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Integrating aquatic and terrestrial flux components to construct a complete landscape carbon budget for a highly erodible semiarid catchment

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River systems are an important component in the global carbon (C) cycle. They transport and transform large quantities of land-derived C. Therefore, the magnitude of the terrestrial C sink at the landscape scale may be overestimated if the C losses through fluvial networks are not properly accounted for. In this study, we hypothesize that terrestrial-aquatic C transfers represent a major loss of the terrestrial C sink in semiarid catchments characterized by low terrestrial primary production and severe soil erosion. To test the hypothesis, we assessed the net landscape carbon balance (NLCB) of a highly erodible catchment on the semiarid Chinese Loess Plateau by compiling terrestrial net ecosystem productivity (NEP) estimates and aquatic fluxes of downstream C export, emission of CO_2 and CH_4, and C burial. Our results showed that, despite the severe erosion and strong C mobilization, this catchment was a net C sink (NLCB = 48.3-54.8 Mg C km^{-2} $year^{-1}$). Downstream C export at catchment outlet and evasion of CO_2 and CH_4 only offset terrestrial NEP by 7.7-8.5% due largely to low flow discharge and small water surface area of the stream network. Furthermore, C burial in reservoirs played a considerable role, reducing an additional 7.5-8.3% of the NEP. Altogether, approximately 84% of the net terrestrial C production was stored within the catchment. Our study reveals that semiarid catchments with widespread erosion and low terrestrial production remain a net C sink, although the magnitude is lower than those found in other climate zones. Our study further advocates that, if we are to develop credible landscape C balance estimates, future studies should work toward a more holistic framework that effectively integrates all landscape components, including aquatic C transport. Ignoring the aquatic C loss will cause biased estimates of the overall C sink strength and thus huge uncertainties to net C balance accounting at the landscape scale.