A Diversified Approach to Generate High-Resolution Topographic Data on the Maunakea Summit, Hawaiʻi Island

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The Maunkea summit (3200-4205 m) of Hawai'i Island is a unique aeolian-driven stone alpine desert ecosystem created by late stage volcanism and glaciation. The summit area geomorphology contains steep cinder cones, scoria, and glacial moraines and erosional features, producing a somewhat complicated pattern of surface mineralogy. The summit is also home to the world's most advanced constellation of telescopes and numerous endemic or rare plants and arthropods. Surprisingly, little high-resolution topographic data exists over much of the area, which are needed to further understand summit erosional processes and to better conserve and manage endemic species habitat. To rectify this situation, we used a VZ 400 Riegl terrestrial laser scanner to collect a high-resolution lidar dataset (33 pts/m^2 average) over ~15 km^2 across the summit area in 2014. The lidar coverage contained occlusions due to environmental obstacles and perspective issues. To 'fill' two of the largest/important occlusions (36,081 m^2 within the interior crater of a cinder cone and a 256,485 m^2 exterior slope of another remote cone) we generated new topographic datasets vie Structure from Motion (SfM) by taking photos of the missing areas from ground and airborne (unmanned aerial vehicle) camera campaigns. The lidar and SfM-derived point clouds were then merged together to create a blended and continuous topographic dataset. Vertical errors from the ground-based photo campaign were generally higher than for the UAV survey, ranging between +3.76 & -1.75 m, though after geoprocessing the average vertical errors for both datasets was <0.05 m. Lessors learned include the importance of creating enough overlap between the raw lidar and SfM point cloud datasets to be able to register them together, instead of solely relying on differential GPS coordinates for ephemeral ground control points. The merged dataset will be compared to future topographic survey campaigns to detect areas of active geomorphic change and quantify contemporary erosion rates. These data are also being used to define quality habitat for the endemic wekiu bug and serve as a template for habitat restoration following future telescope decommissioning.

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