PHOTOGRAMMETRICAL AND FIELD MEASUREMENT OF GULLIES WITH CONTRASTING MORPHOLOGY

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1. Introduction

Hitherto, most of the studies on gully erosion aim to estimate the spatial and/or temporal evolution of either single gullies or gully networks under different situations. With regard to the accuracy of experimental datasets, a field survey makes possible to obtain accurate measurements on gully geometry, even in three-dimensional coordinates, with (relative) ease (Oostwoud Wijdenes and Bryan, 1994). In addition, the accuracy of this *direct* measurement mainly depends on the researcher's judgment (e.g., to choose the experimental setup and the density of measurements), rather than in the precision of the measuring equipment used.

On the other hand, remote-sensing techniques of gully measuring, in two and three-dimensional coordinates, have been increasingly used (e.g., quantification of volumen loss, Marzolff and Poesen, in prep). Unlike field measurements, these indirect measuring techniques allow covering of large study areas with a minimum of time and effort (e.g., Martínez-Casasnovas et al., 2004). However, the accuracy of the dataset obtained in this way does much depend on the precision of the applied technique (e.g. on image resolution, quality of ground control). Moreover, an accurate gully measurement on three-dimensional coordinates may also (much) depend in the gully morphology (e.g., on the gully width/depth relationship). A gully cross-sectional area is more difficult to assess in a narrow, deeply eroded feature where measuring may be somewhat hindered by shadows cast on gully walls and bottom.

Despite a wealth of studies on monitoring different types of gullies by using remote-sensing technique such as photogrammetry, relatively few efforts have been made to test their accuracy. Therefore the question arises as to what extent the accuracy of gully monitoring using photogrammetric technique depends on gully morphology. The objective of this work is to investigate this issue. To do that, we confront field measurements of cross-sectional areas of gullies with contrasting morphology with a similar dataset obtained using photogrammetry. Below, we present the first findings of this investigation.

2. Material and Methods

Within the region of Bardenas Reales (Navarre, Spain) a plot of around 1000 m2 presenting a large collection of gullies of different sizes and morphologies, was selected to carry out the experiments (Fig. 1).

Fig. 1. Aerial picture of the experimental plot showing different types of gullies. A person in the lower, right-hand margin for scale (see arrow). Bardenas Reales, Navarre, Spain.

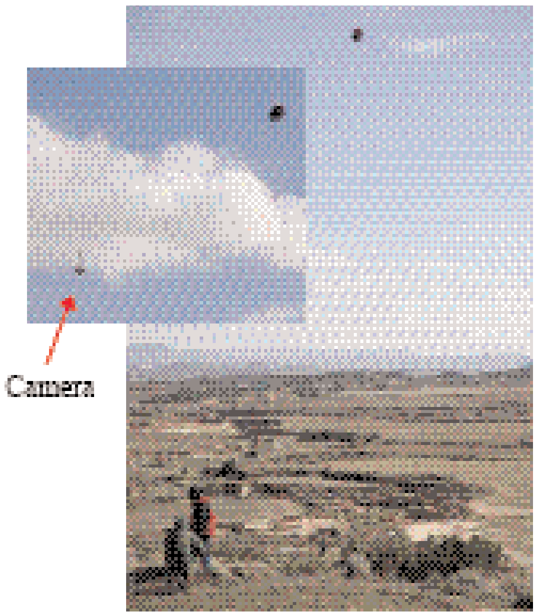

Fig. 2. Kite used as an aerial camera platform.

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Five different gullies were selected according to contrasting differences in their width/depth ratio. Several ground control points were marked in the study area prior to the surveys and their coordinates measured with a total station. With a specially designed kite (Marzolff et al., 2003) as a sensor platform, large-scale aerial photographs were obtained from the study area (Fig. 2). These high-resolution stereoscopic pictures allowed for further digital image processing and the constructions of large-scale digital elevations models (DEM) and GIS analysis. In addition, several cross-section elevation profiles along each of the different types of gullies were obtained from the stereo image models.

On the other hand, cross-section profiles in the same location as before were obtained by field survey. These were determined by using a laser profilometer (Fig. 3). Where the extremely large width and depth of the largest gully prevented the use of the profilometer, cross-section profiles were obtained instead by means of a total station.

Fig. 3. Determination of a gully cross-section profile using a laser profilometer.

3. Results

Hitherto, 12 cross-section elevation profiles have been obtained from 6 transects located along the largest gully headcut (Fig. 4): from each transect we determined a pair of elevation profiles, one by photogrammetry and the other one by using the total station (Fig. 5). At this point, it is important to mention that this large gully underwent local collapses of its walls and headcut. This occurred after the image capture and before mapping the entire surface height with the total station. However, only two of the aforementioned elevation profiles were affected by some change at the southern gully wall, all other areas remaining largely unchanged. Each pair of elevation profiles was plotted apart for a better comparison (Fig. 5). It can be seen that there is a remarkable match between equivalent profiles. Nevertheless, a lesser concordance between both set of result was observed in some spots densely cover by shrubs. Here, relative surface height is somewhat overestimated by photogrammetry since soil surface is (partially) hidden by the vegetation canopy.

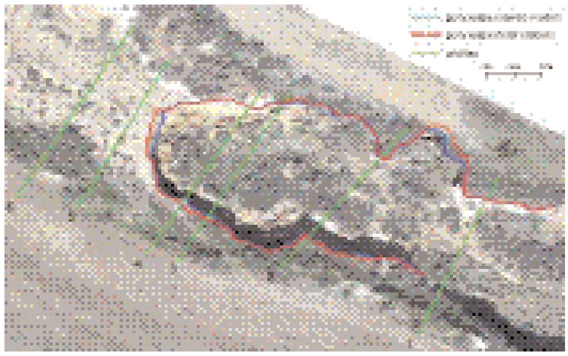

Fig. 4. Aerial view of the largest studied gully. Transverse lines indicate the exact position of each of the six gully cross-section profiles.

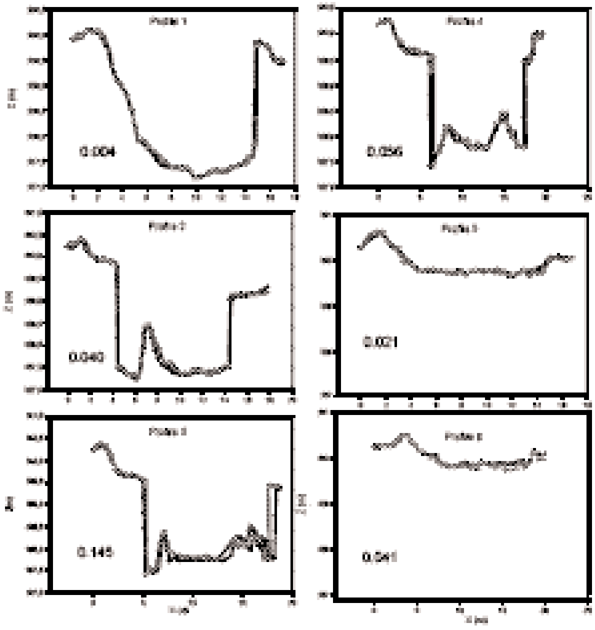

Fig. 5. Cross-section elevation profiles of the largest gully, facing upstream. (For location, see Fig. 4). Full circle: from total station; Empty circle: from stereo model. Inner number is the mean of height differences in meter.

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