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Human impact on erosion and burial of soil carbon through time

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The effects of soil erosion on atmospheric carbon is governed by three key mechanisms that are i) the replacement of soil organic carbon (SOC) at eroding sites, ii) the mineralization of SOC during erosion and transport and iii) the stability of buried SOC at depositional sites. Markedly different assumptions have been made about the relative importance of the key mechanisms, resulting in a global release of 1 Pg C yr^{-1} to a global uptake of 1 Pg C yr^{-1}.

Here we present results of a sediment-associated carbon budget in a small headwater catchment in Germany, to highlight the importance of the timescale in controlling the relative importance of the key mechanisms. Therefore, we estimate the loss of SOC through land use change from forests to arable land and compare it with SOC losses at degraded sites and burial of SOC in colluvial deposits.

Our results show that the transition of forest to arable land (without erosion and deposition of soils and sediments) resulted in a rapid loss of SOC from 11.8 kg C m^{-2} to 7.2 kg C m^{-2} in our study site. Eroded sites are characterized by carbon stocks of 6.9 kg C m^{-2} compared to depositional sites with 27.9 kg C m^{-2}. Thus the combined effect of soil erosion and deposition results in a slow net withdrawal of atmospheric CO_2, which compensates land use driven losses. We show that the net effect of SOC degradation and burial depends on the rate of soil erosion and time since the erosion commenced. Given the erosion history in the study site, the removal of SOC through land use change will be compensated after approx. 120 years of erosion and deposition.