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Landnutzung und Kohlenstoffhaushalt

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Titel
Degradation mechanisms and consequences for SOC stocks for the world´s largest alpine pastoral ecosystem on the Tibetan Plateau

Abstract
Approximately 1.5 million km² of the Tibetan Plateau are covered with grasslands. Thereof one third is occupied by the world's largest pastoral alpine ecosystem (Kobresia pastures). Paleo-records indicate the grazing-induced origin of this ecosystem since more than 8000 years or at least since yak domestication since 4000 years. Long-term moderate grazing by yak and sheep increased belowground C allocation of Kobresia pygmaea, caused the development of dense root-mats and finally lead to an accumulation of soil organic carbon (SOC) and nutrients such as nitrogen (N) and phosphorus (P) in the topsoil. These pastures, however, are increasingly affected by large-scale degradation caused by overgrazing of these highly sensitive ecosystems. Loss of the topsoil threatens several ecosystem functions: i.e. SOC and nutrient storage, biodiversity, provision of grazing-ground and supply of clean water for large parts of SE-Asia.
Here, we present a conceptual model and results of degradation processes combining anthropogenic and natural amplifications. To evaluate losses of SOC and nutrients we synthesize field observations and surveys in the highlands and validates this with own analyses in the Kobresia core area. We show that drought- and frost-induced polygonal cracking opens the root-mats, already weakened by overgrazing. This initiates a dying of the Kobresia turf, extends the surface cracks, triggers soil erosion and promotes SOC mineralization and leaching losses. Soil erosion caused further high losses of SOC and nutrients from the topsoil (i.e. 0-10 cm: ~5.1 kg C m^{-2}), whereas SOC loss beneath the surface cracks was primary caused by both, decreasing C-input and SOC mineralization (mineralization-derived SOC loss: ~2.5 kg C m^{-2}). The root biomass decreased with intensity of pasture degradation and lower C input constrains the ecosystem recovery. A negative ?^{13}C shift of SOC reflected intensive decomposition and corresponded to a relative enrichment of ^{13}C depleted lignin components. In sum, degradation triggered high SOC loss (up to 70% of intact soil in 0-30 cm: ~7.6 kg C m^{-2}) from this ecosystem with profound consequences for carbon sequestration, atmospheric CO_2, water quality and ecosystem stability.