A Laboratory Study on Rill Network Development and Morphological Characteristics

F. Zheng[1], C. Qin[2], X. Xu[3]

Rill erosion is one of the key erosion patterns on loess hillslopes, and rills are the main pathway for runoff, sediment and nutrient transportation within watershed systems. The objectives of this study were to develop a method for the survey of micro-topographic soil surface changes and quantitatively investigate the rill network development process and the rills' morphological characteristics.

Therefore, a soil box (10 m long, 1.5 m wide and 0.5 m deep) with a slope gradient of 15° was subjected to four successive simulated rainfall events under rainfall intensities of 90 mm h^{-1}. The duration of each rain event was 20 min. The 3-D laser scanning technique was performed during the intervals between each rainfall event. High-resolution digital elevation models extracted from the point cloud data were used for rill morphological characteristics analysis. Some of the maps of the rill network development results are shown in Figure 1.

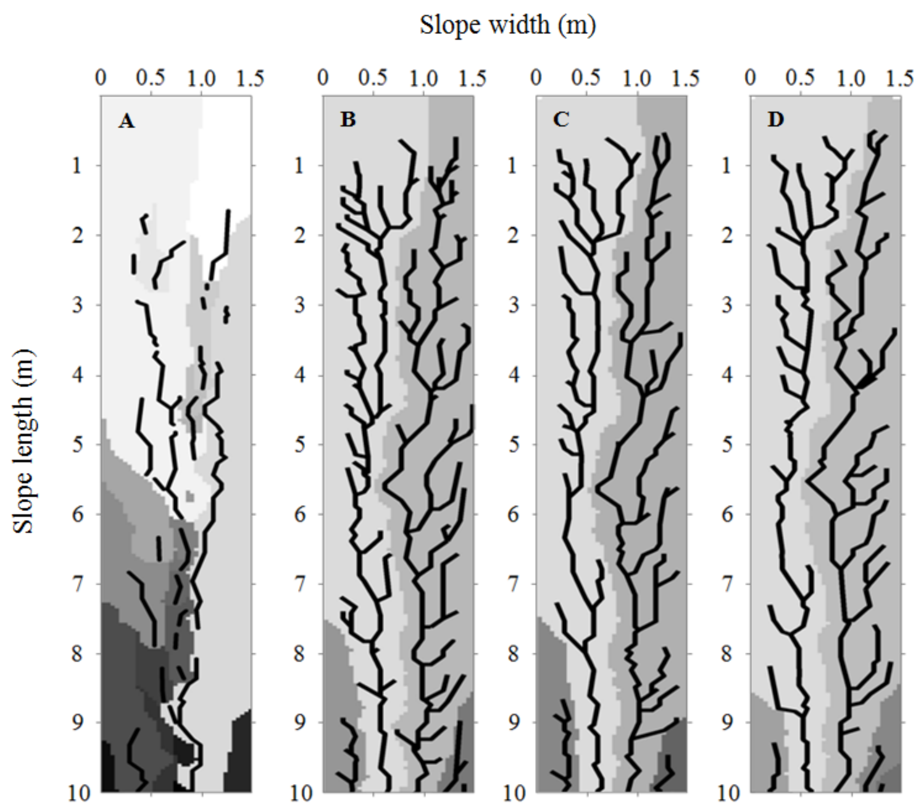

Figure 1. Rill network delineation after the 1st (A), 2nd (B), 3rd (C) and 4th (D) rainfall events.

The results indicated that different rill development processes significantly affected the soil loss, rill erosion, and rill morphologies. The range of rill erosion rates was 5.8-16.0 kg m^{-2}

[1]Fenli Zheng, Professor, Northwest A&F University, Yangling, Shaanxi, China; [2]Chao Qin, Ph.D. candidate, Northwest A&F University, Yangling, Shaanxi, China; [3]Ximeng Xu, Ph.D. candidate, Northwest A&F University, Yangling, Shaanxi, China; Corresponding author: F. Zheng, email: flzh@ms.iswc.ac.cn.

and contributed 54.2%-80.1% to the total soil loss. The formation of the rill network during the 2nd rainfall event was more complex than that during the other events. Two well-developed main rill drainage catchments were formed and occupied 87.3%-94.0% of the total surface area of soil box (Figure 1B). Rill width and depth increased with rainfall duration. The main rill length increased with rainfall duration. Secondary rill length increased at first and then decreased with the increase of rainfall due to rill piracy. The values of the erosion surface index (ε) and degree of contour line departure (μ) increased with increasing rainfall, while rill density (d) increased at first and then decreased later with rainfall duration. The ε and μ lines showed similar spatial variation trends and reached peaks at the 7-9 m slope length, while the d line peaked at a slope length of 3 m for all rainfall events (Figure 2).

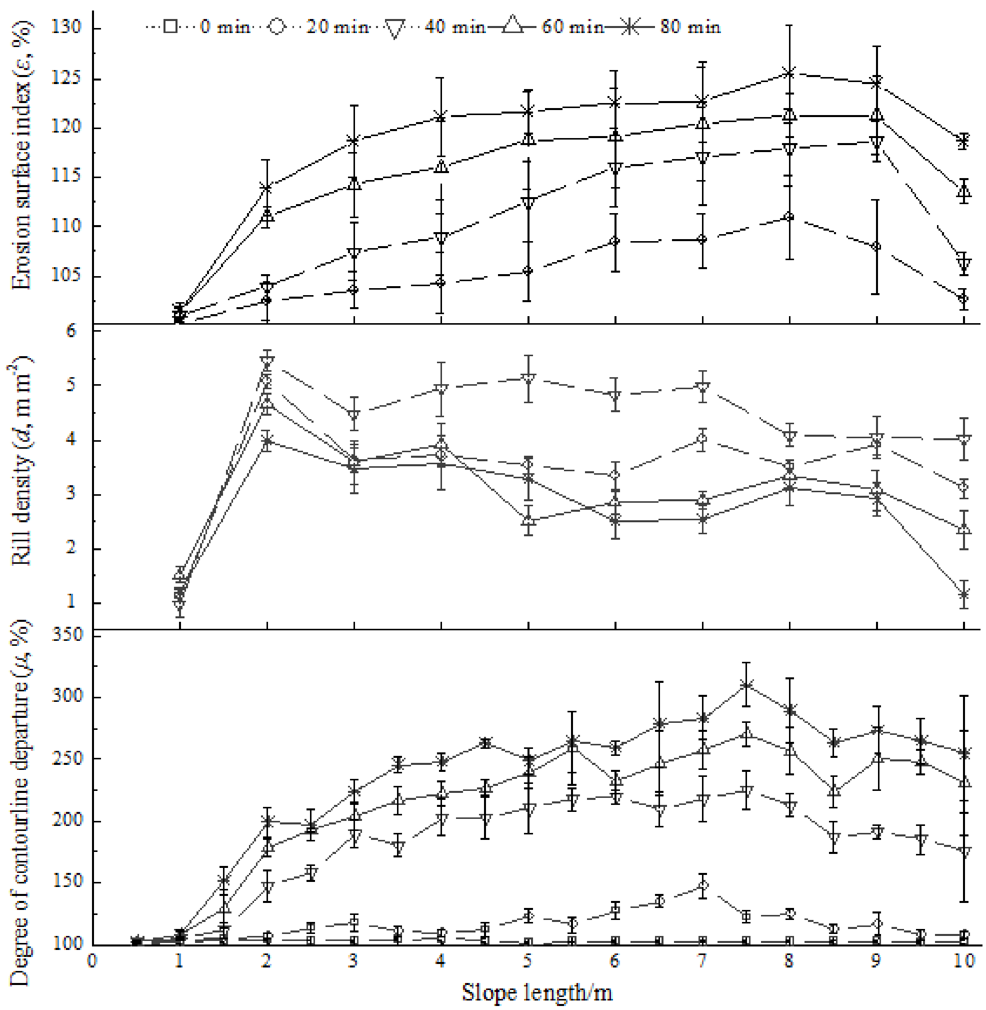

Figure 2. The erosion surface index (ε), rill density (d), and degree of contour line departure (μ) down the soil boxes before the run and after the 1st, 2nd, 3rd and 4th simulated rainfall events.

<u>References</u>

Schneider, A., H.H. Gerke, T. Maurer, and R. Nenov. 2013. Initial hydro-geomorphic development and rill network evolution in an artificial catchment. Earth Surf. Process. Landforms 38: 1496-1512.