A Diversified Approach to Generate High-Resolution Topographic Data on the Maunakea
Summit, Hawai'i 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.

Keywords: UAVs, Geomorphic, Lidar