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Development of continuous and discontinuous gullies in the Moldavian Plateau of Romania

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Intense gully erosion has sculptured remarkable channels into the Moldavian Plateau of eastern Romania. These permanent gully types are: (1) discontinuous gullies, mostly located on hillslopes and (2) large continuous gullies in valley bottoms.

This study seeks to improve our understanding of the development of 1) continuous gullies over six decades (1961-2020) and 2) discontinuous gullies over variable time-scales (mostly 17-30 years, but also including data collected since 1961) by providing quantitative information on gully evolution and processes. Several methods were used to measure and estimate gully growth. These include intensive field monitoring using the 'stakes grid method,' repeated levelling until 2019, analysis of aerial photographs and Caesium-137 analysis.

As regards the continuous gullies, results indicate that gully erosion rates have significantly decreased since 1981. The mean linear gully head retreat rate (LGHR) of 7.7 m yr^{-1} over 60 years was accompanied by a mean areal gully growth rate in plan (AGG) of 213 m^2 yr^{-1}. However, erosion rates between 1961-1980 were 4.0 times larger for LGHR and 5.9 times more for AGG compared to those for 1981-2020. Two regression models indicate that annual precipitation (P) is the primary controlling factor, explaining 57% of the LGHR and 53% of the AGG rate. The contributing area (CA) follows, with ~33%. Only 43% of total change in LGHR and 46% of total change in AGG results from rainfall-induced runoff during the warm season. Accordingly, the cold season (with associated freeze-thaw processes and snowmelt runoff) has more impact on gully development. The runoff pattern, when flow enters the trunk gully head, is largely controlled by the upper approaching discontinuous gully.

The discontinuous gullies occur as single, successive chains or clusters. These are associated with small catchments (usually <100 ha in area) and ephemeral peak runoff discharges are usually ≤2 m^3 s^{-1}. The mean LGHR for 31 gullies was 0.97 m yr^{-1}, indicative of a relatively small erosion rate. However, their 'pulsatory' development was mostly controlled by runoff accommodation when runoff enters and is conveyed through a gully. We further analysed the changing runoff pattern or '*variable-geometry flow*.' The R^2 of the relation between LGHR or AGG and (CA) indicated a weak correlation for discontinuous gullies.