The impact of typhoon precipitation on flow routing, river chemistry and carbon cycling

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Chemical weathering is commonly thought to be the most effective abiotic component of the carbon cycle, and it is strongly modulated by several factors, such as erosion, precipitation, and lithology. Extreme precipitation events, for example typhoons, can contribute a high fraction of the yearly precipitation in many mountain ranges and erode or mobilize large volumes of sediment. The impact of such extreme precipitation events on stream chemistry and the carbon cycle, on the other hand, is not well constrained. We present a time-series of stream chemistry from the fast exhuming Sinwulyu River catchment in southeast Taiwan, collected at a three-hour interval during typhoons Nesat and Haitung in 2017. Water samples were also obtained from the non-typhoon period for comparison. Further, the water levels from four wells in the study area, and a groundwater separation model were used to constrain the groundwater contribution to stream flow and chemistry during the storm. The combination of chemical fluxes and hydrologic data suggests that the typhoon precipitation rapidly infiltrates, flushing the pre-existing deep groundwater into the river with high concentration of solutes signal. As a result, the initial high contribution of direct fast draining to river discharge is progressively complemented with evacuated groundwater. The initial storm phase coincides with a high fraction of carbonate and sulfide weathering that can act as a source of CO_2 to the atmosphere. As the groundwater contribution gradually comes to dominate over direct fast draining, after peak precipitation, the contribution of sulfuric acid-driven weathering decreases, leading to more drawdown of atmospheric CO_2 during the recession phase of the typhoon flood. Overall, this study provides a framework to dissect the dynamic changes of weathering signals and hydrological circulation during a typhoon event. The results also offer a unique view on the cycling and budget of CO_2 regulated by chemical fluxes during extreme precipitation events in a catchment with rapid uplift rates.