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Sustainable management of grassland in a changing social-ecological system: a case study in China

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Introduction

Grasslands in China provides habitation and production materials for about 60 million herders(Li and Bennett, 2019). Up to 80% of total grassland is degraded and grassland production declined 30-70% between 1980 and 2000 (Briske et al., 2015). The degrading grasslands provided less biomass yield for livestock production and worse environment, which had made the grassland region one of the poorest rural areas of China in the first decade of this century. However, during last 10 years, a lot of changes happened in grassland region of China under the influences of both policies and market. In general, the degradation is decelerated while the livestock production and local household income increased; hence the outcome of the social-ecological system is cheerful. The analysis and review of the changes in last 10 years in the coupled human and natural system provide experiences and insights to the global reduction of poverty in ecosystem vulnerable zone.

A research was carried out to explore the different adaptive activities in the changing SES in China and explain how the interaction among variables within the social-ecological system leads to the system adaptation.

Data and study area

This research is done based on a panel household survey data from three counties in Xilingol League of Inner Mongolia, China, which are East Wuzhumuqin banner, Xilinhot and Sunite right Banner. The data were

collected in 2010, 2015 and 2019 respectively by face to face interview. In 2010, sixty households were selected using a stratified random method in each county and then the households were revisited in 2015 and 2019. In each survey, production data in the previous year were collected as most of the surveys were done in middle year. These counties were selected to represent counties with similar policy settings while different social-ecological conditions. Herders in East Wuzhumuqin banner own larger and best grasslands. The grasslands in Xilinhot per household are smaller than the other two counties but the quality is good, better than that of Sunite right banner. Sunite right banner, which is recognized as desert steppe, is the poorest in ecological dimension.

Variance analysis and multi variable regression were used to analyzing herders' activities. The difference among social-ecological systems and the interactions within the systems were analyzed under the framework of SES (McGinnis and Ostrom, 2014).

Results

In the last ten years, grassland policies, especially the grassland ecological subsidy and award policy made direct cash payment to local herder households to reduce the stocking rate on grasslands. However, these payments could not pay-off the loss if just reducing livestock to the legal stocking rate. Reacting to the policy, herders adjusted their production activities from whole year grazing to seasonal grazing and supplement forages in shed. From the panel data we can see, the supplement cost per sheep unit increased significantly from 2009 to 2018 in all three counties. Herders in poorer ecosystem (Sunit Right banner) used more supplements than those in better ecosystem (East Wuzhumuqin and Xilinhot). However herders in better ecosystem rented more grasslands than those in poorer ecosystem. Besides the two main activities adopted by herders in three counties, more herders in Sunit

Right banner took part in short period work such as delivering the take-out.

Farm gate market selling is still the main form of livestock trade, but the trading time is changing, although in a very slow speed. Herders in the studied area used to sell livestock (mainly sheep) at late autumn when the animals at peak of weight. With better shed condition and more feeds in spring, trading time has been advanced 10 days to one month in most area and almost three months in some part of Sunit Right banner due to a shift of lambing time. As a supplement of local market, E-shops emerged quickly in recent years which had enlarged the system by connecting the local production with a larger market.

The interplay of policies and markets played important role in herder livelihoods and sustainable management of grasslands in different social-ecological systems. In ecologically poor system, like Sunite Right banner, the policy payments have enabled herders purchase more supplements and build better warm shed to produce winter lambs, which is more profitable than spring lambs. However, in East Wuzhumuqin, where herders produce hay on contracted grasslands, the lambing time didn't change much during last ten years.

Discussion and conclusion

The structure of the social-ecological system is transforming due to changing connections at all scales(Janssen and Ostrom, 2006). Herders are connected at a larger scale than they used to owing to the fast development of information techniques and transport services. In this case study, purchased forages and livestock market have become two primary drivers of herders' household production and thus drive the SES succession in a larger scale.

In this study, the SES in better ecological region (East Wuzhumuqin banner) was more stable than that in poor (Sunit Right banner). But the

changes in poor ecological systems look effective concerning the results in the coupled human and natural systems.

The interaction between actors and resource units are different in different ecosystem, even with the same governance system and same policy, which further lead to different changes in the SES. Based on this, grassland policies are better to be implemented according to local conditions rather than one size fits all.

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