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Gully-walls soil loss effect on gully modelling: a Brazilian Semiarid case of study

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In the Brazilian semiarid region (a one-million km^2 area that coincides with the Caatinga biome), due to the shallow soils gully erosion processes are limited to small dimensions, being less representatives than sheet erosion, concerning total sediment yield. Nevertheless, gullies, even with small sizes, have a high influence on sedimentological processes, changing the sediment dynamics inside the watershed. Due to the land use change in the Caatinga, agricultural automation, deforestation for extensive cattle rising and development of infrastructure, as construction of new roads, gully occurrence has been becoming more frequent. This study focuses on the Madalena representative basin (124 km2, state of Ceará, Brazil), a land-reform settlement with 20 inhabitants per km^2, whose main economic activities are agriculture (especially Zea mays), livestock and fishing. Topographic surveys were performed using Total Station and UAV (Unmanned Aerial Vehicle), to obtain digital terrain models and assess the volume of soil eroded in the channel. Soil samples were collected in order to estimate their erodibility and the critic shear stress. We used the Model Foster and Lane (MFL; 1983) for ephemeral gullies to model the measured gullies, adjusting it to fit the model to the Caatinga conditions. We could observe that the MFL was not able to predict properly the geometry and area of the gully once it has as basic premise the verticality of walls, which was not observed in any of the cases. Thus, a statistical correlation was proposed in order to consider the loss of stability of the gully walls and the bank erosion. With this new factor we obtained positive responses from the modelling (NSE = 0.75; for the Cross section area), implying that the model can be applied as tool of volume prediction of gully volume in the semiarid, even for small classical gullies, once the analysed gullies began around 58 years ago, due to the construction of a new road. As secondary result, we identified that the 30-minute intensity is the most representative for the gully process, the same for sheet erosion proposed by Wischmeier and Smith (1978).