

MODELING SYSTEM DYNAMICS IN RANGELANDS OF THE MONGOLIAN PLATEAU

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INTRODUCTION

The Mongolian Plateau contains a vast area of grassland straddling the border between northern China and Mongolia. Historically inhabited by pastoralists who migrated seasonally with livestock herds, these areas have undergone drastic changes over the past thirty years due to shifts in land tenure and livestock ownership, globalization, and urbanization.¹ Rapid ecological and socioeconomic changes have caused significant grassland degradation.²



Fig. 1 Four dominant land use/land cover categories in contemporary Inner Mongolia: (a) Grassland, primarily used for grazing livestock; (b) Cropland, typically converted from former grassland; (c) Degraded grassland, here undergoing restoration measures; (d) Urban development.

Policies are in place to protect the grasslands and limit cropland expansion, but it is unclear how future changes in climate the economy will affect grassland sustainability. In order to respond to future uncertainty, we need a better understanding of the inter-connectivity between human, natural, and livestock sectors of the Plateau system. In this study we use a system dynamics approach to explicitly link the social, environmental and land-use sectors to reveal underlying dynamics in this arid rangeland system.



Fig. 2 Map of the study area, Xilingol League.

SYSTEM DYNAMICS MODEL

QUESTIONS:

- How will the rapid urbanization of northern China affect grassland resilience?
- How sensitive is the grassland to changes in population, livestock and climate?

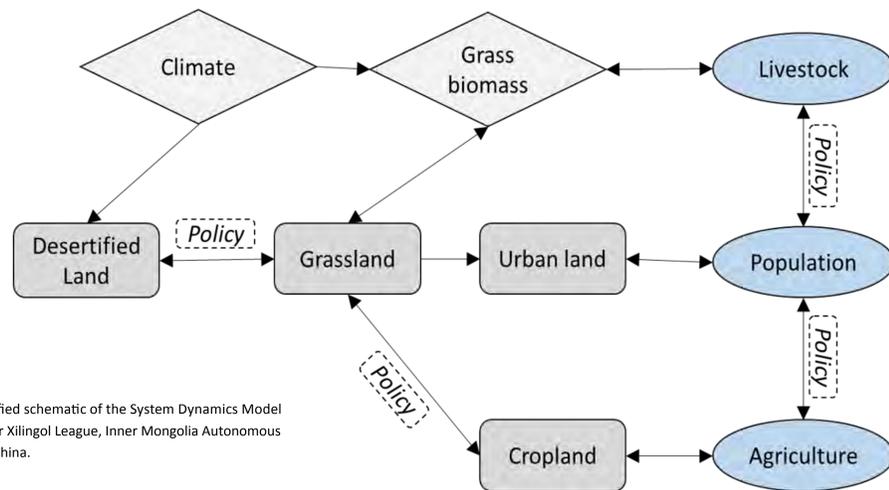


Fig. 3 Simplified schematic of the System Dynamics Model developed for Xilingol League, Inner Mongolia Autonomous Region, P.R. China.

We modeled the Xilingol system as an interacting set of three subsystems:

human system (population and livestock sectors); **natural system** (grassland biomass, climate); and **land-use system** (grassland, cropland, urban land, and degraded land). Many more variables and relationships are included in the model, but in the interest of space we provide only broad descriptions.

SCENARIOS

- *Baserun*: represents the continuation of current conditions.
- *Scenario 1*: assumes an increasing trend in Jan-July precipitation.
- △ *Scenario 2*: no Grassland protection policies.
- ▲ *Scenario 3*: no restrictions to Cropland expansion.
- ✕ *Scenario 4/ "Worst Case"*: no grassland protection policies, no limit to cropland expansion, declining trend in precipitation, and rural population growth.

MODEL OUTCOMES

The outcomes of the scenarios explored in this modelling exercise highlight the link between the urbanization of the population in Inner Mongolia and the reduction in pressure on the grassland system. Increasing urbanization in Xilingol is due to a combination of greater employment opportunities, changes in land tenure and resource rights and degraded grassland resources which have led to many abandoning grazing livelihoods. The model projected a steady decrease in livestock population over time, due to the anticipated continued decline in the number of rural herders, which alleviates degradation pressure on the grasslands even under fairly extreme decreasing trends in precipitation. However, that

Key factors promoting grassland sustainability:

1. declining rural population
2. policies promoting protection and restoration of grasslands
3. policies limiting cropland expansion

relationship is dependent upon the continuation of the current policies promoting protection and restoration of grasslands (via grazing prohibitions and active restorations). In the absence of such policies, grassland area declines

steadily (Fig. 4a; Scenario 4).

We modelled several different future climate scenarios. We present the results of a predicted increase of over 40% by 2050 in Scenario 2. The amount of biomass remaining at the end of the year, per unit grassland, is predicted to rise under all climate scenarios, even those with declining precipitation trends (not pictured). This is due to the effect of decreasing rural population on livestock numbers and grazing pressure, which is greater than any potential decline in biomass due to drying climate. The one scenario under which remaining biomass declined over time is under the assumption of no change in the proportion of rural population (Scenario 4). Under that scenario rural population increases over time, rather than declines, resulting in an increasing in grazing pressure.

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