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Temporal and spatial variation in soil respiration in two semiarid steppe ecosystems with different degrees of land degradation

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Climate change scenarios predict increases in temperature, changes in precipitation patterns and longer drought periods in most semi-arid regions of the world. Ecosystems in these regions are prone to land degradation which may be aggravated by climate change. Soil respiration is one of the main processes of loss of organic carbon from arid and semi-arid ecosystems. We measured soil respiration over three years in two steppe ecosystems with different degrees of land degradation under three ground-covers: with vegetation, biological crust and bare soil.
Soil respiration showed strong temporal variation with average annual rates of 1.1 and 0.8 μmol CO2 m-2 s-1 in the natural and degraded sites, respectively. Land degradation caused drier and hotter soils and thus, a longer dry season. As a consequence, at the degraded site, plant and soil activity were further constrained by water availability and in turn, seasonal patterns were different at both sites. Precipitation was the main variable explaining internannual variability.
Despite significant differences in soil carbon, soil nitrogen and soil texture among ground-covers at both sites, they were no-significant differences in respiration rates, i.e., the temporal variation was much larger than the spatial variation. Other non-biological processes may have been involved in CO2 production at bare soil and biological crust ground-covers such as photodegradation and soil transport processes. At both sites, soil moisture was the sole controlling driver of soil respiration for most of the year. An empirical model based on soil temperature and soil moisture explained 90% and 72% of the seasonal variability of soil respiration on the natural and degraded sites, respectively.
This study suggests that land degradation may alter the carbon balance of these ecosystems through changes in the temporal dynamic of carbon loss by soil respiration and plant productivity.