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Tectonic controls on gravitational deformation: a regional sagging mapping in the western Mino Mountains using LiDAR

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Many linear geomorphic features of gravitational origin, known as sagging or sackung, are recognized on and around high mountain ridges worldwide. A complete scanning and mapping of those sagging features in a given region, however, has ever been difficult because classic aerial-photograph examination does not allow detection of small geomorphic features under forest canopies. We here present the first complete distribution map of sagging features in a wide area using high-resolution airborne LiDAR and the elaborate DEM visualization that facilitates mapping and interpretation of small geomorphic features of various morphology and orientations. The target area is the western Mino Mountains, central Japan, where the ˜35-km-wide and ˜24-km-long area is characterized by relatively monotonous, moderate- to high-relief mountains of 1000-1600 m high and uneven active-fault distribution. The recently acquired 1-m-resolution LiDAR data of the Etsumi Sankei Sabo (Erosion Control) Office cover the entire western Mino Mountains, providing the rare opportunity to examine various controls on large-scale gravitational deformation and mass-wasting in a humid temperate tectonically active region. We produced stereo-paired Red Relief Image Maps to visualize DEMs and carefully mapped sagging features. Our mapping reveals that sagging feature prevails almost everywhere in the studied area, with a total number being as many as 10486 and a total length being as much as 716 km. The average line density is 0.68 km/km2. We also found a strong positive correlation between sagging-feature density and altitude, indicating that potential energy is a very important control for the formation of sagging features. The areas underlain by sedimentary rocks tend to show higher line density than those of igneous rocks. We also examined the impact of strong ground motions and static crustal strain associated with movement of active faults within the area and found that both parameters are positively related to sagging-feature density. In particular, the static strain has a stronger effect than strong ground motions, suggesting that we need to take into account static crustal strain associated with active faulting in accessing mass movement potential, in addition to strong ground motions.

Keywords: sagging, airborne LiDAR, active fault, Mino Mountains