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The relevance of bedrock involvement for shallow landslide susceptibility assessment by physically-based modelling.

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Shallow landslide susceptibility is often assessed by means of physically-based models evaluating stability of slope deposits by the so-called infinite slope approach. In our experience, this approach has good predictive performance if the input datasets are well constrained by engineering geology field survey and laboratory data for the involved slope deposits. For these reasons we developed a procedure based on integration of bedrock geology, cluster analysis of morphometric variables and soil laboratory data which allowed us to obtain maps of depth and engineering geological properties of slope deposits for about. 200 km2 study area in the Garfagnana basin (Northern Apennines, Italy). Then, shallow landslide susceptibility was assessed by a probabilistic infinite slope model which provided AUROC values ranging from 0.75 to 0.78. Nevertheless, on-site checks highlighted that almost 70% of landslides involved both slope deposits and a weathered and fractured upper portion of the underlying bedrock. In order to investigate the engineering geology characteristics of the bedrock, we conducted a field survey aimed to classify rock masses inside, in the surroundings and far from shallow landslides. In the study area the Late Oligocene-Early Miocene arenaceous flysch of the Macigno is the most widespread formation, also showing the highest landslide density, hence we focused the survey within this formation for an area of about 100 km2. For each survey site, in order to obtain estimations of the Rock-mass Quality Index (RQI), we collected 200-400 Schmidt hammer rebound measures, bedding and joint data, samples for laboratory analyses (unit weight and slake durability test) and we also estimated degree of weathering as well as the Geological Strengh Index. The results allowed us to identify three different spatial domains discriminated by both landslide density and RQI, where we can observe that lower landslide density values are characterised by higher RQI. Moreover, low RQI values characterize those areas where high density of landslide involving bedrock occur. Comparing the susceptibility maps to shallow landslide distribution, we also observed that some landslides unexpectedly fall within very low susceptibility areas. Field observations allowed us to realize that these landslides are often characterized by thin slope deposits and involve low RQI bedrock. This suggests that better AUROC values could be obtained by implementing a multi-layer infinite slope model where also the shear strength parameters of the weathered and fractured bedrock are taken into account.