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Land Use and Land Cover Change Shrink Carbon Residence Time, Leading to Reduced Terrestrial Carbon Stock: Traceability Analysis

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Land use and land-cover change (LULCC) plays a key role in land-atmosphere carbon (C) balance, accounting for about 30% of historical anthropogenic CO_2 emissions since 1850. However, how LULCC impacts various processes so as to influence terrestrial C sequestration is not clear. In this study, we applied the traceability analysis to diagnose relative impacts of long-term LULCC on C input (i.e. net prime product, NPP) and residence time. The latter two jointly determine terrestrial C storage capacity. This study used model outputs from simulations of the Land-Use and Climate, IDentification of Robust Impacts (LUCID) for Phase 5 of the Coupled Model Intercomparison Project (CMIP5) during 2006 to 2100 for representative concentration pathway 2.6 (RCP 2.6) and RCP 8.5. Our results showed that LULCC decreased global terrestrial C storage by 75±54 (mean ± standard deviation, the same below) and 84±64 PgC for RCP 2.6 and RCP 8.5, respectively, at the end of 21th century. However, decreases in C storage capacity were much greater than that of C storage, being 109±61 and 105±84 PgC for RCP 2.6 and RCP 8.5, respectively. Residence time was shortened by LULCC, which resulted in the loss of terrestrial C storage capacity by 92±58 and 92±33 PgC for RCP 2.6 and RCP 8.5, respectively. In contrast, changes in NPP under LULCC only led to reduced C storage capacity by 20±101 and 20±71 PgC, respectively. Using the traceability framework, we identified mechanisms underlying LULCC impacts on terrestrial C stock, which are likely useful to improve future LULCC modelling.