Building Resilience of Mongolian Rangelands: A Trans-disciplinary Research Conference – Preface

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ABSTRACT

Mongolia is a semi-arid and arid country in Asia where the climate has been changing more drastically than many other locations across the globe. The proceedings of the "*Trans-disciplinary Research Conference: Building Resilience of Mongolian Rangelands*" is divided into five sections: 1) Rangeland Ecology and Management, 2) Climate Change and Hydrology, 3) Institutional Innovations in Mongolian Rangelands, 4) Social and Economic Development in Rural Mongolia, and 5) Methods of Knowledge and Data Integration. The papers presented provide cause for concern regarding observed changes in climate, rangeland conditions and livestock populations, as well as reasons for hope and motivations for action to address the current challenges. We hope that this volume and the conference it accompanies, will inspire renewed commitment to support science and science-based policy-making and management to sustain Mongolia's unique natural and cultural heritage as they adapt to a changing planet.

INTRODUCTION

Mongolian rangelands and the pastoral systems that depend on them are at a potential tipping point. Some research reports widespread grazing- and climate-induced degradation (Liu et al., 2013; Hilker et al.m 2014), while other assessments find that Mongolian rangelands are resilient but at risk (Khishigbayar et al., 2015). Herders observe changes in both climate and rangeland conditions (Bruegger et al., 2014; Fernandez-Gimenez et al., 2015a), and rural poverty remains a persistent challenge. New institutional innovations in rangeland assessment, monitoring and management offer reason for hope (Baival and Fernandez-Gimenez, 2012; Fernandez-Gimenez et al., 2012; Leisher et al., 2012; Upton, 2012; Fernandez-Gimenez et al., 2015b), but scientific evaluations of their process and outcomes are scarce. This trans-disciplinary scientific conference provides a venue for researchers from physical, biological and social sciences to share recent scientific advances in understanding the causes and

consequences of rangeland social-ecological transformation in Mongolia, and emerging solutions to climate and socio-economic changes.

BACKGROUND OF THE CONFERENCE

Mongolia's grasslands cover 75% of its land area and support globally important wildlife populations as well as a vibrant nomadic culture whose herds depend on the steppe for their sustenance. The average annual temperature in Mongolia has risen by 2.1 over the past 60 years (Dagvadorj et al., 2014), one of the steepest increases on Earth. Since the transition to a democracy and market economy in 1992, poverty in rural areas has grown from zero to over 35% of the population. As a result, herding families are increasingly vulnerable to severe weather events, such as the winter disasters (*dzud*) of 1999-2002 and 2009-2010, as well as volatility in world markets. At the same time, the number of livestock grazing Mongolia's steppes has increased, leading to concern for the future sustainability of the steppes and the people and animals that depend on them. To address these concerns, over 2000 formally organized herder groups formed since 1999 to help empower and educate herders to manage their lands and herds sustainable (Mau and Chantsalkham, 2006). This movement, called community-based rangeland management (CBRM), is unprecedented in the world and offers an unparalleled opportunity to learn from the outcomes of grassroots collective action, and put this knowledge to work designing better policies and practices.

The Mongolian Rangelands and Resilience (MOR2) project is a collaborative, interdisciplinary research, education and outreach project that seeks to understand the impacts of climate and socio-economic change on Mongolian rangelands and pastoral people, and to identify the management practices and institutions that build rural community resilience and improve rangeland sustainability. This project grew out of a collaborative research planning meeting held in Ulaanbaatar in June 2008, in which herders, Mongolian and US scientists, donors and policy-makers met to identify critical questions facing Mongolia's rangeland systems and pastoral communities. At this meeting, participants collaboratively designed a country-wide research program to understand how livestock grazing and climate change are affecting the condition of Mongolia's rangelands across multiple ecoregions, and whether and how institutional innovations such as formally organized community-based rangeland management (CBRM) are affecting rangeland health and pastoral livelihoods and social conditions.

The overarching objectives of the MOR2 project are to: 1) assess the vulnerability of Mongolian pastoral systems to climate change; 2) evaluate the effects of community-based rangeland management on the resilience of Mongolian pastoral systems; 3) strengthen linkages between natural resource science and policy-making in Mongolia; and 4) build the capacity of Mongolian and US scientists and students to analyze the dynamics of complex natural-human systems.

The *Building Resilience of Mongolian Rangelands Conference* brings together researchers from Mongolia and around the world to share what we have learned about the dynamics and vulnerability of Mongolia's rangelands and the potential for new innovative solutions to the challenges Mongolia's pastoral communities and ecosystems face. In addition, this conference provides a scientific foundation for policy recommendations grounded in the empirical findings included in this volume. Finally, it provides an opportunity for all participants to participate in an international scientific conference and publish in this peer-reviewed conference proceedings, advancing our capacity-building objective.

In this preface to the proceedings, we briefly summarize key findings within and across the major conference themes: rangeland dynamics and changes, climate and hydrological changes and impacts, institutional innovations for rangeland management,

rural social and economic development, and methods to advance knowledge and data integration in transdisciplinary research.

RANGELAND ECOLOGY AND MANAGEMENT

To manage rangelands sustainably, it is essential to understand the differences in ecological capacity of different soil and vegetation types across the landscape, and the distinct ways that different plant communities respond to management and disturbance. Heiner et al. and Bulgamaa et al. both propose improved approaches to classifying ecosystems (Heiner) and soil-plant complexes (Bulgamaa), also referred to as ecological sites—a type of land with the potential to produce a certain kind and amount of vegetation (Bestelmeyer and Brown 2010), as determined by climate, landform and soil type. The ecosystem-scale classification proposed by Heiner is based on a combination of satellite (remotely sensed) data and field validation plots, and is useful for conservation planning at the ecoregional scale. The ecological site classification advanced by Densambuu is based on extensive field sampling and forms the basis for soum-level rangeland assessment, planning and monitoring. Together these classifications should help inform conservation and rangeland planning in the future and both local and regional scales.

Amartuvshin et al. and Baasandorj et al. inform current knowledge of rangeland dynamics using observational studies of vegetation response along grazing intensity gradients. Amartuvshin et al. confirm that different desert steppe plant community types respond differently to grazing, but the three communities studied all show a gradient in the cover of perennial grasses with increasing distance from a water point, where grazing pressure is presumed to be heaviest. Baasandorj et al. sampled soils along gradients from winter camps in three ecological zones and found that bulk density was highest close to the camps, where trampling is greatest, and that humus, soil carbon, nitrate, phosophorous and potassium generally increased with increasing distance from camps.

Tserendulam observed the phenology of two important feathergrass (*Stipa*) species in Hustai National Park over 10 years found that climate variables correlated with each phonological stage varied with species and topographic location. Only one species (*Stipa krylovii*) in one plot significantly shifted phenology over the observational period.

The question of whether Mongolia's rangelands are overgrazed has been the subject of public and scientific debate. While one recent broad-scale remote sensing study claims that observed declines in greenness (a proxy for vegetation production) are correlated with increases in livestock density (Hilker et al. 2014), a recent field study in three ecozones within Bayankhongor Aimag found that rangelands are resilient but potentially at risk (Khishigbayar et al. 2015) and another study of winter-grazed pastures across 4 ecological zones in 10 aimags found that these pastures showed little evidence of degradation (Chantsallkham 2015). Gao et al. conducted a novel country-wide analysis comparing stocking densities and forage availability to calculate percent forage use over time in all Mongolian *soums* from 2000-2014. Contrary to reports of widespread overgrazing, they found that heavy stocking was pervasive on about a third of Mongolia's rangelands with 11% experiencing consistent overgrazing (more than 70% use for 10 or more years out of the 15 year period assessed). A remote sensing study of Gobi Altai *Aimag* by Vova et al. advances methods for using remote sensing to detect land degradation, but found no net change in degradation over a 13 year period of observation. In another country-wise study, Kang et al. used remote sensing, climate and livestock data to assess the predictors of livestock mortality in *dzud*, finding that the causes are spatially variable across the county, but that temperature, precipitation and production play important roles.

Together, these studies provide important tools and results to inform the assessment and management of Mongolia's rangelands and the livestock populations that graze

them. Moving forward, it will be ever more critical for Mongolia to adopt a uniform system for classifying, assessing and monitoring rangeland conditions and to make use of both field-based monitoring to assess changes in species composition as well as remote sensing, meteorological and livestock census data to forecast forage availability in relation to livestock forage demand, and the probability of forage shortages or extreme weather events.

CLIMATE CHANGE AND HYDROLOGY

How climate change will unfold and its current and future impacts on Mongolia's rangelands and pastoral economy are themes of critical concern to scientists, policy-makers and herders. Venable et al. used gridded data to track changes in temperature and precipitation over the past 50 years across Mongolia, finding significant increases in minimum and maximum temperatures for all and most of the country, respectively, with significant declines in precipitation over 25-30% of the country. These results largely confirm past analyses based on station data with a few important differences. Hessl et al. used tree-ring methodology to track changes in drought over centuries, demonstrating that the early 21st century droughts are the most severe in 1100 years (Hessl et al.). Wolf and Venable examined tree-ring correlations with seasonal precipitation regimes. Kenner et al. determined minimum flows of the Orkhon River required to maintain ecological function. As Mongolia considers water storage projects (reservoirs) to address increasing climate variability, understanding flow regimes is essential to implementing adaptive management. Fassnacht et al. described the hydraulic conditions of the internally draining Tuin River, laying the groundwork for future hydrologic modelling of climate change scenarios.

INSTITUTIONAL INNOVATIONS

The dramatic socio-economic and political changes of the late 20th century in Mongolia, coupled with sequential severe winter disasters in 1999-2002 and 2009-2010 gave rise to a number of institutional experiments and innovations across Mongolia. Primary among these was the initiation of over 2000 formally-organized, donor facilitated community-based rangeland management groups. Several papers in this proceedings report on the social and ecological outcomes of these formally organized groups, which demonstrate significant social outcomes, dependent on key facilitating factors and donor approaches (Ulambayar et al), but only slight ecological benefits to date (Reid et al, Angerer et al). Livelihood outcomes have also been modest but Solongo and Batkhishig and Ulambayar et al. show that households belonging to formal CBRM groups have more diverse income streams and more non-livestock income sources than other households, which may reduce their vulnerability to climate and socio-economic shocks.

Thrift and Byambabaatar identify shortcomings in CBRM approaches to risk management, and advise that greater attention is needed to the role of herder-non-herder social networks that transcend local social groupings and link rural and urban households. Murphy shows how herder views about institutional change, especially property rights, may be conditioned by recent climatic and pasture conditions, alerting us to the potential for institutional transformation to be triggered by such events. Upton and colleagues assess the potential for novel payment for ecosystem services schemes that link ecological and cultural services.

Several papers on the history of land tenure in Inner Mongolia and the attitudes and preferences of Inner Mongolian pastoralists provide a useful comparative contrast to Mongolia's institutional context. Zhang and Amarjargal review the theoretical basis for managing the commons, and then compare and contrast the evolution of pastoral property rights in Inner Mongolia and Mongolia. Reporting on a survey of Inner Mongolian

herders, Xu et al. report that the majority currently graze within fenced pastures with a small minority continuing traditional nomadic movements. Most herders report satisfaction with their current management, and perceive that fencing combined with grazing prohibition, controlled stocking or rotational grazing are the most effective means of restoring pastures.

In sum, recent decades have brought promising institutional innovations to Mongolia, and the research reported here shows that formal community-based management organizations demonstrate significant social outcomes compared to informal herder neighborhoods. Other studies in this volume suggest that institutional innovations may not provide all the benefits expected and that approaches to major policy changes, such as pasture possession leases, should be cautious.

RURAL SOCIAL AND ECONOMIC DEVELOPMENT

In the wake of the transition to a market economy and the recent mining boom, the future of rural social and economic development and the pastoral economy remain in question. Papers in this volume explore multiple dimensions of rural development from the through reducing vulnerability and improving the economic and ecological sustainability of livestock production, and understanding the economic impacts of mining.

Altanbagna et al. present a case study applying an integrated vulnerability index that integrates different ecological sources of vulnerability for livestock production including the frequency and intensity of drought and *dzud*, vegetation production, hay and fodder storage, and surface water among others. Suvdantsetseg et al. report on a test of a new text message (SMS)-delivered early warning system for disasters (*dzud*), which would provide herders real-time information on weather and forage conditions and encourage them to prepare for severe weather events, enhancing their adaptive capacity.

Ge and Kinnucan assess the potential effects of Mongolia's mining boom on Mongolia's agricultural economy, diagnosing an incipient case of "Dutch Disease" whereby a commodity boom leads to currency appreciation, decline in the strength of other economic sectors, potentially increasing vulnerability to future economic shocks. Using employment survey data for the entire country, Amarjargal et al. examine whether mining is affecting migration patterns within Mongolia and conclude that is not. This suggests that mining is not producing sufficient local economic benefits to motivate herders to immigrate from other *soums* to mining *soums* in order to share in these economic opportunities. Yan et al. propose an agent-based model of meat distribution in Mongolia to help improve the quality of meat, its distribution and improve terms of trade and incentives for quality production over livestock quantity in rural Mongolia.

These papers address diverse challenges and opportunities facing rural Mongolia at the beginning of the 21st century. Though the challenges are great, and the impacts of the mining boom requires further study, these contributions suggest how technological innovations from SMS to refrigeration could improve herder livelihoods while helping to protect the resource base on which they depend.

METHODS OF KNOWLEDGE AND DATA INTEGRATION

The study of complex natural-human systems requires new tools to organize, integrate and analyze disparate types of data and the relationships that link biophysical and social systems. Further, research that aims to solve applied problems and empower non-scientists to participate meaningfully in the scientific process calls for novel approaches to knowledge integration and cross-sectoral participation in research. In this section of the volume, authors share a diverse set of approaches to organizing, integrating and analyzing diverse data and knowledge sources.

Laituri et al. report on the process of assembling and organizing a multi-scale holistic database of physical, ecological and social data from the Mongolian Rangelands and Resilience (MOR2) Project, identifying key challenges and lessons learned that can inform future efforts. Allington et al. demonstrate how dynamic modelling can be used as an integrative analytical approach to understand coupled system dynamics. Using data from Xilingol, Inner Mongolia they created a dynamic model that integrates human population, land use, grazing policies and climate and validated the baseline scenario against historic trends in the Xilingol area. Comparing the baseline with four potential future scenarios which varied with regard to human population, policies and rainfall, the model predicted increases in rangeland biomass under all scenarios, including a scenario of declining precipitation, except when the proportion of rural inhabitants remained constant instead of declining or current policies restricting grazing were removed.

Several contributions address ways to incorporate herder knowledge into research. Allegretti et al. advance participatory mapping and analysis of resulting maps and map narratives as a method to document both intangible and visible boundaries into our understanding of landscape and institutional dynamics, with potential implications for future pastoral land use policy. Fernandez-Gimenez et al. and Odgarav et al. both combine herder observations of climate and rangeland change with instrument-based meteorological and vegetation observations, illustrating the complementarity between these approaches and highlighting the potential need for more fine-resolution weather and rangeland monitoring.

CONCLUSIONS

While this volume does not encompass all of the excellent research underway to understand the dynamics of biophysical, social and economic change in rural Mongolia, it provides summaries of some of the most important recent advances in knowledge, with an emphasis on innovations in governance, marketing, communication and trans-disciplinary research. As such, the papers presented provide cause for concern regarding observed changes in climate and rangeland conditions and livestock populations, as well as reasons for hope and motivations for action to address the current challenges. We hope that this volume and the conference it accompanies, will inspire renewed commitment to support science and science-based policy-making and management to sustain Mongolia's unique natural and cultural heritage as they adapt to a changing planet.

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