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“Filling gaps and removing traps
for sustainable resource management”

Effects of Different Stocking Densities on Soil Properties in Montane Pastures of the Chinese Altai Mountains

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Abstract

Overgrazing is one of the major threats for extensive terrestrial ecosystems, such as the Central Asian steppe, which belongs to the largest continuous rangeland. The constantly increasing livestock pressure in the Chinese Altai Mountains and changes of traditional mobile pastoralism to paddock-based livestock management are likely to affect soil properties, but little data exists to substantiate this claim. A grazing experiment was conducted on a summer pasture at 2400 m a.s.l. in the Chinese part of the Altai Mountain range, with average annual precipitation of 174 mm and average monthly temperatures ranging from -26 to 30°C. Sheep were kept in paddocks arranged in a completely randomised block design for a period of 56 days per year at densities of 0, 8, 16, and 24 sheep ha⁻¹ in four replicates. After two grazing periods, six samples per paddock were collected from the topsoil and analysed for physical, chemical and microbial soil properties. After two years the sheep density statistically significantly affected clay content and metabolic quotient ($q\text{CO}_2$) at a significance level of $p < 0.1$, while soil organic C (SOC), total N and other microbial indices were unaffected. The clay content decreased from 23.6% to 21.8% at sheep densities $>$ eight sheep ha⁻¹. From zero grazing to eight sheep ha⁻¹, the $q\text{CO}_2$ decreased from 13.5 to 12.9 mg CO₂-C g⁻¹ microbial biomass C d⁻¹ and remained relatively constant at about 12.5 mg CO₂-C g⁻¹ microbial biomass C d⁻¹ with further increase of sheep density. As expected, SOC strongly correlated with microbial indices such as microbial biomass C and N, ergosterol and basal respiration (Pearson's $r = 0.6$ to 0.9) and with the average seasonal aboveground biomass ($r = 0.6$). The gradually decreasing $q\text{CO}_2$ may indicate commencing soil degradation by an increase of grazing pressure, whereas other chemical and microbial soil parameters remained unaffected. The short duration of the experiment and the high spatial variability of measured parameters may explain the marginal effects of sheep density. The results nevertheless underline the significance of SOC for preserving soil quality of summer pastures in Central Asia.

Keywords: Enclosure experiment, metabolic quotient, microbiological indicator, soil degradation, soil fertility