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Changes in particle size distribution of suspended sediment affected by gravity erosion on the Loess Plateau, China

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Gravity erosion generates an enormous volume of sediment on the steep hillslopes throughout the world, yet the response from particle size distribution (PSD) of suspended sediment to mass failure remains poorly understood. Here rainfall simulation experiments were conducted on the natural loess slopes to induce a series of mass failures under rainfall intensity of 48 mm h^{-1}, and then an index of enrichment/dilution ratio was used to quantitatively explore the change trend of suspended sediment PSD affected by gravity erosion. To determine suspended sediment, water samples were collected in a polyethylene bottle directly from the gully runoff and channel flow in the pre and during- slope failures events. Then, the particle fractions of samples were done by combining sieving method and photoelectric sedimentometer technique. The results are shown as follows: (1) Gravity erosion has a significant influence on the particle size distribution of suspended sediment. As the mass erosion occurred, the proportion of sand-sized particles was decreased from 71.2 to 50.8%, whereas the proportions of clay and silt were increased remarkably from 1.3 to 7.3% and 27.5 to 41.9%, respectively. Hence the sediment can be more easily transported into channel flow while the suspended sediment load becomes finer as gravitational erosion occurs. (2) The median particle size (d50), sediment heterogeneity (H) and fractal dimensions (D) were significantly correlated with gravity erosion. As a result, d50 was decreased from 0.084 to 0.051 mm, H was increase from 5.6 to 26.8, and D was magnified from 2.60 to 2.78. This implies that mass failure makes the particle size distribution of suspended sediment more nonuniform and irregular. (3) Suspended sediment tended to enrich in the silt and clay fractions, while it diluted in the sand fractions during landslide erosion. Meanwhile, the enrichment/dilution ratios were 13.9 for the clay fractions, 1.4 for clay, and 0.7 for sand. This reflects the particle size selectivity of sediment mobilization on hillslope, and the selectivity of sediment delivery and transport from hillslope to channel. The results have important implications for understanding the connectivity between gravity erosion and sediment discharge to hydrological processes occurring on the hillslope.