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An Integrated Object-Based Analysis with UAV Imagery and Machine Learning for site-specific Mass Movement Assessment

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Landslide and rockfall accurate identification constitute an important aspect in landslide hazard assessment and risk management processes (Fell et al., 2008). Last years, remote sensing is increasingly used in engineering geology domain for exploiting and monitoring hazardous events. Consequently, the use of up-to-date technologies for landslide detection and monitoring is of paramount importance in reducing landslide risk. Mass movement events are mostly detected through visual assessment of remote sensing datasets (Xu, 2015). Although the visual assessment has high identification accuracy, the process is time-consuming and labor-intensive and most importantly it is subjective to expert's cognition. Thus, automated or semi-automated methods for precise and concrete landslide identification based on close range remote sensing techniques are highly sought. Current studies on site-specific landslide assessment are mainly hinge on high resolution satellite imagery or airborne based imagery or Light Detection and Ranging (LiDaR) surveys, or Digital Terrain Models (DTM) (Guzzetti et al., 2012) and lately with the use of Unmanned Aerial Vehicles (UAVs). UAV platforms have several advantages compared with traditional acquisition platforms, such as flexibility and lower operational costs, higher speed and safety. Moreover, UAVs are able to operate rather close to the object, which leads to ultra high resolution (cm to mm scale) imagery. In addition, they can be efficiently adopted for initial mass movement assessment in post-scenarios, in order to collect information on their magnitude, spatial extent, and temporal evolution, as well as provide imagery in unprecedented resolutions, in unreachable areas. As a result, the investigated scene provides significant details for identification and extraction of specific landslide and rockfall objects' parameters. Obtaining a good overview of individual objects' parameters such as spatial, spectral and contextual information and relate them with engineering geological and scene's morpho-dynamics can lead to a higher understanding of the natural processes of landslides and rockfalls (Figure 1).

In this study, we propose an integrated object-based framework based on fused UAV derivatives and machine learning operators to identify specific landslide and rockfall indicators. The overall process is represented as a pipeline consisting of an optimized UAV data acquisition phase, followed by the hierarchical segmentation phase of the fused RGB layers and the DSM derivatives such as slope aspect, curvature and hillshade and characterization of the extracted primitives in appropriate landslide and rockfall classes. Uniform homogeneity and semantic consistency have been taken into consideration for the segmentation stage. In order to evaluate the best-fitted machine learning procedure for the site-specific assessment different approaches have been tested. For this purpose, five advanced Artificial Intelligence (AI) models, namely, Naive Bayes (NB), KNN (K Nearest Neighbor), SVM (Support Vector Machine), Decision Tree and Random Trees, were applied and compared thoroughly in landslide and rockfall applications to evaluate their individual performance. By using machine learning and deep learning techniques, the proposed object-based mass movement detection and characterization method shows significant robustness and great potential in overcoming landslide cognitive subjectivity.

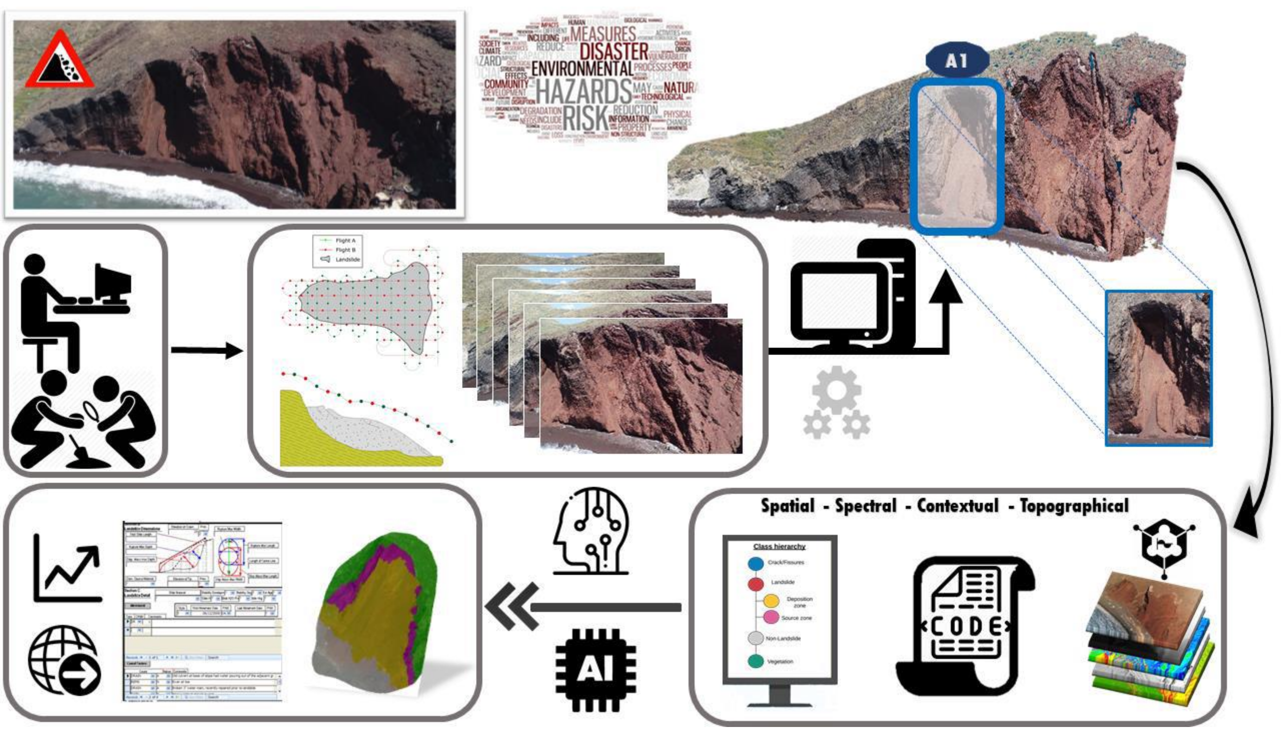

Figure 1. Schematic flowchart for the proposed object-based mass movement analysis.

REFERENCES

Fell, R., Corominas, J., Bonnard, C., Cascini, L., Leroi, E. and Savage, W.Z., on behalf of the JTC-1 Joint Technical Committee on Landslides and Engineered Slopes, 2008, Guidelines for landslide susceptibility, hazard and risk zoning for land use planning. Eng. Geol. 102, 85–98. https://doi.org/10.1016/j.enggeo.2008.03.022

Guzzetti F., Mondini A.C., Cardinali M., Fiorucci F., Santangelo M. and Chang K.T., 2012, Landslide inventory maps: new tools for an old problem, Earth-Sci. Rev., 112 (1), pp. 42-66, 10.1016/j.earscirev.2012.02.001.

Xu C., Xu X., Bruce J. and Shyu H., 2015, Database and spatial distribution of landslides triggered by the Lushan, China Mw 6.6 earthquake of 20 April 2013, Geomorphology, Volume 248, 2015, Pages 77-92, ISSN 0169-555X, https://doi.org/10.1016/j.geomorph.2015.07.002