Geophysical Research Abstracts
Vol. 19, EGU2017-7547, 2017
EGU General Assembly 2017

Detection of flood effects in montane streams based on fusion of 2D and 3D information from UAV imagery

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In the contribution, we are presenting a novel method, enabling objective detection and classification of the alluvial features resulting from flooding, based on the imagery, acquired by the unmanned aerial vehicles (UAVs, drones). We have proposed and tested a workflow, using two key data products of the UAV photogrammetry - the 2D orthoimage and 3D digital elevation model, together with derived information on surface texture for the consequent classification of erosional and depositional features resulting from the flood.

The workflow combines the photogrammetric analysis of the UAV imagery, texture analysis of the DEM, and the supervised image classification. Application of the texture analysis and use of DEM data is aimed to enhance 2D information, resulting from the high-resolution orthoimage by adding the newly derived bands, which enhance potential for detection and classification of key types of fluvial features in the stream and the floodplain.

The method was tested on the example of a snowmelt-driven flood in a montane stream in Sumava Mts., Czech Republic, Central Europe, that occurred in December 2015. Using the UAV platform DJI Inspire 1 equipped with the RGB camera there was acquired imagery covering a 1 km long stretch of a meandering creek with elevated fluvial dynamics. Agisoft Photoscan Pro was used to derive a point cloud and further the high-resolution seamless orthoimage and DEM, Orfeo toolkit and SAGA GIS tools were used for DEM analysis.

From the UAV-based data inputs, a multi-band dataset was derived as a source for the consequent classification of fluvial landforms. The RGB channels of the derived orthoimage were completed by the selected texture feature layers and the information on 3D properties of the riverscape - the normalized DEM and terrain ruggedness. Haralick features, derived from the RGB channels, are used for extracting information on the surface texture, the terrain ruggedness index is used as a measure of local topographical variability. Based on this dataset, the supervised classification was performed to identify the fluvial features, including the fresh and old accumulations of different size, fresh bank erosion, in-stream features and the riparian zone vegetation, verified later by the field survey.

The classification based on the fusion of high-resolution 2D and 3D data, derived from UAV imagery, enabled to identify and quantify the extent of recent and old accumulations, to distinguish the coarse and fine sediments or to separate the shallow and deep zones in the submerged zone of the channel. With the high operability of the data acquisition process, the proposed method appears to be a promising tool for rapid mapping and classification of flood effects in streams and floodplains.