EGU22-11814
https://doi.org/10.5194/egusphere-egu22-11814
EGU General Assembly 2022

The use of UAV for event-based evaluation of soil redistribution on cultivated hillslopes

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Over the last two decades, unmanned aerial vehicles (UAVs) have become widely used in geomorphological investigations at local spatial scales for different purposes. Here we present several examples of the UAV survey application for evaluation of soil redistribution volumes on cultivated hillslopes over a timescale of single to several runoff events. Several cultivated fields with prominent soil erosion and deposition features have been discovered during reconnaissance car trips through several regions of Central European Russia carried out in April-May 2021. The observed features included rill and ephemeral gully networks as well as several types of deposition features such as sheets and fans located within the field, along the field lower boundary and on the adjacent dry valley bottom. Detailed airborne surveys of the detected erosion and deposition zones were carried out using the DJI Phantom 4 Pro quadcopter-type drone with ground control points surveyed by Leica GS 1200 differential GNSS system. Simultaneous control hand measurements of volume of representative sets of erosion and deposition features were carried out within the same areas. Photogrammetric processing of the UAV survey data using the Agisoft Metashape software package allowed producing DEMs and orthorectified images of the surveyed areas with spatial resolution within ±2 cm. Following that, manual and semi-automatic detection of erosion and deposition features were employed and their available parameters (length, width, depth, areas of selected cross-sections, approximate volume for rills and ephemeral gullies; perimeter, area and shape for deposition features) have been measured in the Global Mapper software package. To obtain deposition volumes, the above parameters were combined with hand measurements of the deposited layer thickness. Zones of predominant sediment entrainment, transit, within-slope redeposition, export from the field and deposition in adjacent dry valleys were determined and local sediment budget parameters estimated. Comparison of the results obtained with the spring 2021 meteorological records allowed us to make conclusions on the relative contribution of snowmelt and rainfall-generated runoff into the observed soil and sediment redistribution.

The study is supported by the Russian Science Foundation (Project No. 19-77-10061).