



Quantifying medium-term soil erosion rates in semiarid rangelands of SW Spain by means of check-dam sediments and high-resolution DEMs

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Soil erosion by water represents an important and frequent soil degradation process in rangelands of SW Spain. Check dams are a common mitigation strategy in semiarid areas and represent an exceptional source of information to estimate soil erosion rates quantifying the deposited material. Previous studies needed to acquire high-resolution topography of each check dam by means of total stations, terrestrial laser scanners, differential Global Navigation Satellite Systems (GNSSs), etc. Nowadays, the Unmanned Aerial Vehicle + Structure from Motion (UAV+SfM) workflow allow to acquire high-spatial and temporal resolutions Digital Elevation Models (DEMs), Digital Surface Models (DSMs), point clouds and orthophotographs for estimating the volume of deposited sediments. The main goal of this work is to quantify the volume of the sediments deposited in a large number of check dams located in a large farm (239.3 ha) in SW Spain which is representative of the dehesa land use. The construction of the check dams took place, on average, 23 years ago so they could be used to estimate medium-term soil erosion rates. Secondary objectives are to evaluate the effectiveness of the check dams to trap sediments and to analyze the influence of topography and vegetation cover on the amount of deposited sediments. The methodology included the following steps: 1) flying the study area with a fixed-wing UAV to capture high-resolution aerial photographs and surveying Ground Control Points (GCPs) by means of a GNSS, 2) SfM photogrammetry using the acquired photograms and the GCPs, 3) processing and editing the DEMs, DSMs and point clouds to produce the current soil surface and modelling the past soil surface, 4) estimating the volume of the deposited sediment in each check dam, 5) Spatial analysis of the values calculated by means of a Geographical Information System (GIS).

DEMs, DSMs and orthophotographs with a Ground Sampling Distance of 0.04 m and a Root Mean Square Error of 0.01 m were obtained. A total of 269 check dams were identified and digitized, from which only 160 were valid to quantify the volume of sediment deposited (i.e. they did not present trees or shrubs). The DEMs of Difference approach included as Level of Detection the RMSE and interpolation errors and produced an average sediment volume deposited in each check dam of $0.129 \text{ m}^3 \text{ y}^{-1}$. The total sediment volume deposited in check dams was 413.47 m^3 ($1.73 \text{ m}^3 \text{ ha}^{-1}$) ranging from 0.01 m^3 to 107.62 m^3 . The above results represent a minimum estimation of soil erosion as not all the eroded sediment is deposited behind a check dam. Nevertheless, these results are valuable data to understand the magnitude and the spatial variability of soil erosion rates in dehesa landscapes.

Keywords: sediment, soil erosion, check dams, SfM+UAV, DEMs.