Geophysical Research Abstracts
Vol. 18, EGU2016-**PREVIEW**, 2016
EGU General Assembly 2016

Use of Remotely Piloted Aircraft System (RPAS) in the analysis of historical landslide occurred in 1885 in the Rječina River Valley, Croatia

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Numerous instability phenomena have been recorded in the Rječina River Valley, near the City of Rijeka, in the past 250 years. Large landslides triggered by rainfall and floods, were registered on both sides of the Valley. Landslide inventory in the Valley was established based on recorded historical events and LiDAR imagery. The Rječina River is a typical karstic river 18.7km long, originating from the Gorski Kotar Mountains. The central part of the Valley, belongs to the dominant morphostructural unit that strikes in the northwest-southeast direction along the Rječina River. Karstified limestone rock mass is visible on the top of the slopes, while the flysch rock mass is present on the lower slopes and at the bottom of the Valley. Different types of movements can be distinguished in the area, such as the sliding of slope deposits over the flysch bedrock, rockfalls from limestone cliffs, sliding of huge rocky blocks, and active landslide on the north-eastern slope.
The paper presents investigation of the dormant landslide located on the south-western slope of the Valley, which was recorded in 1870 in numerous historical descriptions. Due to intense and long-term rainfall, the landslide was reactivated in 1885, destroying and damaging houses in the eastern part of the Grohovo Village. To predict possible reactivation of the dormant landslide on the south-western side of the Valley, 2D stability back analyses were performed on the basis of landslide features, in order to approximate the position of sliding surface and landslide dimensions. The landslide topography is very steep, and the slope is covered by unstable debris material, so therefore hard to perform any terrestrial geodetic survey.
Consumer-grade DJI Phantom 2 Remotely Piloted Aircraft System (RPAS) was used to provide the data about the present slope topography. The landslide 3D point cloud was derived from approximately 200 photographs taken with RPAS, using structure-from-motion (SfM) photogrammetry. Images were processed using the online Autodesk service “ReCap”. Ground control points (GCP) collected with Total Station are identified on photorealistic point cloud and used for geo-referencing. Cloud Compare software was used for the point cloud processing. This study compared georeferenced landslide point cloud delivered from images with data acquired from laser scanning. RAPS and SfM application produced high accuracy landslide 3D point cloud, characterized by safe and quick data acquisition.
Based on the adopted rock mass strength parameters, obtained from the back analysis, a stability analysis of the present slope situation was performed, and the present stability of the landslide body is determined. The unfavourable conditions and possible triggering factors such as saturation of the slope, caused by heavy rain and earthquake, were included in the analyses what enabled estimation of future landslide hazard and risk.