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Application of Unmanned Aerial System-based Photogrammetry to Monitor Landforms Evolution of Mudstone Badlands

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Mudstone badlands are the area characteristized by its rapid erosion and steep, fractured, and barren landforms. Monitoring the topography changes in badland help improve our knowledge of the hillslope and river processing on landforms and develop susceptibility model for surface erosion hazards. Recently, advances in unmanned aerial system (UAS) and close-range photogrammetry technology have opened up the possibility of effectively measuring topography changes with high spatiotemporal resolutions. In this study, we used the UAS and close-range photogrammetry technology to monitor the topography changes in a rapidly eroded badland, south-western Taiwan. A small mudstone hillslope with area of 0.2 ha approximately and with slope gradient of 37 degrees was selected as the study site. A widely used and commercial quadcopter equipped non-metric camera was used to take images with ground sampling distance (GSD) 5 mm approximately. The Pix4DMapper, a commercial close-range photogrammetry software, was used to perform stereo matching, extract point clouds, generate digital surface models (DSMs) and orthoimage. To control model accuracy, a set of ground control points was surveyed by using eGPS. The monitoring was carried out after every significant rainfall event that may induced observable erosion in the badland site. The results show that DSMs have the GSDs of 4.0∼5.4 mm and vertical accuracy of 61∼116 mm. The accuracy largely depends on the quality of ground control points. The spatial averaged erosion rate during six months of monitoring was 328 mm, which is higher in the gully sides than in the ridges. The erosion rate is positively correlated with the slope gradient and drainage contributing area that implies the important role of surface gully erosion in mudstone badland erosion. This study shows that UAS and close-range photogrammetry technology can be used to monitor the topography change in badland areas effectively and can provide high spatiotemporal resolutions of DSMs for developing distributed surface erosion models.