Effects of different controlling factors on the experimental landform development

*Shunji Ouchi

Geomorphic experiments with uplift and rainfall erosion cannot be a scale model of real landform development; however, I believe that it can provide some useful ideas to help interpreting the real landform development, which left only scarce and sporadic evidence. I have been conducting this type of experiments for years, and now as I finished the series of experiments, I would like to explain what those experiments indicated. A mixture of fine sand, kaolinite and water (ca. 10 : 1 : 0.7 by weight) compacted in a square prism-shaped stainless container (ca. 60 ×60 ×40 cm) is pushed up by an uplift-generating device set under the bottom plate. Mist-type rainfall is generated by a pump through spray nozzles set at four corners. The duration of experiments was rather long (ca. 200 - 1800 hours) to accommodate slow uplift. The results of experiments suggested the existence of two threshold uplift rates. Below the lower threshold (ca. 0.05 mm/h), fluvial erosion alone can offset the uplift, and gentle landforms reflecting the mound erodibility appear (Characteristic relief phase). Above the upper threshold (ca. 5.0 mm/h), uplift overwhelms and a massive mountain grows until it hits the limit determined by the experimental setting (Mountain building phase). When the uplift rate is between these thresholds, average surface height stops increasing after valleys fully develop and slopes grow enough to cause landslides, and then changes around the certain equilibrium height depending on the uplift rate (Steady state phase). This phase is the most common condition throughout the series of experiments. The experimental landform in this phase develop through 3 stages. **Stage 1:** The surface erosion starts with the formation of small grooves at all sides of uplifted area. One groove in the middle at each side soon grows larger with capturing smaller ones and develops into a valley system. The average height of uplifted area increases linearly with uplift at a little lower rate. **Stage 2:** As the uplift and valley incision continue, slopes grow and slope failures start to occur on valley side slopes and on fault scarps. The frequency and size of slope failures increases with relief, and the increase rate of average height goes on declining. **Stage 3**: The average surface height stops its continuous increase and repeats ups and downs around a certain height (equilibrium height) determined by the uplift rate. Landslides dominate the erosion process, and channels of stable profiles become conduits for transporting sediments yielded by slope failures. The occurrence of landslides (followed by fluvial transport) tends to concentrate periodically and reduces the surface height on a certain cycle, while the surface slowly rises with uplift at a lower rate between the times of landslide concentration. Rainfall intensity is another important factor controlling the rate of fluvial erosion. Low rainfall generates less overland flow and makes the surface rise higher with less fluvial erosion. However, in runs with higher permeability, less rainfall caused more intensive erosion. The higher permeability of the same material acquired by the lower degree of compaction associates with lower shear strength, which is considered to promote slope failures by infiltrated water. More rainfall generates more overland flow. This provably promotes the development of grooves in the early stage and accelerates the development of valley systems. Efficient water drainage through valleys of high density may reduce water infiltration and retard slope failures. This possibly resulted in the higher surface under heavier rainfall. Even in the simplified experimental condition, a little difference in one controlling factor apparently cause complex effects among factors and then on the development of landform. We have to be very careful and try not to rush into a clear conclusion when we study the development of landform.

Keywords: geomorphic experiment, uplift rate, rainfall intensity, permeability, fluvial erosion, landslide

