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A SIMPLE PROCEDURE TO CALIBRATE SOIL PARAMETERS FOR SLOPE STABILITY MODELLING: THE LANGHE (1994) CASE STUDY

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Purpose: Shallow landslides triggered by rainfall represent common geotechnical hazards in Italy. In this context, the hundreds of landslides which occurred in the Piedmont Langhe area in November 1994, still identified among the most extensive areal event in the last 30 years in Italy, are investigated. Exploiting data from the surveys of Campus et al. (1998), here we calibrate simple soil water and mechanical properties (i.e., the saturated permeability and cohesion values) to overcome the large uncertainty affecting the determination of parameters to be used as inputs for physically based soil slip models. This work aims to contribute to the development of reliable soil data inventory that may be of direct interest in slope stability modelling, following Vannocci et al. (2020).

Methods: The analysis was conducted on a small number of cases selected from a sample of 238 observed landslides, to which geometries and geotechnical features were attributed from a regional database. The calibration was performed using a simple hydrological model, i.e. that of Rosso et al. (2006), since it allows a reasonable check on the sensitivity of soil parameter values to the instability conditions. For saturated conductivity, a variation range was obtained, whose upper limit referred to the so-called bucket model. Assuming that part of the rainfall contributes to surface runoff, a lower permeability value was derived using the proportional flow method ψ, consistently with the real dynamics of the processes. Soil cohesion was calibrated by mechanical analysis based on the infinite slope theory, by targeting the Safety Factor SF to assume the value 0.99.

Results: When comparing locally calibrated parameters and the reference ones found in the database some differences arise; in particular, in several cases, based on calibrated values, SFs quite lower than 1 were derived. It must be pointed out that the calibration procedure allowed us to characterize shallow soils, made up of remolded and often vegetated soil, while the regional dataset provide information on undisturbed soil samples, typically collected at depths greater than those of interest.

Conclusions: The possibility of getting reliable soil parameters to be used in physically based modelling of shallow landslides is a complex task. Here we use a calibration method to obtain meaningful saturated hydraulic conductivity and cohesion values, compatible with the observed instabilities. The implications of the differences found between the calibrated parameters and those published in the regional dataset will lay the foundations for subsequent investigations, as this analysis will be part of the research framework of the RETURN Extended Partnership Project.

References

1. Campus, S., Forlati, F., Susella, G., Tamberlani, F. (1998) Frane per mobilizzazione delle coperture detritiche. In: Eventi alluvionali in Piemonte, 266-287, Regione Piemonte, Torino.
2. Rosso, R., Rulli, M.C., Vannucchi, G. (2006) A physically based model for the hydrologic control on shallow landsliding. Water Resour. Res., 42, W06410.
3. Vannocci, P., Segoni, S., Masi, E.B., Cardi, F., Nocentini, N., Rosi, A., Bicocchi, G., D'Ambrosio, M., Nocentini, M., Lombardi, L., et al. (2022) Towards a National-Scale Dataset of Geotechnical and Hydrological Soil Parameters for Shallow Landslide Modeling. Data, 7(37).