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Detection of early stage large scale landslides in forested areas by 2 m LiDAR DEM analysis. The example of Portainé (Central Pyrenees)

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Mass movements have been classically detected by field inspection and air-photo interpretation. However, airborne LiDAR has significant potential for generating high-resolution digital terrain models, which provide considerable advantages over conventional surveying techniques. In this work, we present the identification and characterization of six slope failures previously undetected in the Orri massif, at the core of the Pyrenean range. The landforms had not been previously detected and were identified by the analysis of high resolution 2 m LiDAR derived bared earth topography. Most of the scarps within these failures are not detectable by photo interpretation or the analysis of 5 m resolution topographic maps owing to their small heights (ranging between 0.5 and 2 m) and their location within forest areas. 2D and 3D visualization of hillshade maps with different sun azimuths, allowed to obtain the overall picture of the scarp assemblage and to analyze the geometry and location of the scarps with respect to the slope and the structural fabric. Near 120 scarps were mapped and interpreted as part of slow gravitational deformation, incipient slow flow affecting a colluvium, rotational rock-sliding and slope creep. Landforms interpreted as incipient slow flow affecting a colluvium have headscarps with horse-shoe shape and superficial (< 20 m) basal planes whereas sackung features have open headscarps and basal planes that are likely located at 200-250 m maximum depth. Other distinctive features are toppling or extensive scarps, double ridges and rock rotational landslides. The sharpness of the scarps suggests their recent activity, which may pose a potential risk for the Port-Ainé sky resort users and facilities. These results suggest that the systematic analysis of 2 m LIDAR derived bared earth topography would significantly help in the rapid detection and mapping of early stage slope deformations in high mountain areas, which could contribute to 1) a better understanding of the spatial controlling factors and 2) obtaining rapid diagnosis of the state of the slopes, critical for the proper forecast of future catastrophic failures.

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