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Changes in terrestrial carbon storage exert a strong control over atmospheric CO₂ concentrations but the underlying mechanisms are not fully constrained. Anthropogenic land cover change is considered to represent an important carbon loss mechanism, but current assessments do not consider the associated acceleration of carbon erosion and burial in sediments. We evaluated the role of anthropogenic soil erosion and the resulting carbon fluxes between land and atmosphere from the onset of agriculture to the present day. We show, here, that agricultural erosion induced a significant cumulative net uptake of 198 ± 57 Pg carbon on terrestrial ecosystems. This erosion-induced soil carbon sink is estimated to have offset $74 \pm 21\%$ of carbon emissions. Since 1850, erosion fluxes have increased 3-fold. As a result, the erosion and lateral transfer of organic carbon in relation to human activities is an important driver of the global carbon cycle at millennial timescales.