



Soil degradation in semi-arid grasslands due to intensive grazing in Northern China

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Degradation of semi-arid grasslands is a global environmental problem, particularly in Inner Mongolia, Northern China, where up to 70% of the total area is classified as degraded steppe. The main cause of grassland degradation in Northern China is overgrazing as a result of increasing stocking rates and a static grazing management during the last 50 years. The aim of this study was to investigate the impact of intensive grazing on the stabilization processes, the amount and the spatial distribution of soil organic matter (SOM) in the grasslands of Inner Mongolia. Within the Xilin River Catchment, intensively grazed sites were compared with ungrazed experimental sites at different spatial and temporal scales. In order to determine short-term effects of intensive grazing, a controlled grazing experiment was established in 2005. Topsoil samples were taken in 2005 and again in 2008 from ungrazed (UG05), moderately grazed (MG) and heavily grazed plots (HG) and analyzed for chemical and physical soil properties. The effects of long-term grazing were investigated in detail at continuously grazed sites (CG) and compared to adjacent ungrazed sites that were fenced in 1979 (UG79). To elucidate the spatial structure of selected topsoil parameters at the field scale, 100 grid points with spacings of 5 m and 15 m were sampled. For detection of small-scale variability at the plant scale, 40 randomly selected points were sampled inside areas of 2 m × 2 m at each plot. Semivariances were calculated for the determined soil properties. To quantify the contribution of single soil fractions to total SOC stocks, a combined density and particle size fractionation was applied. Carbon mineralization was determined in an incubation experiment for a period of one month for UG79 and CG sites.

Grazing exclusion led to a significant decrease of SOC in the topsoil already three years after grazing exclusion and resulted in 25-30% lower amounts after 30 years. This decrease was related to lower organic matter input, destruction of soil aggregates due to enhanced animal trampling associated with mineralization of formerly protected SOM and enhanced soil erosion. The analysis of the spatial distribution of SOM showed a small-scale homogenization of SOM at grazed sites compared with a heterogeneous pattern at ungrazed sites. Apparently, heterogeneously distributed grass tussocks, which act as "islands of fertility" in undisturbed steppe ecosystems, are removed by heavy grazing that in turn deteriorates the accumulation of SOM. We conclude that semi-arid grasslands of Northern China are very susceptible to intensive grazing, which led to a considerable depletion and a spatial homogenization of SOM. Further intensification of the grazing management or an extension into undisturbed boundary areas of the steppe should be prevented.