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Evaluating time dynamics of topographic threshold relations for gully initiation

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Gully erosion is one of the most important soil degradation processes at global scale. However, modelling of gully erosion is still difficult. Despite advances in the modelling of gully headcut rates and incision rates, it remains difficult to predict the location of gully initiation points and trajectories. In different studies it has been demonstrated that a good method of predicting gully initiation is by using a slope (S) – area (A) threshold. Such an S-A relation is a simple way of estimating the critical discharges needed to generate a critical shear stress that can incise a particular soil and initiate a gully. As such, the simple S-A threshold will vary if the rainfall-runoff behaviour of the soil changes or if the soil's erodibility changes. Over the past decades, important agronomic changes have produced significant changes in the soil use and soil management in SW Spain. It is the objective of this research to evaluate how S-A relations for gully initiation have changed over time and for two different land uses, cereal and olive.
Data was collected for a gully network in the Cordoba Province, SW Spain. From photo-interpretation of historical air photos between 1956 and 2013, the gully network and initiation points were derived. In total 10 different time steps are available (1956; 1977; 1984; 1998; 2001; 2004; 2006; 2008; 2010; 2013).
Topographical thresholds were extracted by combining the digitized gully network with the DEM. Due to small differences in the alignment of ortophotos and DEM, an optimization technique was developed in GIS to extract the correct S-A value for each point.
With the S-A values for each year, their dynamics was evaluated as a function of land use (olive or cereal) and in function of the following variables in each of the periods considered:
• soil management
• soil cover by weeds, where weed growth was modeled from the daily soil water balance
• rainfall intensity
• root cohesion, , where root growth was modeled from the daily soil water balance
We found important differences between cereal and olive and significant changes in the S-A relation over time.