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Parallel processing for efficient 3D slope stability modelling

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We test the performance of the GIS-based, three-dimensional slope stability model r.slope.stability. The model was developed as a C- and python-based raster module of the GRASS GIS software. It considers the three-dimensional geometry of the sliding surface, adopting a modification of the model proposed by Hovland (1977), and revised and extended by Xie and co-workers (2006). Given a terrain elevation map and a set of relevant thematic layers, the model evaluates the stability of slopes for a large number of randomly selected potential slip surfaces, ellipsoidal or truncated in shape. Any single raster cell may be intersected by multiple sliding surfaces, each associated with a value of the factor of safety, FS. For each pixel, the minimum value of FS and the depth of the associated slip surface are stored. This information is used to obtain a spatial overview of the potentially unstable slopes in the study area. We test the model in the Collazzone area, Umbria, central Italy, an area known to be susceptible to landslides of different type and size. Availability of a comprehensive and detailed landslide inventory map allowed for a critical evaluation of the model results. The r.slope.stability code automatically splits the study area into a defined number of tiles, with proper overlap in order to provide the same statistical significance for the entire study area. The tiles are then processed in parallel by a given number of processors, exploiting a multi-purpose computing environment at CNR IRPI, Perugia. The map of the FS is obtained collecting the individual results, taking the minimum values on the overlapping cells. This procedure significantly reduces the processing time. We show how the gain in terms of processing time depends on the tile dimensions and on the number of cores.