3D Landslide Assessment and Monitoring in a Heterogeneous Geological Environment using Close-Range Aerial Photogrammetry

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Abstract. Landslides can be caused by numerous conditional and triggering factors such as the geologic setting heterogeneity, terrain relief, and local climate. The Mediterranean region represents a typical geologic environment of such a heterogeneity in materials and processes. Understanding the complex slope failure mechanisms and mitigate the associated hazards occurring in such a complex environment has been a challenge. Exceeding the boundaries of conventional site investigation, monitoring techniques based on 3D multi-temporal data have demonstrated great effectiveness as a means of identifying and characterizing morphological changes in harsh environments. The current study area is located at the Perivoli village in the northern part of the "Pindos" mountain range, Greece. Geologically, the predominant geological formation in the wider region is composed from a tectonic mixture, known as "Avdella Melange", which includes thin bedded limestones with chert intercalations, flysch layers of siltstones and sandstones and ophiolites. The structure of the rock masses is generally characterized by sub-vertical strata dipping inwards the slope, while the in-situ engineering geological investigations led to the estimation of GSI values for the different rock masses along the slope. Consequently, limestones have been characterized by 45-50 GSI, while thin-bedded interlayers of siltstones and sandstones, with some limestone floaters, are highly tectonized and characterized with a GSI of 20-30. Those geological characteristics produce weak to very weak surfaces which result in instabilities in various scales. In this steep mountain terrain, all these geological formations are highly tectonic disturbed, weathered and are classified as likely to landslide. The intense rainfall not only contributes to the rock mass weathering, but also increases significantly the water content in the surficial clay layer that leads to reduction in slope stability. In the current study, a landslide assessment and monitoring framework based on multi-temporal 3D point clouds is discussed. The conception is based on ultra-high-resolution imagery collected from a low-cost UAV platform for 3D model creation through SfM photogrammetry. Automatic change detection between sequential point clouds is performed in order to capture surficial changes in great detail. The spatial extend of the changes captured is assessed

and interpreted with respect to engineering geological model providing a solid cognitive understanding of the failure.

Keywords: Landslide assessment, Monitoring, Heterogenous rock mass, Flysch, Change Detection, Unmanned Aerial Vehicle (UAV), Photogrammetry