



## **Gully Morphological Characteristics in the Loess Hilly-gully Region Based on 3D Laser Scanning Technique**

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Gully erosion plays an important role on sediment production in the Loess Hilly-gully Region. Gully morphology is strongly affected by gully erosion process and can be well used to describe gully developmental condition. The Chabagou watershed, located at hilly-gully region of the Loess Plateau, was selected to investigate gully morphological characteristics using 3D laser scanning technique (LIDAR). Thirty-one representative gullies at active stage, including different watershed locations and gully orders, were chosen to quantitatively describe gully morphology and establish empirical equations for estimating gully volume based on gully length and gully surface area. Images and point clouds datum of 31 gullies were collected and digital elevation models (DEMs) with 10 cm resolution were generated; then gully fundamental morphological characteristics covering gully length ( $L$ ), gully width ( $W_T$ ) and gully depth ( $D$ ) and some derivative morphological indicators including gully head curvature ( $C$ ), gully width depth ratio ( $w/d$ ), gully bottom to top width ratio ( $W_B/W_T$ ), gully surface area ( $A_g$ ) and gully volume ( $V_g$ ) were extracted by ArcGIS 10.1. The results showed that gully length decreased gradually from upstream to downstream in the study watershed and gully depth was greater in the downstream of watershed. Differentiation method of gully head and gully sidewalls was proposed with a mean relative error of 8.77%. Gullies in the upstream and the 2<sup>nd</sup> order were more developmental for their high values of gully head curvature. Gullies had more developmental potential from the 2<sup>nd</sup> order to the 4<sup>th</sup> order. Within the same gully orders, gullies in the downstream of watershed were more active. U-shaped cross-sections were widely distributed in the upstream of watershed and upper position of a gully; while V-shaped cross-sections were widely distributed in the downstream of watershed and lower position of a gully. Gully cross-section shapes at gully scale and watershed scale were similar, namely gully cross-sections had self-similarity.  $V - L$  and  $V - A_g$  empirical equations with acceptable accuracy established in this study could be used to estimate gully erosion degree in the study area.