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There-dimensional change detection in coastal cliffs using UAV and TLS

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Measuring three-dimensional morphological changes in rocky coasts is essential in protecting the coastal areas and evaluating the sediment dynamics therein. In this study, we carried out repeated measurements of the three-dimensional morphology of a small rocky island using terrestrial laser scanning (TLS) and unmanned aerial vehicle (UAV)-based structure-from-motion (SfM) photogrammetry for 5 years. The TLS-derived point cloud data is used to align the UAV-SfM point cloud with a better accuracy at a centimeters scale, for which iterative closest point (ICP) method was applied. Aligned UAV-derived point clouds were then compared each other to extract changed mass for each time period. The extracted point cloud of changed mass was converted to 3D mesh polygons, by which the total volume of eroded mass was calculated.

The temporal analysis of the point cloud revealed spatially variable rockfalls and wave cuts. The eroded mass volume for each period varied from 10.6 to 527.7 m3, which is equivalent to the horizontal erosion rates of 0.03 to 0.63 m/y. The temporal changes in the eroded volume is roughly associated with that in the frequency of high tidal waves (higher than 3 m) observed in this area. However, less correlation was found with the frequency of large ground shakes by earthquakes. The modern erosion

rate is lower than the previously reported cliff retreat rates, but this suggests that the small island will

disappear in decades. Three-dimensional structural analysis will also help understand the dynamic

processes of the erosion of the bedrock cliffs in the island.