Intensive Grazing Leads to Degradation and Spatial Homogenization of Topsoils in Two Major Steppetypes in Inner Mongolia, P. R. China

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Intensive grazing leads to degradation and spatial homogenization of topsoils in two major steppe types in Inner Mongolia , P .R . China

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Introduction Intensive land use and especially overgrazing in semi-arid grasslands results in degradation of steppe vegetation associated with changes in the amount , composition , and turnover of soil organic matter (SOM) . The concurrent degradation of soil structure and destruction of aggregation leads to enhanced soil erosion . The effect of intensive grazing on the amount and composition of SOM was assessed by comparison of grazed and ungrazed plots in *Leymus chinensis* and *Stipa grandis* dominated steppe types in Inner Mongolia , China .

Materials and methods The research was conducted at the Inner Mongolia Grassland Ecosystem Research Station (IMGERS , Chinese Academy of Sciences) in the Xilin River Basin (Inner Mongolia) at an altitude of 1270 m above sea level . The semiarid shortgrass steppe ecosystem is composed of *Leymus chinensis* and *Stipa grandis* dominated steppe types . Climate is characterised by a mean annual temperature of 0 .7℃ and precipitation of 343 mm with the highest values from June to August . Soils are classified as Calcic Chernozems derived from Aeolian sediments above acid volcanic rocks (WRB , 2006) . Both *Leymus* and *Stipa* dominated sites were sampled at continuously grazed plots (CG) and ungrazed plots (UG79) , which were fenced in 1979 . At all sites regular , orthogonal grids with spacings of 15 m and 5 m were sampled at 0-4 cm to elucidate the spatial structure of topsoil parameters . Each sample was analysed for bulk density , texture , soil organic carbon (SOC) content , total N and S content , inorganic C , C/N , pH , and $\delta^{13}C$.

Results Intensive grazing in both *Leymus* and *Stipa* dominated grasslands results in changes in the amount , composition , and turnover of SOM . All CG plots have significantly increased bulk densities and decreased SOC contents , total N and S contents . The *Stipa* dominated site tends to show higher bulk densities and lower SOC , total N and S contents at CG than the *Leymus* dominated site . Elemental stocks for SOC , total N and S are also lower on *Stipa* dominated sites . No significant differences were detected for pH values , C/N and $\delta^{13}C$ between CG and UG from *Leymus* and *Stipa* dominated sites . The spatial distribution of the investigated topsoil parameters changes under intensive grazing at both major steppe types . Generally , heterogeneity of bulk density , SOC content , total N and S concentrations and Ah thickness decreases under continuously grazing from a pure nugget or patchy to a homogenous distribution .

Conclusions The observed changes in the amount and composition of SOM under continuously grazed plots of both *Leymus* and *Stipa* dominated sites can be attributed to the combined effect of animal trampling , reduced above-and belowground organic matter input , and erosion in consequence of grazing . These effects could lead to degradation of soil aggregation and release of aggregate-protected soil organic matter , associated with enhanced susceptibility to soil erosion . The results of Steffens et al . (2007) confirm the assumption of declined soil aggregation , as they reported reduced microaggregation and reduced free and occluded particulate organic matter contents at the same sites , which are the most sensititve indicators for topsoil organic matter effects due to intensive grazing . The higher sensitivity of *Stipa* dominated sites to intensive grazing compared to *Leymus* dominated sites can explained by drier soil conditions associated with a lower degree of stabilisation of soil organic matter in microaggregates and organo-mineral associations . Moreover , a reduced input of organic matter and a lower stage of regeneration at *Stipa* dominated sites lead to lower elemental stocks and higher bulk densities . The increased heterogeneity at sites with grazing exclusion can be ascribed to vegetation recovery due to formation of islands of fertility" , and deposition of windblown material in ungrazed plots (Steffens et al . , accepted) .

Our results show a significant deterioration of topsoils at both major steppe types in consequence of intensive grazing and the benefit of excluded grazing in securing the status quo of affected soil parameters .

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