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Multi-phase model simulation of landslide-channel connectivity during an extreme flood event in the Philippines

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Tropical storms, such as typhoons, trigger a large number of landslides with a knock-on effect on the river network. Standard methodologies (for example, stream power) do not consider the role of landslide-channel connectivity in flood dynamics and may not capture the geomorphic impact of floods in catchments with a high density of landslides. Multi-phase computational models may offer a valid tool to overcome this difficulty, since they replicate the physical phenomena that occur between the solid (i.e. sediment) and liquid (i.e. water) phases. To this end, we have tested the performance of the multi-phase model r.avaflow on a catchment in the Philippines during Typhoon Mangkhut in 2018. The catchment was selected based on the very high density of landslides triggered by the typhoon and the impact of tailing dams on the channel network. The model results showed that the simulated erosional and depositional areas were consistent with the landslide and channel extents observed from satellite imagery. Furthermore, the model shed light on some important phenomena: for example, the impact of tailing dams on sediment continuity depended on their distance from landslide input. Additionally, the model reveals the development and collapse of debris dams during the flood event that influence the flood dynamics but that are not apparent in the post flood landscape. Overall, the model was in good agreement with post-event observations and offered novel insights into the role of landslide-channel connectivity in flood dynamics, with impacts for flood hazard assessment in similar catchments.