

## SINO-GERMAN WORKSHOP

### Resources of the agro-pastoral transition zone of Inner Mongolia grasslands: Challenges and opportunities for 'marginal lands'

#### Ziele des Workshops

##### 研讨会目标

The envisaged Sino-German workshop will enable interdisciplinary knowledge exchange among young and established scientists on the topic entitled "Resources in the agro-pastoral transition zone of Inner Mongolia: Challenges and opportunities for 'marginal lands'".

It is planned to present and critically reflect methodological approaches and results of case studies, reviews and opinion papers to define major threats, challenges and opportunities for steppe ecotones, which are located in or adjacent to the agro-pastoral transition zone (APTZ). Transition zones between permanent agricultural lands and more extensively used natural grasslands, often referred to as 'marginal lands', are primary target areas to increase crop production, although less reliable rainfall and less favorable site conditions bear the risk of crop failures. Marginal lands in steppe ecotones are threatened by management changes, land-use intensification, and climatic variations. Despite their relevance for global matter fluxes and food security, marginal lands are still underrepresented in the public perception and research. The workshop intends to fill this gap and will address pressing research questions with the focus on ecosystem process dynamics as affected by land-use intensification and climatic changes.

As particular the APTZ could potentially address various ecosystem services such as carbon sequestration, mitigation of greenhouse gas emissions, water conservation, biological conservation, or food security, it appears essential to initialize a scientific discussion on criteria to define the aims of grassland ecosystem management. For this reason an interdisciplinary team of scientists representing different research fields of biodiversity, grassland ecology, soil science, soil-plant-atmosphere interactions, micro-meteorology, hydrology, plant nutrition, crop- and animal production, landscape-, economic- and ecological modeling, grassland management, and socio-economy is invited to contribute to the workshop.

The workshop will try to outline basic and applied research concepts in the context of current and future grassland ecosystem services, thereby identifying key parameters and methods required to answer open research questions. To define research gaps, through considering grassland ecosystem services from a multidisciplinary view, will help to develop potential future project's logical frameworks and, at the same time, future avenues of new research concepts and directions in the frame of Sino-German co-operations. Additionally, the workshop will give the chance to determine potential research sites and facilities, and to discuss basic and innovative methodological approaches in grassland research.

Major outcome of the workshop should be the definition of chances and threats of new land-use strategies and potentials of land-use change scenarios for grassland ecotones, which are located in or adjacent to the APTZ of Inner Mongolia. The meeting intends to show recent and multi-functional effects of land-use changes and to project strategies of "sustainable land-use intensification", including environmental and socio-economic effects on ecosystems and local farmers.

## Wissenschaftliche Begründung

### 学术理由

Grasslands are considered as one of the major terrestrial key ecosystems affecting sink and source dynamics of global matter fluxes (e.g. Conant et al. 2005; Davidson and Kinglerlee, 1997; Houghton, 2010; Lal 2008; Stallard, 1998). Main services provided by (semi-)natural grassland systems are, among others, biomass production, carbon and nitrogen sequestration, conservation of biodiversity, and living basement of herdsman (Bullock et al. 2011).

Traditionally, grasslands of Inner Mongolia were used as sustained grazing land by nomadic herdsman, which lived in equilibrium with its natural productivity. Since 1950s herdsman were forced to give up their nomadic way of life and settle in small villages or individual farms (Sneath, 1998). Within the following decades, the average area per sheep unit (SU) decreased rapidly from some six hectare per SU in the 1950s to about one hectare per SU in the 1970s (Wu and Loucks, 1992). Due the ongoing conversion from native grassland to cropland, the pressure on natural grasslands further increased (Wang et al. 2009). Today, global food prices and trends to grow bio-energy crops enforce the economic pressure, threatening grassland ecosystem services (Zhen et al. 2010) and consequently valuable steppe ecotones and wetland biotopes.

Most impacted by management change are such grasslands, located in and adjacent to the agro-pastoral transition zone (APTZ), e.g. the forest steppe ecotone in the Hailar County and the desert steppe ecotone near Hohhot. Steppe ecotones in transition zones are characterized by influencing biodiversity patterns, ecological flows and landscape mosaics (Sui et al. 2009). They are vulnerable against climatic changes (Neilson, 1993; Strauss and Schickhoff, 2007), changes in regional water management (Dong et al. 2011) and land-use intensification (White et al. 2000). It must be expected that steppe ecotones in transition zones are not only threatened by management intensification or conversion itself, but also by intensive cropping activities, such as over-utilization and intensive irrigation, in the APTZ. As marginal lands are also accessible from cropland-dominated APTZ with developed infrastructure, they are identified as hot-spots for land conversions in the near future.

In the last decades several efforts were undertaken to combat grassland degradation processes, e.g. the afforestation programs "Three Norths-Shelter Forest System Project" (Li 2004) and the "Grain to green project" (Zhang et al. 2000). However, success of most measures was doubtful for the grasslands of Inner Mongolia (Cao 2008, Su 2004). Today, more important than afforestation programs for the APTZ seems to develop and apply resource use-efficient management strategies for meadows and croplands, to preserve ecosystem functions, water and soil resources and natural biodiversity and to ensure food production at the same time.

All concepts must be based on an improved understanding of the underlying mechanisms, affecting regional matter fluxes, including effects of land-use activities in spatial distances. Significant effects of changed water cycles on vegetation abundance, soil microbial activity, carbon and nitrogen cycles and biosphere-atmosphere interactions must be expected.

Methods and models to evaluate management concepts on the different ecological and economical systems are still missing. For example, we cannot clearly describe effects of groundwater lowering by increasing irrigation of croplands on grasslands and wetlands in certain distances. New research approaches and economic models would be helpful to assess social and ecological interactions under changing economic situations. Not least, modeling and up-scaling processes

and results based on field or regional measurements are needed to understand their relevance in continental and global contexts.

The former Sino-German DFG research-group MAGIM (FG 536, Matter fluxes as influenced by stocking rate in Inner Mongolia, 2004-2010) contributed significantly to an improved functional understanding of effects of different grazing systems in northern Chinese typical steppe on different ecosystem's processes, such as carbon and nitrogen dynamics, wind erosion, biodiversity, greenhouse gas balance and sheep growth (e.g. Hoffmann et al. 2008 ; Lin et al. 2012 ; Ren et al., 2012 ; Schönbach et al. 2012 ; Wolf et al. 2010). The research group manifested an output with some 110 publications in international, ISI-listed, journals and numerous presentations at international grassland- and dryland conferences. Overviews of MAGIM group studies are given in e.g. Butterbach-Bahl et al. (2011) and Giese et al. (in press). The impressive scientific outcome underlines both, the great demand of data and field studies in grasslands of Inner Mongolia on different spatial and time scales and the outstanding potential of German and Chinese cooperation in grassland research.

Recent research activities, such as the DAAD funded climate network "GrassNet", continued and intensified cooperation between German and Chinese scientists and the scientific discussion on grassland ecosystem's vulnerability to climate and land-use change in Inner Mongolia.

The next step in Sino-German grassland research is to concentrate existing knowledge and to tackle recent challenges of marginal lands in Inner Mongolia. Existing contacts and interactions between scientists from both countries are basis for new research concepts. After studying processes in a typical steppe, we plan to leave measurements on more local scales in the center of Inner Mongolia, and to focus on marginal lands at transition zones between meadows and croplands. The logical next step is to include social and economic aspects to provide ecosystem services as well as ecological and economic modeling to assess changes and effects of policies on regional and supra-regional scales.

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## Erläuterung der zu diskutierenden Themen

### 阐述会议拟探讨的主要内容和拟探讨的课题

Rising conflicts of global food security against the background of depleting natural resources demand for more efficient and sustainable production systems at the same time. New management strategies and concepts are therefore required to reduce greenhouse gas emissions and soil degradations, to protect plant biodiversity, to promote land restoration in steppe ecotones along the APTZ, and, not to forget, to ensure conditions for secure food and fodder production. We define *sustainable land-use intensification* by the combination of both, natural conservation and food security.

Challenges for a sustainable food and feed production, as well as nature- and landscape conservation of the steppe ecotones along the APTZ are, among others

- improved grass- and cropland management: e.g. annual alternating hay making systems (including transport and dispersion), reducing greenhouse gas emissions, combinations of crop-livestock systems and/or alley cropping systems and efficient fertilizing of meadows
- water conservation and plant waterstress management, protecting of wetlands and surface water bodies
- grassland restoration and protection: e.g. improving degraded and sanded soils, the establishment of areas/times of grazing cessation and wind erosion control during drought periods
- improved grazing-based land-use systems at those sites of high crop failure risks
- regionalization and process up-scaling: e.g. modeling carbon and water fluxes under different land-use systems
- socio-economic aspects, value chain analyses, farmers perception and participatory research approaches
- alternative land-use options: e.g. renewable energy “bio-energy crops”

New land-use strategies, under consideration of the grassland ecosystem services, require evidences about the impact of different management practices and land-use systems on soils, water, matter fluxes and species composition change across plot to landscape scales. Under changing conditions, it is further necessary to identify and assess multi-faceted interactions between ecosystems, humans, society, local value chains and global economy.

Therefore, special emphasis will be given to socio-economic research approaches with close contacts to different stakeholders to cover both, biophysical analyses and farmers as primary actors, affecting the ecosystem functions via land-use practices.

#### *Possible research questions to be discussed at the workshop*

In particular, carbon-, nitrogen- and water dynamics in semi-arid steppe ecotones are of major interest, since water and N are primary, respectively co-limiting C assimilation of semi-arid ecosystems. A central research question is to assess the values and implementations of management concepts for selected ecotones in and near the APTZ of Inner Mongolia. Different methodological approaches for field experiments and data processing and modeling will be discussed at the workshop, e.g.

- effects of adjacent grazing-cropping systems on soil, water and soil-atmosphere-exchanges, e.g. by providing enclosures in different distances to water intensive cropping systems
- effects of land-use change, e.g. effects of conversion of grassland to cropland and vice versa on biotic and abiotic systems.
- effects of changes in temperature and precipitation e.g. on microbiological activity, plant functional traits, permafrost conditions and connected water cycles in the Hailar forest steppe ecotone



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- effects of irrigation and connecting decreases in ground water levels, e.g. on wind erosion and salinization processes in desert steppe ecotones
  - effects of driving economic and social forces for marginal lands.

### **Erwarteter Nutzen für die deutsch-chinesische Kooperation**

#### 预期成果对中德合作的促进作用

The workshop will show existing social, economic and ecological conflicts of the transition zone between meadow grasslands and croplands of Inner Mongolia. The workshop will be used to identify potential consortia of Sino-German scientists being able to translate work-shop results into own research proposals and ready-to-go networks, answering international thematic research calls. By particularly addressing the participation of young scientists the basis for new and sustainable scientific Sino-German partnerships will be promoted. Consequently, all workshop participants will benefit by state-of-the-art presentations and discussions for mutual exchange of knowledge and experiences in grassland research.