Badland erosion and deposition mapping using Unmanned Aerial Vehicles in South African rangelands

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Badlands are areas of intensive erosion, characterized by a strongly dissected and gullied landscape with sparse or absent vegetation unusable for agriculture. Badland erosion is a major sediment source for river systems in drylands. High erosion rates thus not only account for a loss of soil productivity, but ultimately can also lead to reservoir siltation. In South Africa, land degradation is a significant environmental problem throughout the whole country. Erosion frequently leads to the formation of badland features on overgrazed rangelands such as the Karoo highveld. However, it remains unclear how much sediment the heavily eroded sites characterized by badland features contribute to watercourses and reservoirs. Identifying the relevance of the badlands as a sediment source in the Karoo is therefore critical for measures aimed at reducing reservoir siltation and ensuring the country's water supply. Measuring and mapping sediment movement in badlands has so far been challenging because of the varied topography that is not captured by conventional mapping procedures. Unmanned Aerial Vehicles (UAVs) offer an alternative that potentially provides information on the required spatial scale. The aim of this study was to investigate the use of UAVs for generating high-resolution DTMs of badland features and sediment deposits in the Karoo rangelands of South Africa. Combining groundtruthing with UAV imagery, we obtained a high-resolution orthomosaic and DTM that enabled us to identify, map and quantify the volume of badland erosion features as well as the key depositional areas downstream. A comparison of eroded and deposited volume showed that while badlands represent a significant source of sediment, areas affected by other forms of erosion were the dominant source. Images acquired by UAVs thus improved our understanding of catchment sediment dynamics, in particular the relevance of badland erosion as source.