

EGU2020-3845

<https://doi.org/10.5194/egusphere-egu2020-3845>

EGU General Assembly 2020

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## Soil cracking induced by overgrazing triggers the severe degradation or initiates the natural recovery of overgrazed alpine meadows on the Tibetan plateau?

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Soil cracking is an important feature of degraded terrestrial ecosystems, which cuts the closed and intact land, alters microtopography and also influences the dynamics of soil nutrients, water and heat, then further affect species distributions. Despite their importance, the patterns and causes of cracks related to overgrazing on alpine rangeland have rarely been reported previously, and the effects of cracks on soil properties and plant distributions are poorly understood. Therefore, we used a comprehensive cross-scale approach to investigate the distribution of crack-soil areas at the eastern Tibetan plateau (217 survey sites), then selected the grazing-induced parameter that was closely related to the cracks at a small scale, and quantified the effects of microtopography (raised areas and healed cracks) induced by cracking on the soil properties, and community composition at crack-mosaic patch from 2013-2018, then to evaluate the further roles of soil cracking on alpine rangelands. The results showed that cracks only formed in the alpine meadow after overstocking. The increased soil compaction under overgrazing was closely related to soil cracking. On crack patch scale, the healed cracks facilitated nutrient and water enrichment due to the increasing surface roughness, then improved the plant communities. To some extent, healed crack mosaics are good for the conservation of water and nutrients. We provide key and easy-to-measure indicators to prevent overgrazing and cracking: a residual biomass greater than 65 g/m<sup>2</sup> and a height greater than 6 cm, and the soil compaction should be lower than 1044.26 ± 188.88 kPa. We should pay more attention to crack phenomena to prevent severe degradation. Overgrazed alpine meadows should be treated in the early phase of cracking and it may be able to return to optimum conditions in healthy rangelands. Otherwise, soil cracking becomes the most critical turning point in the process of alpine rangeland severe degradation.