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Intense CO_2 release from channel deposits generated by catastrophic failure of a landslide-induced dam in eastern Taiwan

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Chemical weathering imposes a vital control on climate fluctuation by regulating the atmospheric CO_2 level through various processes that bear different degrees of dependency on geological material supply and chemical inertia. The extent to which these reactions proceed with major landscape changes in orogenic belts remains largely unconstrained. A landslide in the Matai'an River in the Central Range of eastern Taiwan generated 320 million cubic meters of deposits that were accumulated on the hillslope and dammed the river flow on July 21, 2025. Subsequent torrential precipitation associated with typhoons resulted in the overflowing and failure of the dam about two months later, re-distributing 52 million cubic meters of sediments along the river bank. Such a large quantity of lithogenic materials produced by mass wasting and fluvial processes on a monthly scale could be reactive for CO_2 production, thereby providing an unparalleled opportunity to constrain how extreme and what mechanism CO_2 evasion is manifested by material supply. In this study, direct measurements of CO_2 gas fluxes were performed at more than 100 sites, yielding gas accumulation at a rate spanning from 0.4 to 150 g-C/m^2/d. This range ranks among the highest ever reported for weathering processes in mountainous catchments. Analyses of carbon isotopic compositions further revealed that the collected CO_2 was predominantly sourced by pyrite-driven carbonate dissolution, with minor contributions from carbonate dissolution by atmospherically derived carbonic acid, and rock-bound and soil organic carbon. By multiplying the averaged flux with the sediment coverage area along the river, the emission of gaseous CO_2 was estimated at a rate of ~220 ton-C/d. This rate exceeded catchment-wise event-induced (this landslide) and pre-event baseline levels based on riverine chemistry by at least an order of magnitude. Such an enormous carbon export would persist until these landslide deposits are completely evacuated and pyrite is exhausted. Our results demonstrate that the jumpstart of carbon evasion through rapid weathering of bank sediments by transient and extreme landscape changes in active orogenic belts represents a missing link to the catchment-scale carbon budget in active orogenic belts.