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Gully head development controlled by land surface management in Lake Tana basin, Ethiopia

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In contrast to level areas where drainage ditches mainly aim at lowering the level of the phreatic surface when it comes near or at the surface, digging ditches to divert runoff water on sloping cropland is a physical soil conservation practice to protect the land from uncontrolled runoff and hence decrease the risk of topsoil and seedling erosion. However, researchers are still divided about the balance of the positive and negative effects which can be both on-site and off-site. A case study area was chosen around Wanzaye (North Ethiopia) where three different cropland-management practices were studied in 75 catchments: (i) the catchment-wide use of stone bunds on the contour, (ii) the use of slightly sloping drainage furrows (feses), and (iii) the combined use of stone bunds and feses. A standardized procedure for topographical threshold analysis was applied to study the impact of different land management practices on gully head development in cropland. Topographical thresholds for gully head development reflect the vulnerability of lands to gullying, i.e. s > kA^-b, where s represents slope gradient of the soil surface, A the drainage area at the gully head, b an exponent, and k the resistance of the land to gully head development. The lowest k-values are found for feses catchments, which implies that catchments with the exclusive use of drainage ditches are the most vulnerable to gully head development compared to mixed catchments and stone bund catchments. Yet, on-site sheet and rill erosion are reduced by the use of feses as they reduce the runoff gradient.