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Interrill and rill erosion quantification using ground-based stereophotogrammetry technique – A case study from the bare plot of Mollisol, Northeast China

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The erosion processes at the hillslope scale most commonly encountered are interrill and rill erosion, proved by wide-spread RUSLE 2 and WEPP model. A significant problem related to the study of hillslope erosion within the field research consists in separating interrill and rill erosion amount from total erosion, mainly due to lack of precise measurement techniques. Stereophotogrammetry is a low-cost and user-friendly technology that could build high resolution three-dimensional (3D) model using structure-from-motion (SFM) software, allowing measuring the microtopography spatial variation and successive change within the hillslope after each erosive rainfall event, from which the interrill and rill erosion amount could be measured precisely. This paper reports the results of a field investigation on the interrill and rill morphology and soil loss as well as temporary change under natural rainfall events (2015-2016) using ground-based stereophotogrammetry, at a typical Mollisol zone, Northeast China. The experiments were carried out at in a 22.0*4.5 m bare plot with 5 gradients. The three-dimensional coordinates of control and check points outside the plot were measured by total station at May before rainfall season each year, in order to build bare plot's local coordinate system. Around 500 photos covering the whole plot were taken after rainfall event. The plot surface's high-density point clouds and interpolated Digital Elevation Models (DEMs) were constructed by PIX4D 2.0 using above photos and control points. The CloudCompare was used to analysis point clouds for interrill and rill morphology and successive change as well as respectively soil loss of the bare plot after each erosive rainfall. The ArcGIS was applied for sediment connectivity analysis to evaluate the potential effect of connectivity using DEM, which could help rill initial formation understanding. The results showed that the mean root mean square (RMS) error of the check points was 3 mm, and the ground resolution of DEMs was 1 mm. Throughout the rainfall season the bare plot's microtopography became smoothly, and the hillslope height variety decreased from 57% to 53%. The runoff lines density decreased, and main runoff lines appeared, which captured surrounding small runoff lines with time. The main runoff lines created rills. The rills appeared at slope foot firstly, and then the rill headcuted towards slope back. Besides, among the early stage the main rill development process was rill headcut and incision. Within the late stage it shifted to rill width increasing.