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# A steady-state analytical hillslope stability model

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We present a steady-state analytical hillslope stability model to study the role of topography on rain-induced shallow landslides. We combine a bivariate continuous function of the topographic surface, a steady-state hydrological model of hillslope saturated storage, and the infinite slope stability assumption to investigate the interplay between terrain characteristics, saturated storage within hillslopes and soil mechanics. We demonstrate the model by examining stability of nine characteristic hillslope types (landform elements) with three different profile curvatures (concave, straight and convex) and three different plan shapes (convergent, parallel and divergent). For each hillslope type, the steady-state saturated storage corresponding to given recharge rates is computed for three different average bedrock slope angles. Based on the infinite slope stability method, the factor of safety (FS) along the hillslopes is determined. Our results demonstrate that the least stable situation occurs in hillslopes with convergent plan shapes and concave or convex length profiles, the straight ones being more stable. In addition to testing our method for nine characteristic hillslope types, a general relationship between plan and profile curvature of landform elements and the factor of safety is derived for a predefined hillslope length scale. Our results show that slope stability decreases for all length profiles when plan shape changes from divergent to convergent. However, we find that the effect of plan shape is more pronounced for concave or convex length profiles than for straight ones. Overall, we demonstrate that, in addition to bedrock slope, hillslope shape as represented by plan shape and profile curvature is an important control on hillslope stability.