Geophysical Research Abstracts
Vol. 14, EGU2012-13006, 2012
EGU General Assembly 2012

N dynamics of Inner Mongolia typical steppe as affected by grazing

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For large areas of Inner Mongolian semi-arid grasslands, as for many regions of the Eurasian steppe belt, substantial land degradation was reported as a consequence of excessive overgrazing during the last decades. Nitrogen is considered as a key element for ecosystem functions and therefore, a comprehensive analysis of the system's N balance and cycle as affected by land-use change is of fundamental importance to maintain, improve or restore ecosystem services such as forage production, carbon sequestration and diversity conservation.

In this comprehensive case study of a Chinese typical steppe, we present an in-depth analysis of N dynamics including the balance of N gains and losses, and N cycling. N pools and fluxes were simultaneously quantified on three grassland sites of contrasting grazing intensity.

Our N balances indicated the ungrazed site as N sink with annual net N input of up to 3 g N m-2, mainly due to N input by dust deposition, whereas the heavily grazed site must be considered as N source with net losses of up to 1.7 g m-2. Mayor N losses occurred via dust emissions and excrement export from grazing sites, the latter as a consequence of the common practice of keeping sheep in paddocks overnight. Compared to these fluxes, gaseous N losses, export of animal products (live weight and wool) and biological N2 fixation were of minor relevance. Heavy grazing reduced pool sizes of both topsoil organic N, and above- and belowground biomass N. Furthermore, grazing reduced N fluxes with regard to N uptake, decomposition, gross microbial N turnover, and immobilization.

Most N-related processes were more intensive in seasons of higher water availability indicating complex interactions between land-use intensity and climate variability. The projected increase of annual atmospheric N wet deposition and changes in rainfall pattern will likely affect the N sink-source pathways and N flux dynamics, indicating high potential impact of future N enrichment and climate change on ecosystem functions. Land use practice (e.g. pastoralists in context of socio-economic systems) will be increasingly important for the management of N dynamics in Chinese typical steppe and, therefore, must be considered as a key component to maintain and optimize ecosystem services.