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Reliability analysis applied to slope instability prediction

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Uncertainty is a component associated with engineering in general, even more in geoscience context, because of the great number of approximations needed to obtain suitable models and trustable outcomes.
Nature offers many soil characteristics, way different from those assumed in analyses and projects because of their large complexity, moreover environmental conditions and loads defy accurate predictions. The challenge is to find the best way to obtain reliable models and to use or create methods to represent, analyze, prevent and manage properly potentially dangerous evolution of real situations, throughout their simplification.
Important issues about soil modelling are represented by uncertainties in soil parameters that have large possibilities of variation, due to the high complexity of orogenic processes as well as local deformations which have effect on the level of knowledge of phenomena, data reliability, geological and geotechnical characterization, short/long term effects, complexity of specific territorial context.
Probabilistic methods, even thank to advanced computational software, complementing conventional analyses, are able to incorporate these uncertainties and to optimize financial resources in mitigation measures, defining an acceptable level of uncertainty to complete the analysis and estimating the failure associated with slope instability in term of Factor of Safety (FS) and Probability of Failure P(FS).
Thanks to the wide availability of data and investigations performed to date, the large extension of the moving mass and the area involved in the landslide events (crossed by railway and main road infrastructures), the study has been applied to Montaguto earthflow located in Southern Italy.
Through the back-analysis procedure, the aim was to define the probability of FS after the main landslide reactivations in 2006 and 2010 by using both deterministic and probabilistic approaches, splitting the whole slope in 'Mosaic Tiles'.
The variation of orographic conditions, groundwater level and geo-mechanical soil properties, has pointed out the critical states of slope instability per tile defining each Probability of Failure.
The analysis carried out based on the infinite slope method has enabled interpretation of the spatial variability to be used in the soil stability assessment, identifying the crucial importance of the controlling factors that have effect on P(FS) values in order to act on them and on the system as a whole with more awareness and caution.