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Using Unmanned Aerial Vehicle (UAV) for spatio-temporal monitoring of soil erosion and roughness in Chania, Crete, Greece

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This article presents a remote sensing approach for spatio-temporal monitoring of both soil erosion and roughness using an Unmanned Aerial Vehicle (UAV). Soil erosion by water is commonly known as one of the main reasons for land degradation. Gully erosion causes considerable soil loss and soil degradation. Furthermore, quantification of soil roughness (irregularities of the soil surface due to soil texture) is important and affects surface storage and infiltration. Soil roughness is one of the most susceptible to variation in time and space characteristics and depends on different parameters such as cultivation practices and soil aggregation.
A UAV equipped with a digital camera was employed to monitor soil in terms of erosion and roughness in two different study areas in Chania, Crete, Greece. The UAV followed predicted flight paths computed by the relevant flight planning software. The photogrammetric image processing enabled the development of sophisticated Digital Terrain Models (DTMs) and ortho-image mosaics with very high resolution on a sub-decimeter level. The DTMs were developed using photogrammetric processing of more than 500 images acquired with the UAV from different heights above the ground level. As the geomorphic formations can be observed from above using UAVs, shadowing effects do not generally occur and the generated point clouds have very homogeneous and high point densities. The DTMs generated from UAV were compared in terms of vertical absolute accuracies with a Global Navigation Satellite System (GNSS) survey.
The developed data products were used for quantifying gully erosion and soil roughness in 3D as well as for the analysis of the surrounding areas. The significant elevation changes from multi-temporal UAV elevation data were used for estimating diachronically soil loss and sediment delivery without installing sediment traps. Concerning roughness, statistical indicators of surface elevation point measurements were estimated and various parameters such as standard deviation of DTM, deviation of residual and standard deviation of prominence were calculated directly from the extracted DTM. Sophisticated statistical filters and elevation indices were developed to quantify both soil erosion and roughness.
The applied methodology for monitoring both soil erosion and roughness provides an optimum way of reducing the existing gap between field scale and satellite scale.

Keywords : UAV, soil, erosion, roughness, DTM