



Tracking human effects on the regional distribution of gully systems in a Mediterranean-dry agricultural setting, the Conca d'Òdena (NE Spain)

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Agricultural areas in the Mediterranean region broadly reflect the effects of land management on physical settings and provide environmental clues on historical landscape transformations. The presence of gully systems and small, isolated badland areas within these agricultural settings is commonly perceived as a result of human disturbance of a fragile natural equilibrium, where anthropogenic alteration of the surface hydrology and drainage network may be responsible of incision and gully development on erodible (marly and/or dispersive) materials. The occurrence of anomalous drainage layouts (e.g., gullies that do not follow the general topographic axis of valleys, gullies that cross obliquely a hillslope, gullies that are initiated in, dispersive, topographic convexities, or in artificial channels) can provide physical evidence for (human-induced) agricultural origin of the erosive landforms in these systems. We applied large-scale (approx. 60 km²) landform analysis to explore evidences of anthropogenic origin in the distribution of gully systems within the regional agricultural setting of the Conca d'Òdena (central Anoia basin, Catalonia, NE Spain), a Mediterranean-dry differential erosion depression on marls and clayey materials where traditional surface-leveled and terraced agricultural fields alternate in space with agricultural ditches, large gullies and small badland areas. A total of 316 extensive gully systems covering about 3% of the terrain were identified and digitized within the region by using high resolution pictures and LiDAR DEM information. Nearly 80% of the identified gully systems showed anomalous topographic layouts, suggesting anthropogenic origin of these erosive landforms. Further development and application of a semi-automated GIS method for gully origin assessment indicated that combining the use of simple DEM smoothing and flow routing algorithms can provide satisfactory results for determining the origin in small-to-medium size (up to 20,000 m³) gully systems. Overall, these results indicate a large influence of human disturbance for the formation of gully systems in Mediterranean agricultural landscapes, and highlight the usefulness of morphometric GIS assessment for elucidating gully origin at the regional scale.