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Evaluation of topographic measurements using UAV- and ground-based SfM and TLS: A case study at a rocky coast bench

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Recent advances in measurement methodologies of high-resolution topographic data, including terrestrial laser scanning (TLS), structure from motion photogrammetry (SfM) on unmanned aerial vehicle (UAV) and ground-based SfM, enabled detailed investigations of land surface morphology in terms of morphometry and processes. Although such advanced methodologies are becoming widely applied in geomorphological studies, the nature of such data including error estimates needs to be carefully assessed when being applied in geomorphological researches. In this study we examine similarities and differences among three methods for the topographic data acquisition at a local scale (˜100 m): UAV-SfM, ground-based SfM and TLS. The study site is a coastal bench at Aburatsubo in Miura Peninsula, central Japan, which suffers from intermittent uplift by large earthquakes such as the 1923 Kanto earthquake (M 7.9). UAV-based SfM was performed from higher altitude (ca. 30 m) to lower (ca. 10 m) using a quadcopter on which a digital camera with single-focus lens is mounted. We also used a digital camera mounted on a 4-m long pole for ground-based SfM. TLS measurement was carried out using a short-range scanner from 6 scan positions. Also, coordinates of three benchmarks on ground that are commonly used in all the methods were measured using global navigation satellite system (GNSS) capable of receiving dual radiowaves and post-processing based on career-phase correction with an accuracy of centimeters. The comparisons of the point clouds and digital elevation models (DEMs) obtained by three different methods indicate that 1) SfM-based data shows good accuracies in and around, but significant discrepancies outside of the benchmarks, 2) TLS sometimes give significant lack of data in shadow areas, and 3) data quality of SfM partly depends on the altitude of its platform (either UAV and pole). These characteristics we assessed will give insights into the selection of appropriate methodology for different purposes of geomorphological surveys.

Keywords: rocky coast, structure from motion, terrestrial laser scanning, point cloud, digital elevation model, accuracy