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Geomorphological mapping with a small unmanned aircraft system (sUAS): Feature detection and accuracy assessment of a photogrammetrically-derived digital terrain model

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Highlights

â€¢ In 4.5Â h we collected airborne imagery and ground data to produce a 1Â m DTM.

â€¢ The accuracy of the sUAS DTM is equivalent to a bare Earth LiDAR DTM.

â€¢ Small-scale biogeomorphic features in 0.1Â m imagery were not visible in 1Â m imagery.

Abstract

Small unmanned aircraft systems (sUAS) are a relatively new type of aerial platform for acquiring high-resolution remote sensing measurements of Earth surface processes and landforms. However, despite growing application there has been little quantitative assessment of sUAS performance. Here we present results from a field experiment designed to evaluate the accuracy of a photogrammetrically-derived digital terrain model (DTM) developed from imagery acquired with a low-cost digital camera onboard an sUAS. We also show the utility of the high-resolution (0.1Â m) sUAS imagery for resolving small-scale biogeomorphic features. The experiment was conducted in an area with active and stabilized aeolian landforms in the southern Canadian Prairies. Images were acquired with a Hawkeye RQ-84Z Areohawk fixed-wing sUAS. A total of 280 images were acquired along 14 flight lines, covering an area of 1.95Â km^2. The survey was completed in 4.5Â h, including GPS surveying, sUAS setup and flight time. Standard image processing and photogrammetric techniques were used to produce a 1Â m resolution DTM and a 0.1Â m resolution orthorectified image mosaic. The latter revealed previously un-mapped bioturbation features. The vertical accuracy of the DTM was evaluated with 99 Real-Time Kinematic GPS points, while 20 of these points were used to quantify horizontal accuracy. The horizontal root mean squared error ($RMSE$) of the orthoimage was 0.18Â m, while the vertical $RMSE$ of the DTM was 0.29Â m, which is equivalent to the $RMSE$ of a bare earth LiDAR DTM for the same site. The combined error from both datasets was used to define a threshold of the minimum elevation difference that could be reliably attributed to erosion or deposition in the seven years separating the sUAS and LiDAR datasets. Overall, our results suggest that sUAS-acquired imagery may provide a low-cost, rapid, and flexible alternative to airborne LiDAR for geomorphological mapping.

Keywords

Small unmanned aircraft system (sUAS); Digital terrain model accuracy; LiDAR; High-resolution geomorphic mapping; Topographic change detection

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