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The critical compound topographic index approach for locating ephemeral gullies in Iowa agricultural watersheds

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Ephemeral gullies (EG) not only reduce soil productivity and impact water quality, but also increase water, sediment and other pollutant connectivity with the edge of the field. Research documents that EG erosion is one of the major sediment sources in agricultural watersheds where, on average, it accounts for around 40% of the watershed sediment yield. Thus, it seems critical to target conservation practices to areas prone to EG development. Simulation models are great tools to assess the impact of conservation practices, land use and climate changes on soil loss. However, models addressing EG are scarce.

EGs occur as a result of concentrated flow from surface runoff and/or subsurface flow by seepage. Although the role of subsurface runoff is still unknown, it is clear that EG are located in swales where surface runoff concentrates. Topographic indexes such as the Compound Topographic Index (CTI), approximate the erosive power of surface flow and are used to locate areas prone to concentrated flow erosion, i.e. areas where EG would form. The objective of this study is to evaluate the critical threshold approach for identifying EG formation on three agricultural watersheds.

The study area is located within the Walnut Creek Watershed, Iowa (US) where EG formed in three intensively monitored experimental watersheds with similar topography and soils and that are less than 1.5 Km from each other. The cropping system consists of a two-year corn-soybean no till rotation and watersheds are managed by one farmer. EG were digitized using 1-meter resolution orthophotos in years after gullies were filled in by the farmer (2012, 2015 and 2016), and subsequently, reformed the next year. Digitized EG polylines were rasterized using both 2 and 3m DEMs derived from the Iowa Lidar Mapping Project from which topographic attributes were derived too.

The Annualized Agricultural Non-Point Source (AnnAGNPS) pollution model is being applied in the watersheds and was used to calculate CTI value for each raster. To evaluate the coincidence between rasters above the critical threshold with the actual location of the EG, numerical criteria has been established based on matching pixels to assess the critical CTI value.

At the moment, simulations are being done with a 3 m resolution DEM showing critical CTI values of 260, 181 and 103. Preliminary results obtained are higher than values obtained in previous studies: Mississippi (7-75) and Spain (1-5) but much lower than other studies in Iowa (6342-1342) and Mississippi (37313-1412). On the other hand, results obtained are in agreement with those reported in a watershed with similar topography in Kansas (138-113). Properties such as DEM resolution, CTI units, rainfall and soil characteristics could explain such differences. The variability shown in the literature and even among the studied watersheds with similar topographic characteristics and managed by one farmer, emphasizes the importance of the study. Final results and analyses will be presented in the poster.