How surface mounds and depressions change during rainfall events

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Introduction

- Depressions and mounds are two elementary forms of soil surface roughness (SSR). During rainfall, they affect water flow on the surface differently. While depressions serve as temporary water storage, mounds diverge water away from their local summits.
- Different runoff responses to depressions and mounds result in different erosion processes and hence influencing the evolution of the surface microrelief.
- Although SSR effects on runoff and sediment production has been studied, there were no specific studies designed to quantify the morphological changes in depressions and mounds due to different rainfall-erosion processes.

Methods

- Rainfall simulation experiments were carried out on a soil box 1.2 m long by 0.6 m wide at 10% slope.
- Four rainfall intensities (25, 50, 75 and 100 mm h^{-1}) were applied.
- Before and after rainfall, the surface microrelief was measured using a laser scanner.
- The soil was collected from the surface horizon (0-20 cm) of a Crosby-Miami complex alfisol with 20% clay, 66% silt and 14% sand at the Animal Science Research and Education Center at Purdue University in West Lafayette, Indiana.

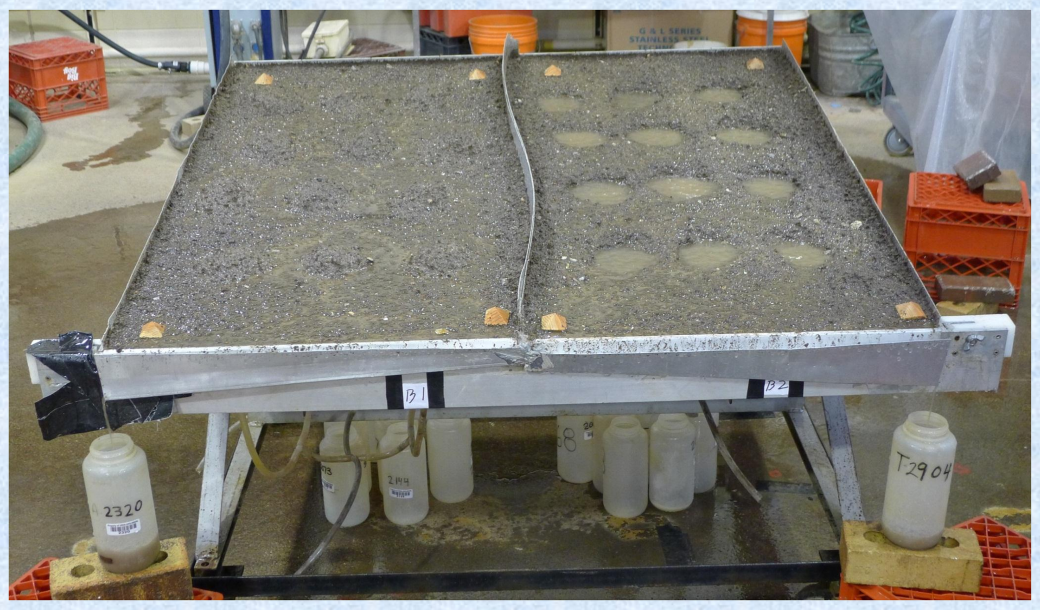

Figure 1. Photography of surface microrelief with mounds (left) and depressions (right) during rainfall.

Each surface contains nine mounds/depressions. The mounds/depressions were uniformly arranged in each box with a 25 cm spacing in the downslope direction. In the perpendicular direction to the downslope, the spacing between mounds/depressions was 15 cm. Both mound and depression have a hemispheric-shaped configuration with 8 to 10 cm in diameter and a height or depth around 5 cm.

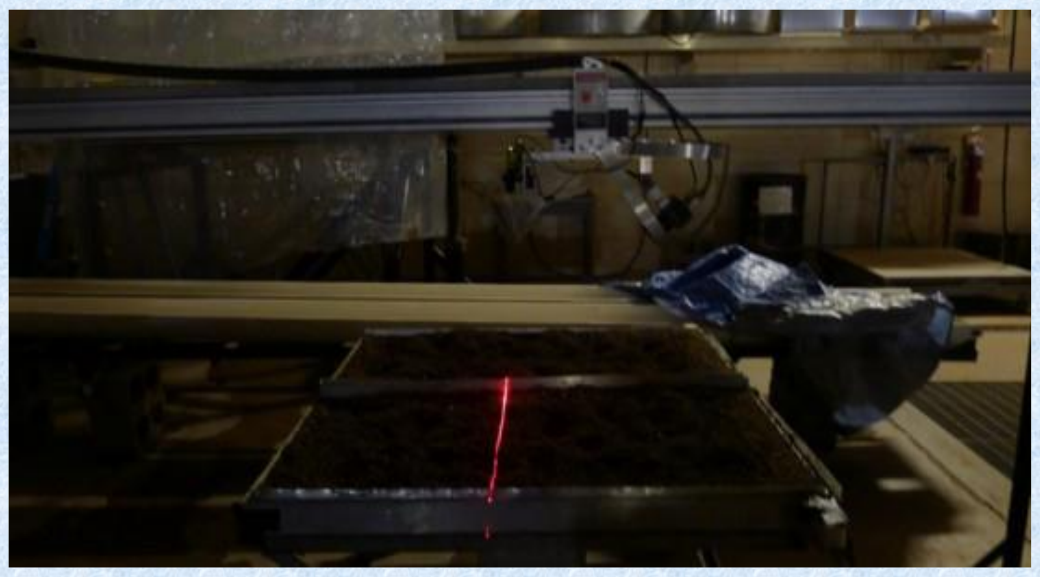

Figure 2. The laser scanner used for experiment.

This laser scanner consists of two diode modules and an 8-bit monochrome CCD camera with a 9-mm lens mounted on a single rail. The system can measure the microtography of a 50 cm by 4 m surface with a positional and elevational accuracy of 0.5 mm. In this study, approximately 160 000 elevation points were obtained for each surface at each run.

Conclusion and Future plan

- The elevation and micro-scale morphological changes of depressions were larger than those of mounds.
- The difference in volume change shows the spatial scale effect, i.e., erosion from each mound contributed to its own volume change while sediments deposited in a depression came from a runoff contributing area above the depression, hence a much greater source area than a single mound. This result can be used to explain why SSR has the positive role in reducing soil loss.
- We plan to analyze the effects of depression deposition and mound erosion on particle size distribution (PSD) of eroded sediments.

Results

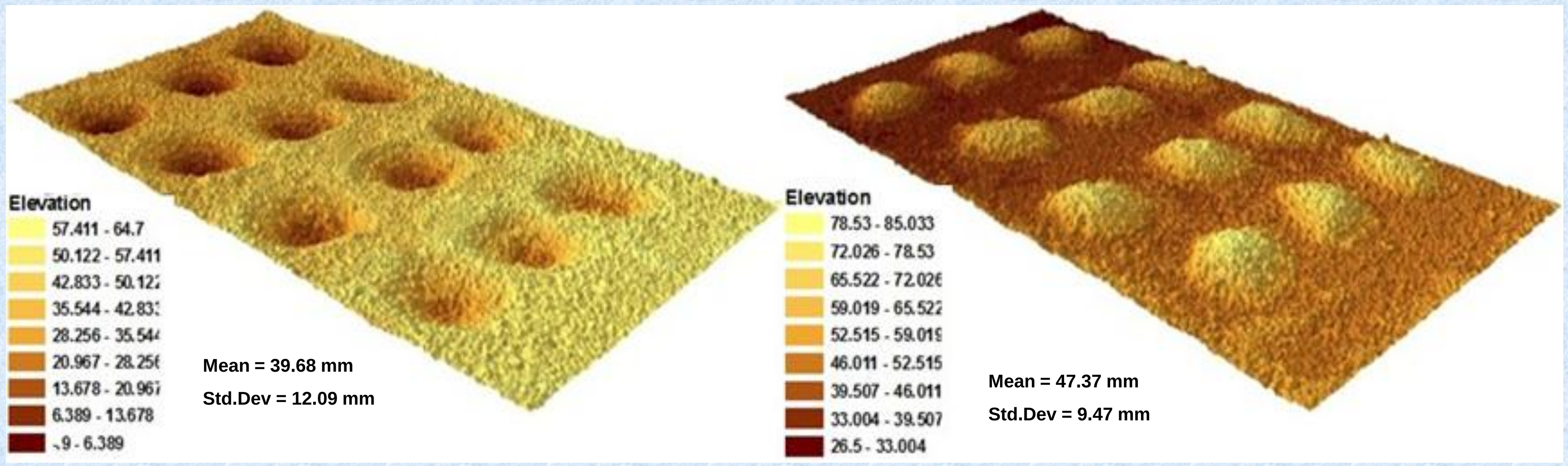

Figure 3. An example of DEMs of the initial surface microreliefs with depressions (left) and mounds (right), respectively. Projected area = 0.54 m^2; Spatial resolution = 2 mm.

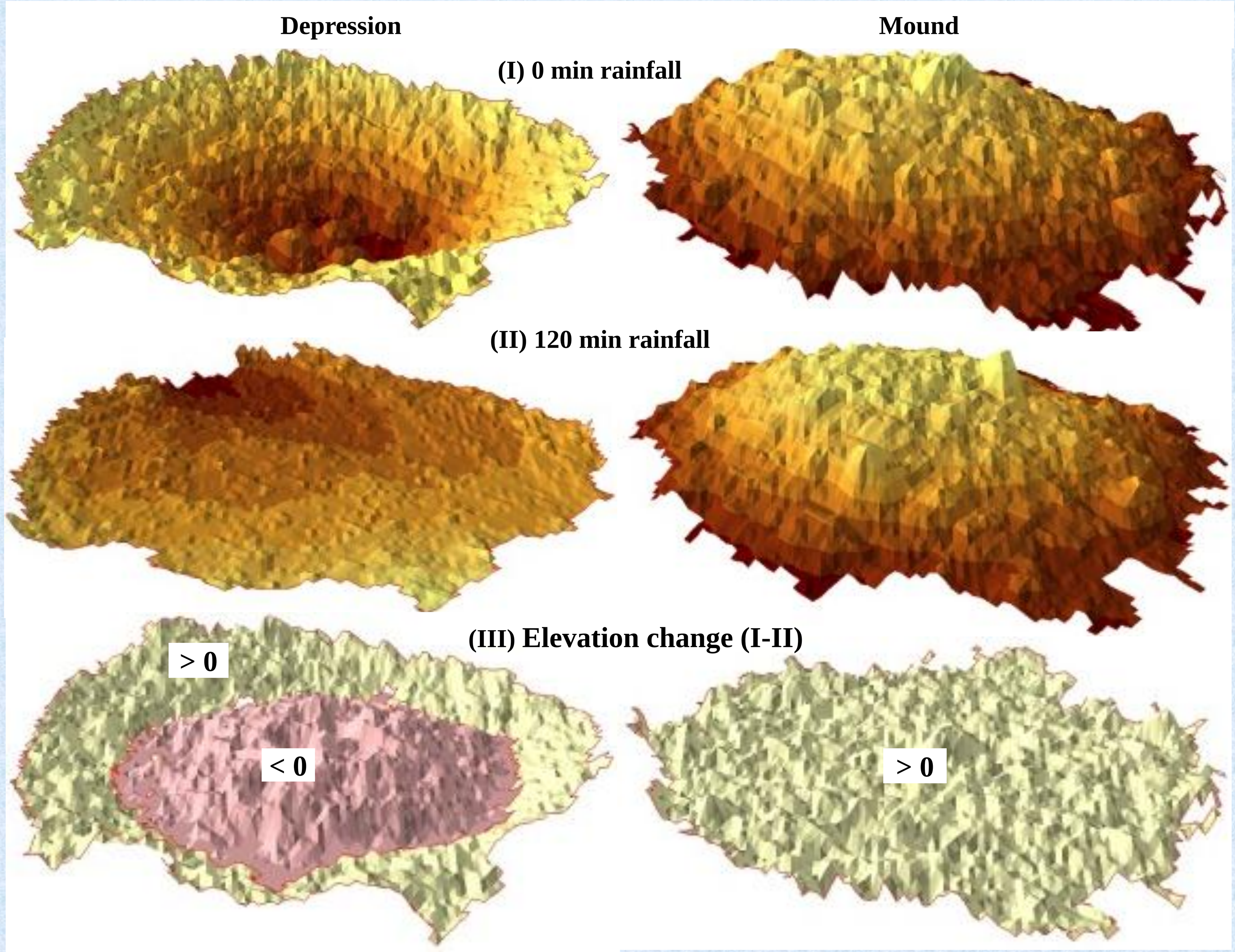

Figure 4. Digital elevation models (DEMs) of depression, mound and their changes after rainfall.

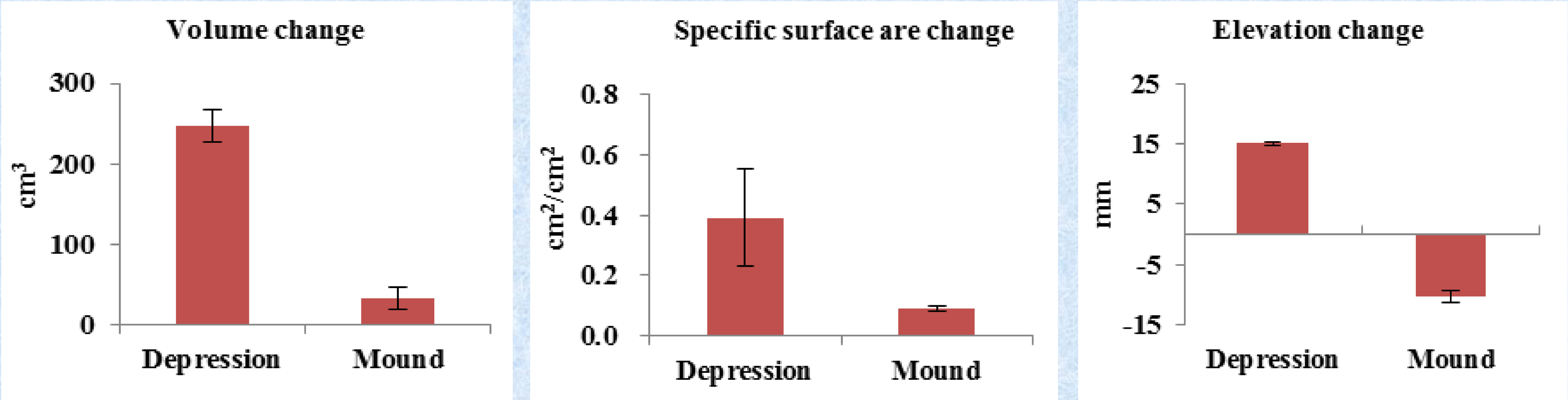

Figure 5. Changes in surface morphological.

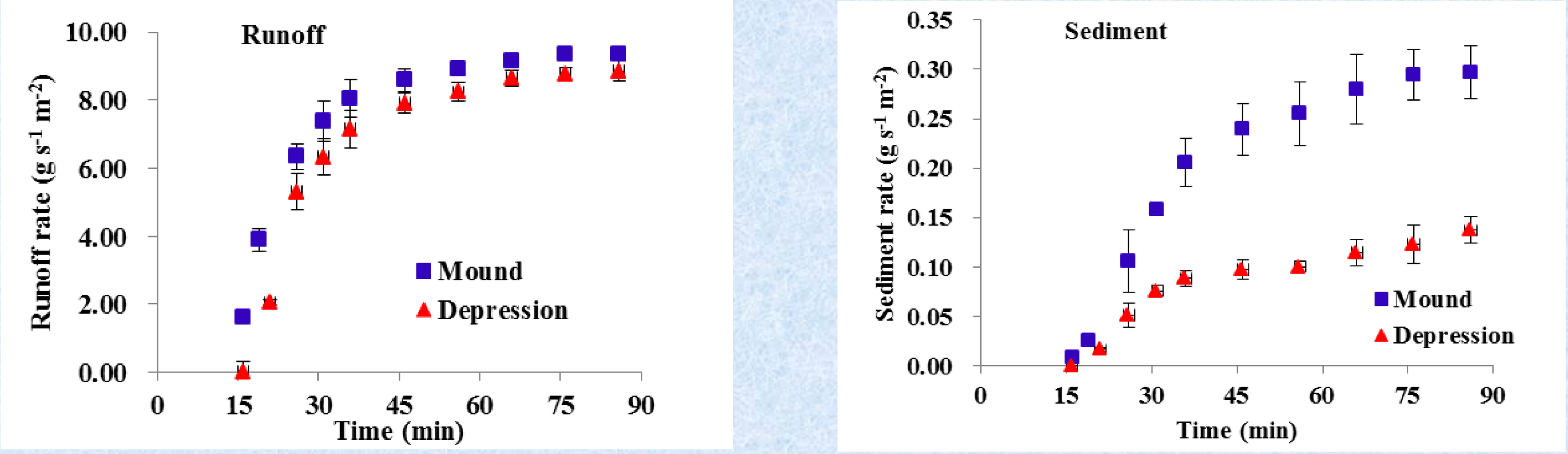

Figure 6. Runoff and erosion response to depression and mound at rainfall of 50 mm/h intensity.

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