Impact of past and present land-management on the C-balance of a grassland in the Swiss Alps

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Grasslands cover about 40% of the ice-free global terrestrial surface, but their quantitative importance in global carbon exchange with the atmosphere is still highly uncertain, and thus their potential for carbon sequestration remains speculative. Here, we report on CO2 exchange of an extensively used mountain hay meadow and pasture in the Swiss pre-Alps on high-organic soils (7-45% C by mass) over a 3-year period (18 May 2002-20 September 2005), including the European summer 2003 heat-wave period. During all 3 years, the ecosystem was a net source of CO2 (116-256 g C m(-2) yr(-1)). Harvests and grazing cows (mostly via C export in milk) further increased these C losses, which were estimated at 355 g C m(-2) yr(-1) during 2003 (95% confidence interval 257-454 g C m(-2) yr(-1)). Although annual carbon losses varied considerably among years, the CO2 budget during summer 2003 was not very different from the other two summers. However, and much more importantly, the winter that followed the warm summer of 2003 observed a significantly higher carbon loss when there was snow (133 +/- 6 g C m(-2)) than under comparable conditions during the other two winters (73 +/- 5 and 70 +/- 4 g C m(-2), respectively). The continued annual C losses can most likely be attributed to the long-term effects of drainage and peat exploitation that began 119 years ago, with the last significant drainage activities during the Second World War around 1940. The most realistic estimate based on depth profiles of ash content after combustion suggests that there is an 500-910 g C m(-2) yr(-1) loss associated with the decomposition of organic matter. Our results clearly suggest that putting efforts into preserving still existing carbon stocks may be more successful than attempts to increase sequestration rates in such high-organic mountain grassland soils.
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