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Integrating Remote Sensing data to assess the protective effect of forests on rockfall:The case study of Monte San Liberatore (Campania, Italy)

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In recent years, great interest has been paid to the risk that hydrogeological instability causes to the territory, especially in densely populated and geologically fragile areas.
The forests, exerting a natural restraint, play an important protective function for the infrastructures and settlements underneath from the danger of falling rocks that fall from the rocky walls. This protective action is influenced not only by issues related to the vegetation itself but also by the morphology of the terrain, as a steeply sloping land surface can significantly increase the momentum of the rolling rock.
The aim of our work is to design a methodology based on the integration of remote sensing data, in detail optical satellite images and LiDAR data acquired by UAVs, to identify areas most prone to natural rockfall retention [1]. The results could then be used to identify areas that need to be reinforced artificially (rockfall nets) and naturally (protective forests).
The test area is located near Monte San Liberatore in the Campania region (Italy), which was affected in 1954 by a disastrous flood, in which heavy rains induced the triggering of a few complex landslides in a region that was almost geomorphologically susceptible. Indeed, there are several areas subject to high risk of rockfalls, whose exposed value is represented by a complex infrastructural network of viaducts, tunnels, and galleries along the north-west slope of the mountain, which is partly covered by thick vegetation, which reduces the rolling velocity of rocks detaching from the ridge.
According to the Carta della Natura, the vegetation most present in the area is the holm oak (Quercus Ilex), an evergreen, long-lived, medium-sized tree. Its taproot makes it resistant and stable, able to survive in extremely severe environments such as rocky soils or vertical walls, so it is ideal for slope protection.
The first processing step involved the multispectral analysis on Pleiades 1A four-band (RGB +NIR) high-resolution satellite images (HRSI). The computed vegetation indices (NDVI, RVI and NDWI) were used to assess the vegetation health status and its presumed age; thus, the most resilient areas of the natural compartment in terms of robustness and vigor were identified. The average plant height was determined using the normalized digital surface model (nDSM).
Next, starting from the Digital Terrain Model (DTM), we derived the morphometric features suitable for the description of the slope dynamics: slope gradient, exposure with respect to the

North direction, plane, and convexity profile. The DTM and the DSM were created by interpolating on a grid the LiDAR point cloud acquired via UAV. Classification of areas having similar characteristics was made using SOM (Self-Organizing Maps), based on unsupervised learning.
The classified maps obtained delimit the similar areas from a morphological and vegetation point of view; in this way, all those areas that tend to have a higher propensity for rock roll reduction were identified.

[1] Fanos, Ali Mutar, and Biswajeet Pradhan. "Laser scanning systems and techniques in rockfall source identification and risk assessment: a critical review." Earth Systems and Environment 2.2 (2018): 163-182.