Mongolian Journal of Biological Sciences 2008 Vol. 6(1-2): 31-38

Soil CO_2 Flux in Hövsgöl National Park, Northern Mongolia

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Abstract

We investigated soil CO_2 flux and bare soil respiration in grasslands that are located at the southern edge of the Siberian boreal forest in Northern Mongolia. The study area has warmed by almost 1.8°C over the last 40 years, and the soil and vegetation covers have been changed due to intense nomadic grazing pressure. Bare soil respiration is decreased with increasing grazing pressure, but there was no consistent pattern of total soil CO_2 flux under three distinct grazing levels. Bare soil respiration and soil CO_2 flux were higher on north-facing slopes than on south-facing slopes, due to high organic matter accumulation and the presence of permafrost. Both bare soil respiration and soil CO_2 flux were significantly higher in riparian areas compared with the lower and upper portions of the south-facing slope. Topography has a stronger effect on variability of soil CO_2 flux and bare soil respiration than variability induced by grazing. Inter-annual variability in soil CO_2 flux and bare soil respiration was very high, because of high variability in climate conditions.

Key words: Soil respiration, temperate steppe, topography, slope aspect, grazing

Introduction

Models of global climate predict that the greatest temperature increases due to greenhouse gas concentrations will be between latitudes 45°N and 65°N (Tans *et al*., 1990). The northern boreal forest ecosystem (taiga) lies along these latitudes, and the southern boundary of the Siberian taiga lies adjacent to a temperate grassland ecosystem that is of great interest with respect to carbon, since there are about 181.1 Mt x 10^9 C in these grassland soils to a depth of 1 m (Schlesinger, 1977).

Around 70-80% of Mongolia is grassland and shrubland, with slightly more grassland than shrubland (Tsogtbaatar, 2000). Grasslands have been overgrazed in many parts of Mongolia.

Soil respiration is one of the primary pathways by which terrestrial C is returned to the atmosphere. The efflux of CO_2 from soils is the product of both respiratory activities of roots and soil heterotrophs (Raich & Schlesinger, 1992). Thus, one may expect higher soil CO_2 flux in places with high soil organic C or high root biomass.

Environmental variables that influence soil respiration may be altered with both grazing pressure and topography. Soil temperature is a major factor controlling soil respiration rates in plot scale measurements in other ecosystem types (Kang *et al*., 2003). In addition, soil moisture, soil substrate quality, and vegetation cover influence soil respiration (Kang *et al*., 2003). In many semiarid grassland or shrubland landscapes, toeslopes are characterized by having higher vegetation cover, finer textured soils, and greater soil organic matter (Burke *et al*., 1999). Since soil respiration is a major component of ecosystem C flux, and the microclimates of Mongolian landscapes vary so strongly, and there is strong potential for high topographic variability in soil respiration.

Published information on how grazing influences soil respiration is inconsistent. In belowground dominant short-grass steppe regions, stable soil organic matter pools are not substantially affected by long term cattle grazing, but are highly variable with respect to topography and microsite (Burke *et al.*, 1999).

Our goal was to evaluate soil respiration in response to grazing across a complex landscape of Northern Mongolia, and to seek possible