Assessment of the Compound Topographic Index CTI to predict Potential Ephemeral Gullies in Navarre (Spain)

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Ephemeral gullies are relatively small (susceptible of being obliterated by conventional tillage operation) eroded channels that are able to generate however important in-site and off-site damages (removal of top soil and nutrients, degradation of drinking water quality, contamination of aquatic ecosystems, siltation, etc.).

Gully initiation and development in a watershed is greatly driven by topographic factors. Precisely, several topographic indexes have been used to identify areas with risk of gully erosion. Among them, the Compound Topographic Index (CTI= A.S.PLANC; A: upstream drainage area, S: local slope, PLANC: planform curvature) is an approach recently implemented in the AnnAGNPS (Annualized Agricultural Nonpoint Source Pollution) model. It allows defining the location of potential ephemeral gullies (PEG).

The aim of this work was to assess the capability of CTI for predicting PEG mouths (potential headcut) location in an agricultural field of Navarre (Spain) through AnnAGNPS.

The study was carried out in a 450 ha area cultivated with wheat and located in Pitillas (southern Navarre). The climate is continental Mediterranean with a mean temperature of 13ºC and annual rainfall of 500 mm. Top soil textures are mostly loamy and silt-loam.

The 3 topographic components of the CTI were computed by TOPAZ program implemented in AnnAGNPS 5.10 using a digital elevation model of 5-m resolution. The CTI is computed for each raster grid. Then all the values are arranged from the smallest to the largest and then percentiles are calculated (for example, the 95th percentile is the threshold CTI value below which 95% of the CTI values may be found). Grid cells whose values correspond to a percentile lower than 90% are discarded by the model by default.

On the other hand, 31 ephemeral gullies located within the studied agricultural field were selected from orthophotos (1:5,000). Natural drainage channels located in abandoned, steep pieces of terrain were not considered in our analysis.

The model was run using alternatively CTI values with percentiles 97%, 98%, 99% and 99.9%. The PEG mouth points cloud generated each time was compared with the points obtained from the orthophoto depicting the selected gullies, looking for the best fit or conversely the smallest error in the prediction of gully location. Error of 29%, 42%, 68% and 87% were determined for CTI values of to 97%, 98%, 99% and 99.9%, respectively. Therefore, CTI values of 97% and 98% can be considered as the best predictor of PEG location for our local conditions.