Effects of land use change and monsoon variability on atmosphere-ecosystem exchange in high alpine grasslands on the Tibetan Plateau

Tobias Biermann (1), Wolfgang Babel (1), Lena Becker(2), H einz Coners (3), Silke Hafner (4,5), Siyuan He (6), Johannes Ingrisch (4), Thomas Leipold (1), E. Seeber (3), O. Shibostova (2), Sebastian Unteregelbacher (4,7), Peli Shi (8), Yaoming Ma (9), Yongpin Yang (9), Keith Richards (6), Karsten Wesche (10), Georg Miehe(11), Christoph Leuschner (3), Yakov Kuzyakov (4,5), Georg Guggenberger(2), Thomas Foken (1)

(1) Dept. Micrometeorology, University of Bayreuth, Germany
(2) Institute of Soil Science, University Hannover, Germany
(3) Institute of Plant Ecology University of Göttingen, Germany
(4) Dept. of Agroecosystem Research, University of Bayreuth, Germany
(5) Dept. of Soil Science of Temperate and Boreal Ecosystems, University of Göttingen, Germany
(6) Geography Department, University of Cambridge, UK
(7) Inst. for Meteorology and Climate Research - Atmospheric Environmental Research, Garmisch-Partenkirchen, Germany
(8) Institute of Geographical Sciences and Natural Resources Research, China
(9) Institute of Tibetan Plateau Research, China
(10) Senckenberg Museum for Natural History, Görlitz, Germany
(11) Geography Department, University of Marburg, Germany
tobias.biermann@uni-bayreuth.de

The Atmosphere Ecology Glaciology cluster (AEG) within DFG SPP 1372 Tibetan Plateau (TiP) investigates the ecosystem response on the Tibetan Plateau (TP) to changes in climate, monsoon dynamics and land use. The highlands of the TP inherit the world's largest alpine ecosystem [1, 2]. Special focus lies on the Cyperaceae *Kobresia pygmaea,* which covers app. 450.000 km ^{2} on an altitudinal range from 4000 to 5960 m a.s.l. (Fig 1). This species is the most abundant on the TP and is especially adapted to grazing pressure, growing only 2-6 cm tall and forming a stable turf built up from roots which play a key role in prevention of soil degradation [2]. Soils on the TP store 2.5 % of the global soil organic carbon (SOC) stocks [1]. Furthermore the TP contains the headwaters of Asia's major rivers, providing a large portion of the worlds population with freshwater and likewise bearing the risk of flooding events [2]. The dynamics of these rivers is strongly affected by Monsoon variability, which in turn is modulated by local circulation systems on the TP and in the Himalayans.
The research of the AEG cluster focuses on two vegetation types, alpine steppe and montane grassland in different altitudes on the TP. Fenced sites, which exclude grazing by livestock, have been established along an altitude gradient on the TP [3], since grazing is considered to be a key factor affecting plant community and fodder quality, soil carbon stocks and turnover as well as the energy and matter exchange between the atmosphere and the ecosystem.
The sites in Qinghai 3300-3600 m a.s.l. (Fig 1), established in 2002, showed in 2009 great differences in vegetation composition on grazed and non grazed plots. Main research focused on the change in vegetation and its fodder quality as well as soil carbon stocks and turnover, which were investigated by soil analysis and ^{13}C pulse labeling. Results indicate that the exclusion of grazing livestock might lead to reduced carbon storage in soils and therefore is not the appropriate choice for management of *Kobresia* meadows [4, 5]. In 2010 the cluster conducted a multidisciplinary experiment in Kema, in the center of the major distribution of *Kobresia pygmaea* 4400 m a.s.l (Fig 1), to investigate the response of these meadows to land use and climatic changes. Focus lied on the energy and matter exchange between the ecosystem and the atmosphere, CO_2 fluxes and water exchange in soil and plants as well as

plant distribution and growth. Fences were established in 2009 to quantify the effect of increasing grazing on the TP. Another objective of the research was to investigate if changes in Monsoon intensity effect evaporation and vegetation. Therefore Eddy-Covariance measurements were conducted to measure NEE and evapotranspiration. Small scale heterogeneities were covered by soil respiration chamber and lysimeter measurements, conducted on representative plots similar to the Eddy-Covariance footprint. Within these plots partitioning of carbon in the plant and soil was tracked with ^{13}C labeling. Additionally to the grazing manipulation a small scale fertilization and a irrigation experiment were carried out at Kema site to investigate additional limiting factors for the growth of *Kobresia pygmaea.* Monitoring of vegetation was conducted on plots representing different stages of degradation. Since the plots were just established at the end of the growing season 2009 effects of grazing exclosure was only noticeable on the degradation plots.

References

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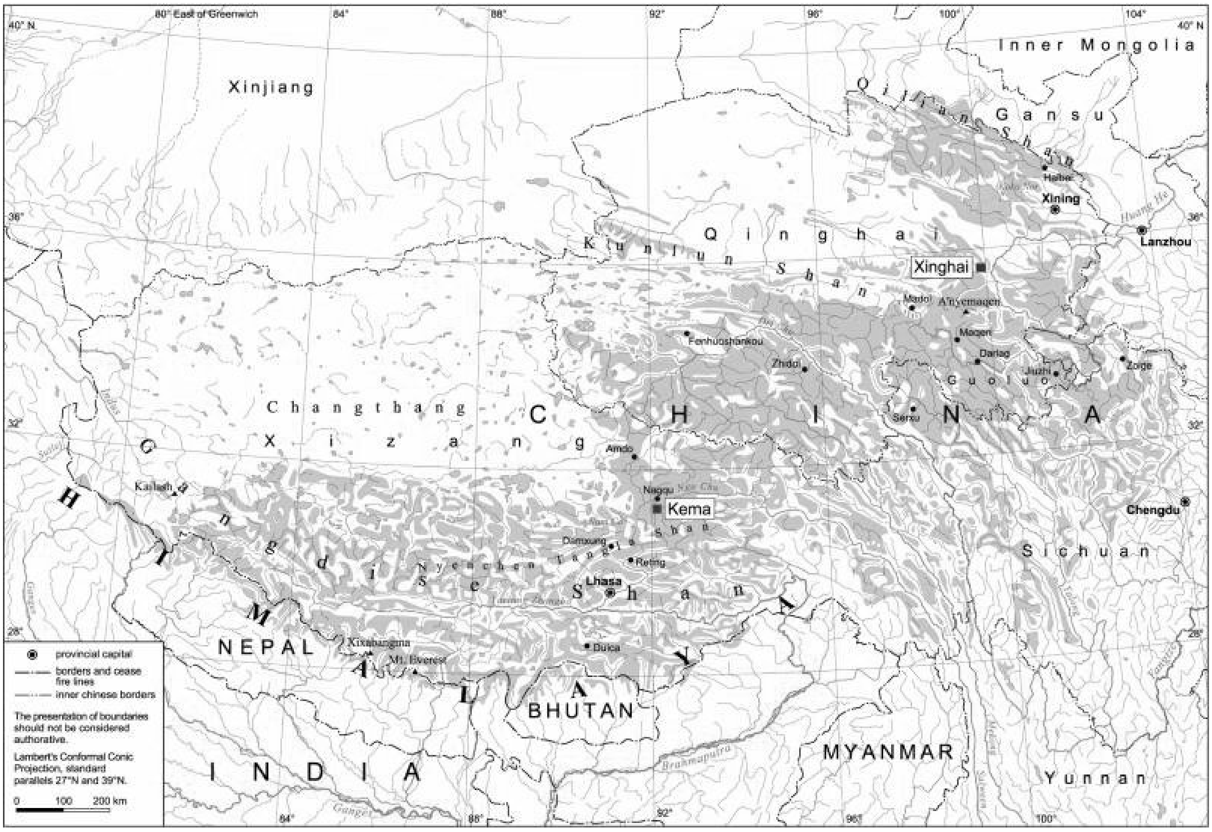

Fig 1. Distribution of *Kobresia pygmaea* on the Tibetan Plateau , indicated by the grey shaded area. Included are also the two measurement sites Xinghai and Kema [2].