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Gully geometry: what are we measuring?

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Gully erosion has attracted the attention of many scientists during the last decades, and gullies are an important source of sediment within catchments. For succeeding in gully erosion research, gullies must be properly characterized. Characterization includes the determination of gully morphology and volume, being the definition of gully width (W) and depth (D) –and consequently related variables such as the well-known W/D ratio– key issues toward to this goal.
However, and surprisingly, universally accepted criteria (rules or guidance) to define gully morphology are lacking. This because the protocol every researcher follows to measure the eroded channel geometry is generally taken for granted and most of the time even no explanation is given about it. For example, when analyzing a gully cross section we usually just identify gully depth with gully maximum depth. But, is this the right protocol? What does this length really represent? What is its meaning? All this uncertainties can lead to non-comparable results and then important inconsistencies. So, to define universal rules of procedure would allow gully scientists “speak the same language” and then deliver truly comparable gully geometry and volume.
On the other hand, there are other misunderstandings. For example, very frequently we characterize or depict a whole gully only through some of its cross sections. Again, is this correct? The problem is even more complex when considering that gully geometry may (largely) change along the channel.
The main aim of this presentation is to highlight some (unnoticed) common flaws when measuring and describing gully geometry, hoping ultimately to open a debate on that subject. For this last purpose, a conceptual approach to define gully cross section width and other derived variables is firstly proposed.
It is based on the subtraction of a highly detailed digital elevation model of a landscape surface containing the studied gully (DEM1) from a detailed spatial representation of the same soil surface previous to gully development (DEM2). The intersection −in a certain point along the gully longitudinal axis (X)− of the resulting DEM with a plane perpendicular to the X-axis results in the cross section area of the gully in this point. The cross section width (Wi) is defined as the length of the horizontal projection of the straight line linking the upper ends of both sides in the cross section (A1-A2 line). This exercise could be repeated in as many points as we want along X-axis, and the corresponding width defined as just stated. On the other hand, the maximum cross section depth can now be directly defined as the distance from the deepest point in the gully bed to the A1-A2 line. But, as quoted before: is this maximum depth meaningful? Is it representative? This is subject to discussion. In addition, it is necessary to define the concepts of effective width (We), effective depth (De), and effective width/ depth ratio of a gully. Effective width will be defined as the average of the individual widths, Wi. At that point, the definition of gully volume (V) is required, being V the subtraction of DEM2 from DEM1. Then, effective depth is De= V / We. De, We and gully length L can be used to represent a gully as a prism with rectangular base. Although this simplification is to some extent an obvious source of experimental error, it allows as to easily define comparable magnitudes.
In this work, several examples of the application of this approach are shown. Although most of these reflections and considerations are thought to ephemeral gullies, they may be also applied to other larger eroded channels.