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Detailed Spectral Analysis of Askja 2014 Landslide Area: From Satellites to the Ground-based Measurements

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Abstract:

A major landslide occurred in 2014 on the east flank of the inner Askja caldera, Iceland, causing massive material redistributions and a tsunami hazard that affected even opposite shores of the caldera lake. The landslide has left a scar on the caldera wall, and was followed by mud flows, depositing mixed materials and un-roofing hydrothermally active sites. In an attempt to analyze the lithological and geomorphological consequences of the 2014 Askja landslide, we have realized a series of unmanned aerial system (UAS) surveys 2015-2019 carrying different sensors. From these drone campaigns we investigated the RGB, RedEdge, Near Infrared and thermal Infrared imagery. In addition, ground-based hyperspectral measurements in the wavelength range 350-2500 nm were acquired in 2019 with a field spectroradiometer to get more detailed spectral information of the surface materials. Here we proposed a geo-data-science approach to map and identify different types of deposits and structures by using Principal Component Analysis (PCA) and classification approaches. Specifically, we tested different supervised and unsupervised classification methods to identify the different types of materials found in the landslide area. For the supervised classification approaches, we defined regions of interest (ROI) to train the classifier and to detect those regions with similar patterns and materials. At the end, we can clearly distinguish 5-6 different classes in the UAS data and compare to ground-based spectral and thermal infrared signals. Results suggest that the 2014 landslide source region is composed of a mixed material class, with sharp contrasts in the north, reaching the lake in the west. This re-deposited material is located in an area of hydrothermal alteration and also encircled by the material class associated with thermal anomalies. By comparing the results from the classifications to the in-situ spectral measurements, we were able to further interpret on the involved types of materials and the degree of hydrothermal alteration. At distance to the landslide we find that the materials differ, signaling virtual absence of major landslides entering the lake and minor alteration. As the study demonstrates the success of the supervised classification approach for material mobilization in the inner caldera wall and identification of mixed and non-mixed materials, important implications for hazard assessment in the Askja caldera and elsewhere can be drawn.

