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Increased tropical forest litter inputs undermine the stability of soil organic matter

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One of the persisting uncertainties in our understanding of the global carbon (C) balance is the dynamics and storage of organic matter in soils. Soil organic matter (SOM) dynamics are strongly linked to plant inputs such as leaf litter and root products, but the processes governing the stabilisation of SOM are poorly characterised, especially in the tropics. Changes in tropical forest productivity as a result of human activities are having a substantial impact on the tropical forest C sink, but we need more information on the processes governing the stabilisation of SOM to assess the knock-on effects of climate and land-use change belowground. Paradoxically, although greater tropical forest productivity could enhance the sequestration of C belowground, increased litter inputs can also stimulate the mineralisation of stored SOM, with unknown consequences for SOM stability. Here, we demonstrate that 13 years of experimentally increased litter inputs destabilised SOM in a lowland tropical forest. We combined physical, chemical, and biological soil fractionation methods to reveal that although total soil C content increased in response to extra plant C inputs, the majority of the C was available for immediate microbial use. The incorporation of extra organic matter with litter addition was offset by declines in mineral-associated SOM. Importantly, long-term litter addition reduced the amount of SOM associated with metal oxide complexes, which are particularly important for the stabilisation of SOM in tropical systems. The increased incorporation of plant material and the concomitant decline in specific mineral-associated SOM fractions have resulted in the overall destabilisation of SOM, making it more susceptible to losses due to disturbance in future.