded Digital Surface Model (DSM) and an orthophoto in visible bands at 1 cm and 5mm pixel resolution respectively. The vertical accuracy of the DSM based on a set of Ground Control Points acquired by RTK-GPS is between 2 and 3 times the DSM pixel resolution. This SfM implementation allows for: (1) a fine estimate, from the high resolution topographic data, of gentle mudflat morphologies including heterogeneous benthic surficial structures (channels, creeks, pools, burrows, pits) and (2) an assessment, from the high resolution visible imagery, of the benthic macrofauna burrowing activity by crabs and the density of their burrows.

Affordable, lightweight and reproducible, SfM photogrammetric implementation based on UAVs offers interesting new perspectives in coastal geomorphology studies requiring high-resolution and accurate topographic data and imagery.