I. INTRODUCTION

Gullies are characterised by one-D erosion, which usually occur when there is concentration of runoff due to natural microrelief, initially producing rills and reaching large dimensions.

The Castings biome is in the Brazilian Semi-arid region (one million km² and 25 million inhabitants) with mean annual precipitation around 600mm and pan evaporation around 2300mm. Its raining season is concentrated (3-4 months) with high spatial and temporal variability. The most important economic activities in the Castings biome are agriculture (Phascolus Vulgaris and Zee May) and raise of cattle in open meadow causing deforestation and consequent damage to soil.

The occurrence of gully erosion has increased in the last twenty years due to land-use change and degradation. Most models adapted to Castings tackle primarily inter-rill erosion and there is a lack of routines to assess gully erosion. This work aims at measuring on-field gully evolution, at estimating its processes using physical models, at improving the physical models merging them with probabilistic concepts (particularly the Principle of Maximum Entropy).

Because the Castings biome is on top of crystalline shallow bedrock (<2m), gully erosion do not reach great depth and are usually limited to ephemeral gullies, which represent a relevant source of sediment, increasing local reservoir siltation.

III. RESULTS

GULLY 1
GULLY 2
GULLY 3

Rainfall (mm)

Chart IV - Measured area x Model results - Envelop

Confidence interval % Limits
C99 0.99 0.970 0.979 0.198 ± 1.126
C95 2.5% 0.666 0.201 ± 0.867
C90 5.0% -0.326 0.203 ± 0.718
C80 10.0% -0.03 0.201 ± 0.367

IV. DISCUSSION

• The Foster and Lane model (1983) has presented a good approximation to the area field data.
• The highest model efficiency was obtained for the 30-minute intensity, the Nash-Sutcliffe efficiency coefficient was 0.441 and the Pearson coefficient was 0.726.
• Both responses to 60-minute and 30-minute intensity have not shown statistical difference between measured and modelled area.
• Notwithstanding, there are many uncertainties concerning the model. The rainfall data has a great variability in semi-arid regions and that could induce or bias the model to underestimate the results. The soil parameters, as rill erodibility and critical shear stress are also uncertainty sources.
• However, a relevant input of uncertainties is the Stream Power (Q = γ R U R₃), which has been already analyzed as a key factor to explain inter-rill erosion (de Araujo, 2007).
• The observed tendency of the model to underestimate the eroded volume can be attributed to the field conditions, that differ from the model assumption that land use is cropland. In all three sites, there are roads, which concentrate the flow and generate higher runoff produced by the upslope areas.

II. METHOD

We selected three sites (0.3 ha on average) in Malaia SHN, where well-developed ephemeral gullies were found. We have used two methods to take measures of the gullies dimensions: Total Station and UAV (Unmanned Aerial Vehicle).

Daily rainfall data were provided by the Brazilian National Water Agency (ANA), whereas rainfall intensity values were obtained by empirical equations from the Albaia Experimental Basin (Figueiredo et al., 2016). Both watersheds have the same hydrological and pluviometric behavior (Mendes, 2006).

To calculate the runoff yield in the gully basin, we used the SCS-CN model. The soil properties related to rill erosion (rill erodibility and critical shear stress) were estimated by the WEPP equations. We tested the model performance for three characteristic rainfall intensities: average (Jan), 60 min (Aug), and 30 min (Jul). The Foster and Lane model (1983) was applied to 17 sections in three gully sites. We used a series of 58 years of daily rainfall as model input. The results of the model were compared with the measured data in terms of area, perimeter and width of the gullies sections.

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