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A new automated method for the determination of cross-section limits in ephemeral gullies

Carlos Castillo (1), Miguel Ángel Campo-Bescós (2,3), Javier Casalí (2,3), Rafael Giménez (2,3)

(1) University of Córdoba, Department of Rural Engineering, Córdoba, Spain, (2) Public University of Navarre, Department of Projects and Rural Engineering, Pamplona, Spain (jcs@unavarra.es), (3) Public University of Navarre, ISFOOD - Institute for Innovation & Sustainable Development in Food Chain, Pamplona, Spain

The assessment of gully erosion relies on the estimation of the soil volume enclosed by cross sections limits. Both 3D and 2D methods require the application of a methodology for the determination of the cross-section limits what has been traditionally carried out in two ways: a) by visual inspection of the cross-section by a certain expert operator; b) by the automated identification of thresholds for different geometrical variables such as elevation, slope or plan curvature obtained from the cross-section profile. However, for these last methods, typically, the thresholds are not of general application because they depend on absolute values valid only for the local gully conditions where they were derived.

In this communication we evaluate an automated method for cross-section delimitation of ephemeral gullies and compare its performance with the visual assessment provided by five scientists experienced in gully erosion assessment, defining gully width, depth and area for a total of 60 ephemeral gullies cross-sections obtained from field surveys conducted on agricultural plots in Navarra (Spain). The automated method only depends on the calculation of a simple geometrical measurement, which is the bank trapezoid area for every point of each gully bank. This rectangle trapezoid (right-angled trapezoid) is defined by the elevation of a given point, the minimum elevation and the extremes of the cross-section. The gully limit for each bank is determined by the point in the bank with the maximum trapezoid area.

The comparison of the estimates among the different expert operators showed large variation coefficients (up to 70%) in a number of cross-sections, larger for cross sections width and area and smaller for cross sections depth. The automated method produced comparable results to those obtained by the experts and was the procedure with the highest average correlation with the rest of the methods for the three dimensional parameters. The errors of the automated method when compared with the average estimate of the experts were occasionally high (up to 40%), in line with the variability found among experts. The automated method showed no apparent systematic errors which approximately followed a normal distribution, although these errors were slightly biased towards overestimation for the depth and area parameters.

In conclusion, this study shows that there is not a single definition of gully limits even among gully experts where a large variability was found. The bank trapezoid method was found to be an automated, easy-to-use (readily implementable in a basic excel spread-sheet or programming scripts), threshold-independent procedure to determine consistently gully limits similar to expert-derived estimates. Gully width and area calculations were more prone to errors than gully depth, which was the least sensitive parameter.