Rainfall erosion experiment with a square sand mound rising from a flat surface

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Artificial rainfall of about 40mm/hour was applied on a flat surface, which has a rectangular parallelepiped mass (60x60x30cm) of a mixture of fine sand and kaolinite (permeability k=4.0x10^{-4}cm/s) buried under the ground at the center. The mass of sand and kaolinite mixture was uplifted by the uplift-generating device set beneath it. The uplift rate was 1.2mm/hour (270 hours; total 339mm) in Run 1, and it was reduced to 0.5mm/hour (646 hours; total 310mm) in Run 2. The surface topography in the area of 110x110cm was periodically measured by a laser sensor installed point gage. The apparent erosion of the uplifted area (60x60cm) started from its periphery with a series of shallow and fine grooves, and valley development by head-ward erosion and the development of valley system were not clearly observed, while the development of valley system by head-ward erosion of valleys from the mound edges was clear in the previous experiments, which started with a square mound having initial height of about 12cm. Wide and flat bottomed valleys and mountain- or plateau-like topography with steep side slopes were developed with the uplift. The height of mountains was increased with the uplift until slopes steepened by the uplift and the erosion at the base caused slope failures, and this process was repeated while the uplift continued. The maximum height increased as much as the uplift for 140 hours(180mm) before collapsed with slope failures in Run 1. It stayed around a certain height while the uplift continued, but decreased rapidly after the uplift ended. In Run 2, the maximum height increased with the uplift for 280 hours (130mm) and to 450 hours with a slightly reduced rate before oscillating around a certain height until the end of the run. The average height of the uplifted area increased at lower rate and the rate of increase declined with time until it reached a stable height of 95mm at about 250 hours in Run 1 (during the uplift) and 68mm at about 520 hours in Run 2. The minimum height of the area slowly increased with the uplift, but it reached a relatively stable height of 42mm at 450 hours in Run 2. The minimum height continued to increase slowly with the uplift in Run 1, but it would have reached a certain stable height if the uplift continued for a longer time. The minimum height reflects the development of alluvial fans around the uplifted area, and the increase in the minimum height indicates the relatively long lasting development of alluvial fans with the uplift. Alluvial fans reached the edge of experimental platform at around the same time as the collapse of the remnant of the original surface, and the development of alluvial fans after this time means the increase of fan slopes. Increased amount of sediments produced by the slope failures probably promoted the increase in fan slopes to a certain limit. After the uplift ended in Run 1, the surface height decreased rapidly and became lower than Run 2.

The stable average height corresponding to the uplift rate possibly indicates the achievement of dynamic equilibrium between uplift and erosion. The development of relatively flat/smooth surfaces and alluvial fans continuous from them, and mountains with steep surrounding slopes, which were uplifted and collapsed repeatedly, are characteristic topographic features in this stage. The sediments produced by slope failures were carried by running water and deposited in the area of alluvial fans, while the mountains gained some height with uplift, and then the process started again and repeated to maintain the same type of landform. The amount of sediments produced by slope failures is considered greater with the uplift of higher rate, and the lower surface and alluvial fans would have higher slopes. The width of area where alluvial fans can develop and the width of uplifted area are also considered to be important factors determining the stable slope and height corresponding to the rate of uplift.