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Interactive comment on "Gully geometry: what are we measuring?" *by* J. Casalí et al.

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In order to make our answer clearer, the original comments from the Editor are maintained (quotation marks).

"The evaluations of the referees were positive, nevertheless, all their questions have not been replied yet. I suggest the improvement of the manuscript following the points mentioned by the referees 1 and 2":

1. "Relationships between DEM and gully width".

Firstly, it must be stated that in this paper the authors do not expect to address points like what a "detailed" DEM is, or what is the level of detail required to reduce the error with respect to the simplified techniques. Besides, the answer depends also on the size of the channel to detect and involves the choice of suitable instruments for the survey. These points are, obviously, very interesting and relevant, but we think that they should be considered in a subsequent development of the methodology. In fact, this is rather a conceptual paper. The main purpose of this paper is to propose an objective, repeatable and of general validity definition of "width of a gully cross section", which is a key magnitude that conditions the assessment of the gully volume and depth. This definition is based on gully genesis criteria instead of gully geometry, the latter with even arbitrary limits. "Equivalent prismatic gully", "mean equivalent width" and "mean equivalent effective depth" are concepts that ultimately derive from the definition of "width of a gully cross section", and try to standardize the assessments of gully characteristics. However, to accomplish with the Editor's request, the following sentences will be included in the text:

(At the end of section 3). "The width of a gully cross section, as defined in this paper, depends on the DEMs pixel size and it depends on the type and size of the studied channel. Hengl (2006) concluded that, to avoid the loss of relevant information, the maximum pixel size must be the average of the minimum distances between sampling points. In the same way, Garbrecht and Martz (1994) fixed the pixel size to the size of the minimum distinguishable object. On the other hand, the new available methodologies (terrestrial or aerial LIDAR, 3D photo-reconstruction, etc.), provide a very detailed information, which can be more than enough, in our opinion, for the purposes of these studies. However, these thresholds should be explored in future researches".

2. "Specific applications of the equivalent prismatic gully additional to the model AnnAGNPS".

The text shown below will be added at the end of the actual last paragraph in section 3:

In effect, we believe that the concept of equivalent prismatic gully shows several benefits and applications. Probably the principal is that it allows for determining the most important characteristics of a complete gully (V, L, Wme y Dme), using objective and repeatable criteria. Otherwise, there is the risk of assigning information from specific cross sections or reaches to the whole gully. Besides, the gully properties (V, L, Wme y Dme), as defined here, can be incorporated in statistical analyses or similar studies in which many gullies are involved, using a common language, repeatable and comparable among different researchers. On the other hand, by using the concept of equivalent prismatic gully, sets of complete gullies can be graphically represented easily, which allows for a quick and explanatory visual comparison".

3. "Following the advice of referee 2, to discuss/develop the content of Figure 5 (analysis of the proposed methodology with different gully geometry datasets) in order to provide more details about its usefulness".

We agree with Referee #2: it is highly convenient to include an analysis of the proposed methodology using data bases from gullies of different geometry. In fact, we think that this objective has been properly achieved in this paper. In effect, the method is applied to six ephemeral gullies of different lengths, widths and depths. These gullies were recently assessed using a very accurate methodology. Other data sets from gullies with varied morphology could have been used, but their assessment was not so accurate. In our opinion, it is preferable to use the more recent and accurate information. Besides, in our opinion, they provide enough information and in accordance with the length of the paper. On the other hand, I must be taken into account that the main objective of this paper is to present the protocol and the methodology, and not to show an in depth analysis of that, which can be done in further studies.

4. "To add the advantages associated to the standardization of gully measurements in different contexts (lines 13-16, page 326) in the conclusions".

A new version of the conclusions including the requirements of both Editor and Referee #2 has been written:

In order to progress in gully erosion research, clear criteria to define and determine the key morphological characteristics of gullies and their related properties (such as

volumes) are needed. In this paper, a new proposal to advance towards such goal is shown. In this way, starting from a precise definition of the width of each gully cross section, the mean equivalent gully width and depth are defined, and also the equivalent prismatic gully (EPG). This approach allows for determining the most important characteristics of a complete gully (V, L, Wme y Dme), using objective criteria. Besides, such gully properties as defined here, can be incorporated in statistical analyses using a common language among different researchers. On the other hand, by using the EPG, sets of complete gullies can be graphically represented easily, which allows for an explanatory visual comparison. The definition of the width of each gully cross section assumes that the topography of the area before the gully appearance is known. It is, in fact, really infrequent, so that a new line of research arises. Anyway, we believe that the proposal is a considerable advance in the applied research on gullies, because it allows to standardize the definition and determination of the most important characteristics of these erosion forms.

"Specific comments:

- Figure 3. Please, explain the content of the figures b) and c), in the figure caption and in the text (page 327, lines 15-19)".

The figure caption has been modified as follows:

Figure 3. Illustration of the effect that the criterion followed to determine the cross section width has on the computed volume of a gully reach. a) Selected gully reach and location of the three cross sections used for calculating the volume of the reach (P1, P2 and P3); the distance between cross sections is known. b) Calculated eroded volume (in blue) when considering a possible criterion for defining the gully cross sections widths. c) Calculated eroded volume (in red) when considering another possible criterion for defining the gully cross sections widths.

The text on page 327, starting from line 16 (included) has been modified as follows:

However, an overall review of all the sections conforming the gully being studied would give a better assessment of this measurement error. Fig. 3 tries to illustrate the effect that the criterion followed to determine the cross section width has on the computed volume of a gully reach. A real gully reach was selected and three cross sections were used for calculating the volume of the reach (P1, P2 and P3) (Fig. 3a), being the distance between cross sections known. First, the eroded volume was calculated considering a possible criterion for defining the gully cross sections width (in blue, Fig. 3b). Then, the eroded was calculated again but considering another possible criterion for defining the gully cross sections widths (in red, Fig. 3b). The difference in the calculated volume for both situations is remarkable, increasing a 96% from option b to option c. Figure 3 is just one example to illustrate: i) the great differences in volumes that can be obtained fixing the gully widths arbitrarily; ii) the error that can be generated and; iii) the necessity of stablishing rigorous and objective criteria and protocols. The purpose of figure 3 is similar to figure 2, the latter illustrating the effect of the uncertainty in the determination of width in a single cross-section of a gully.

- "Figure 4. Please, at the end of the figure caption 4, include the chapter of the text to follow the explanation".

At the end of the figure caption the following text has been included:

"See section 3 for details."

-"Figure caption 5, please correct "different"".

It will be corrected.

Interactive comment on SOIL Discuss., 2, 323, 2015.