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The nonsynchronous processes in debris flow developing

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Debris flow is a mixture of water and granular materials of wide-ranged grain size, which carries huge quantity of sediment. Generally, the flow is implicitly assumed a fluid of water plus solid, ignoring the when and how the mixing is going on. However, as far as the forming processes are concerned, the solid phase (granular sediments) do not always move in step with the flush water. In most cases, material supplies are scattering and discontinuous from the source areas and streambed sediment does not initiates as whole but separately in certain time intervals, while water flow is continuous from upper to downstream channels. The separation of sediment and water in debris flow developing is vividly encoded in the successive surges as ubiquitously observed in the world, especially in the Jiangjia Gully (JJG) in southwest China. Fig.1 shows the time series of water and the carried sediment of two events, indicating the out-of-synch between water and sediment.

Using the data of debris flows in JJG, we attempt to disclose the sediment-water separation effects on the developed surge properties, which is expected to be heuristic for understanding the forming and developing mechanisms of debris flows from sources to the mainstream. Specifically, we consider the following issues as exhibited by the surge sequences.

1) The temporal variability of water and sediment flow series, including the fluctuation, autocorrelation, power spectrum, Hurst exponent;

2) The statistical features of the two series, especially the probability distribution of the quantity (discharge or total volume) and the physical implication of the distribution parameters;

It is found that both the water and sediment bear high autocorrelation and Hurst index, while the sediment sources are randomly supplied. Furthermore, the series satisfies a unified distribution in form of $P(x) = Kx^{-\mu}\exp(x/x_c)$, with x being the discharge and volume of sediment and water. The parameters μ and x_c vary with the events (e.g., Fig.2 for the distribution of magnitude).

These findings are expected to shine a light on how the non-synch processes of water and sediment influence the developing of debris flow and the peak discharge, and this also poses a question in dynamics, which should incorporate the random and discontinuous sediment entrance in the evolution of flow.

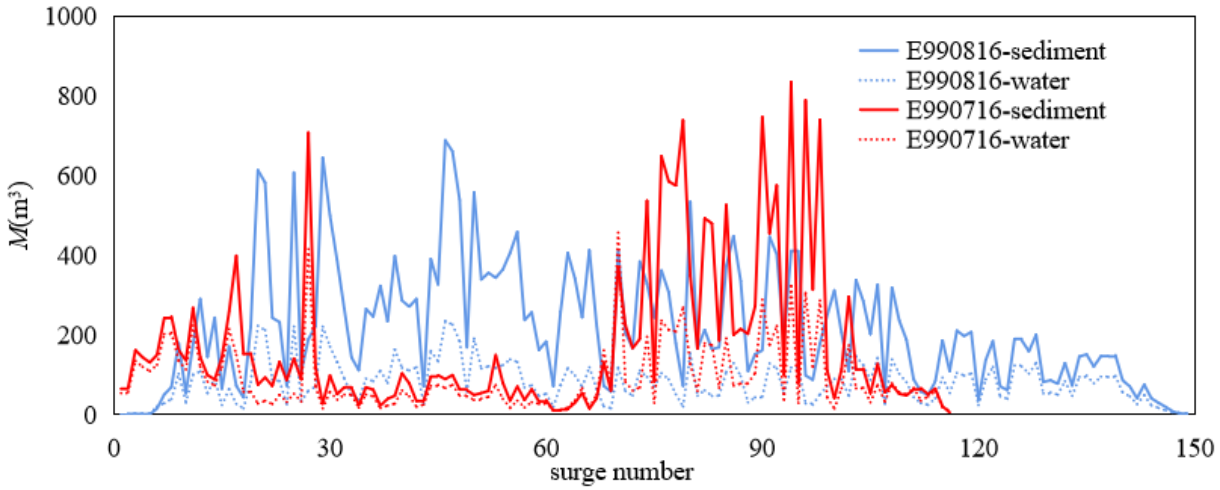

Fig.1 Water and sediment flow discharge series of debris flow surges (E990716 and E990816)

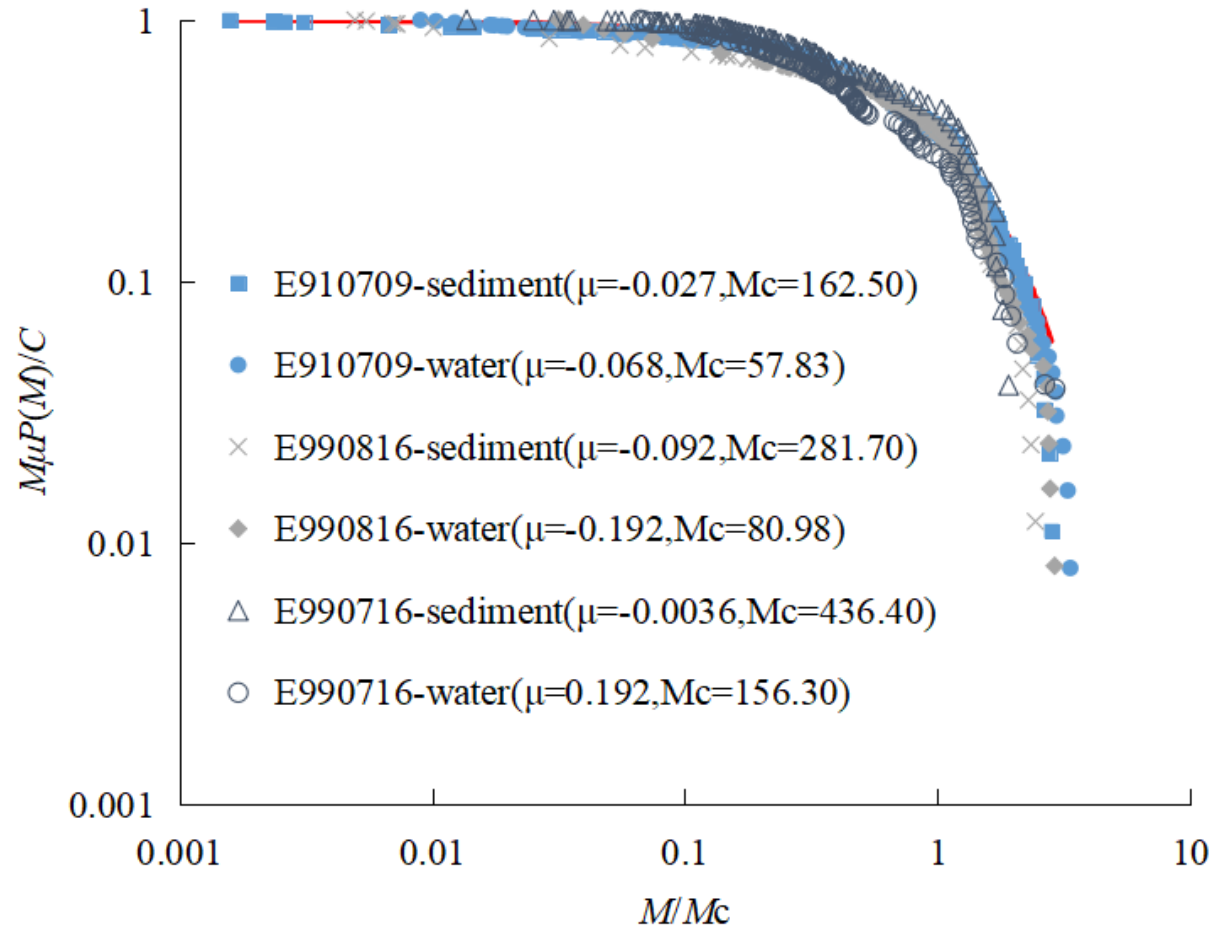

Fig.2 Probability distribution of water and sediment quantity