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Analysis and assessment of ephemeral gully erosion in wide areas of Navarre (Spain) from routinely obtained ortophotographs

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Ephemeral gullies (EG) are linear erosion features located in swales where runoff concentrates during or immediately after rainfall events. EG are temporary because they are easily filled by conventional machinery and cause important soil losses in cultivated areas. Casalí et al. (1999) distinguished three types of EG: “classical”, formed by concentrated runoff flows within the same field where runoff started; “drainage”, created by concentrated flows draining areas upstream from the field; “discontinuity”, found in places where management practices create a sudden change in slope. There is still a great lack of knowledge about the true extent and importance of this EG. In this sense, the information obtained from aerial photographs can be of great value. The main objective of this work is to evaluate the possibility of making an exhaustive characterization of the space-time evolution of ephemeral gullies in a relatively large area from color aerial photographs. The effect of precipitation on the EG will be also analyzed.

The 570 ha study area is almost completely cultivated with winter cereals and located in the Pitillas district (Navarre). Climate is Continental Mediterranean (on average 550 mm yr⁻¹). Soil (upper horizons) are loam–silty loam in texture.

EG within cultivated fields were located, classified and digitized using GIS interfaces over seven colour orthophotos (1:5000 with 0.5m×0.5m resolution) taken between 2003 and 2014. Gully length was determined after locating EG down and upstream ends. EG drainage areas and slopes were determined using a 2 m resolution DEM.

To determine EG volumes, an empirical power model for the study area defining the relationship between EG lengths and volumes was first obtained from previous field measurement, and then used for the EG lengths from this study. The corresponding erosion rates were also calculated.

57 small watersheds affected by EGs were identified, being 39 of them classified as drainage EGs, and the remaining 18 EGs as classic. 70% of the small watersheds were affected by EG only once. In remaining watersheds EG reappeared from twice to seven times. Therefore, it seems that the repeatability is not as high as thought.

The average erosion rate in classical EG is about 1.1 Kg m⁻² year⁻¹. Previous assessments using accurate direct methods reported an average value of 0.8 Kg m⁻² year⁻¹ for very similar watersheds

in the same area. Although it is not a conclusive proof, this findings indicate that both methods provide similar results.

A very high correlation ($r^2= 0.84$) has been found between the length of the gullies formed in the study area and the total annual precipitation. It would follow that EG erosion would also be controlled by the overall amount of rainfall also in Mediterranean climates, and not only by high intensity-low frequency events.

References

- Casalí, J. J. López, J. V. Giráldez, 1999. Ephemeral gully erosion in Southern Navarra (Spain). CATENA 36: 65-84.