Deciphering recent landslide dynamics in the Shirakami Mountains, a World Natural Heritage site, Japan

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Larger and deeper landslides are common phenomena, but measurements relevant to landslide dynamics are scare in the Shirakami Mountains, a World Natural Heritage site, Japan. This study documents recent landslide occurrences (ca. 10 years) of three landslides align on the terrace scarp (at right bank) and have occurred at the outside bend of the meandering channel of the northward-flowing Okawa River. We construct digital surface model (DSM) and orthomosaics at 6.5 cm resolution from UAV imagery obtained on 6 November 2017 using structure-from-motion (SfM) photogrammetric procedures. Then, the DSM was resampled to a 1-m resolution and was used to compare to an airborne LiDAR-derived digital elevation model (DEM) of 1-m resolution acquired on 22 October 2008 to constrain the landslide magnitude and direction of the displacement vectors using CIAS (the Correlation Image Analysis Software; Kääb and Vollmer, 2000). Results were also compared with longitudinal profiles collected by a hand-held laser-ranger finder. The computed horizontal displacements range from 0.1 to 9.7 m with a standard deviation of 1.81 m. At the landslide body of the northern landslide the computed vectors suggest a southward movement, however, the explanation for this movement is currently unknown. The longitudinal displacement for a flat, terrace-like topography of 6×7 m within the landslide body of the southern landslide was computed of ~7 m that is appropriately represented as compared with the filed measurement. Active displacements were generally constrained at the secondary and side scarps (3–9 m) and the edges of toes (2–8 m), where the retreating movements are well identified by the algorithm. The retreat of landslide toes was likely triggered by lateral river erosion based on the interpretation of changes of river courses by aerial photos and an outcrop exposed on the landslide toe that consist of imbricated, horizontally bedded gravels. Our results indicate that a combination of UAV-based SfM data and available DEM and the image correlation algorithm is useful and effective to understand the landslide dynamics.

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