Wind erosion alters ecosystem carbon balance and carbon sequestration potential in a temperate grassland

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Wind erosion and deposition of soil could greatly alter soil C pool and ecosystem C balance in arid and semi-arid ecosystems. Land use change is one of the most important driving forces influencing the intensity of wind erosion in those regions. However, how wind erosion under different land use scenarios will affect ecosystem C balance and its capacity for future C sequestration are poorly quantified. Here, we established an experiment in Xinlinhot, Inner Mongolia, and simulated different intensity of land use in grassland: control, 50% of aboveground vegetation removal (50R), 100% vegetation removal (100R) and tillage (TI). We monitored lateral and vertical carbon flux components from 2013 to 2016. We found that wind deposition resulted in net C gain during growing seasons, whereas wind erosion induced net C loss. Adding up the lateral C flux across the whole year, ecosystems under control behaved as a C sink of 44.85 g C m^{-2} yr^{-1}. However, under relative degradation ecosystems, the disturbance managements resulted in a net C loss, and the loss strength increased from 3.35 g C m^{-2} yr^{-1} under 50R to 135.86 g C m^{-2} yr^{-1} under TI and the erosion intensity increased rapidly with experimental duration. Land use also significantly altered the biological vertical carbon flux. The net ecosystem exchange (NEE) shifted from a net uptake of 86.85 g C m^{-2} yr^{-1} under control to a net emission of 35.12 g C m^{-2} yr^{-1} under TI treatment. With the increase in land use intensity, the contribution of lateral C flux to ecosystem C balance increased from 34% under control to 79% under TI. Wind erosion caused by land use changes not only result in dramatically surface soil C loss, but also significantly decrease soil C sequestration potential by altering soil texture. Permanent losses of organic carbon sequestration potential were 0.10 kg C m^{-2}, 0.12 kg C m^{-2} and 0.31 kg C m^{-2} in 50R, 100R, and TI, respectively. Overall, our study demonstrated that wind erosion could result in irreversible soil degradation and shape the landscapes of arid and semi-arid regions in the long term. Appropriate land use is critical to protect grassland ecosystems from being crashed.

Keywords: temperate grassland, land use changes, wind erosion/deposition, C balance, C sequestration potential

