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Susceptibility models for pipe collapse in loess-derived soils in a temperate humid climate

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Soil piping (tunnel erosion) has been recognized as an important erosion process in collapsible loess-derived soils in a temperate humid climate, which can cause collapse of the topsoil and formation of discontinuous gullies. Still, information on the spatial patterns of collapsed pipes and regional models describing these patterns is limited. Therefore, this study aims at predicting pipe collapse and understanding the factors controlling the spatial distribution. A dataset with parcels suffering from piping (560 collapsed pipes) and parcels without piping was established through a survey in a 236 km^2 study area in the Flemish Ardennes (Belgium). Logistic regression was carried out to find the best model describing the relationship between the presence/absence of a collapsed pipe and a set of independent explanatory variables (slope gradient, drainage area, distance-to-thalweg, curvature, aspect, soil type and lithology). Special attention was paid to the selection procedure of the grid cells without piping erosion. Apart from the first piping susceptibility map created by logistic regression modelling, a second map was made based on topographical thresholds of slope gradient (S) and upslope drainage area (A). The use of the SA thresholds allowed to produce a map with reasonable predictions of piping susceptibility with a minimum of information. However, the logistic regression model allowed to identify the most important factors controlling pipe collapse. Together with distance-to-thalweg, lithology, soil, aspect and curvature, S and A are the main controlling factors. Pipe collapse is more likely to occur when a topographical threshold depending on both slope gradient and upslope area is exceeded in zones where subsurface flow converges (due to topographical convergence and/or the presence of a clay-rich lithology).