

Multiple scale impacts of nomad settlement on social-ecological systems

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Introduction

There are complex interactions and feedback mechanisms between human and natural systems within the coupled social-ecological systems (SEs) (Liu *et al.* 2007, Li and Li 2012). Human society is the major driving force that changes ecosystem dynamics from local environments to the biosphere (Liu *et al.* 2007, Kirch 2005). Grasslands, especially the vulnerable arid and semi-arid grassland ecosystems upon which pastoralists live and graze livestock, can be considered as SEs; pastoral activities influence the biophysical environment and set up interactions between the components of these systems (Robinson 2009). In recent years, the ecosystem services provided by grasslands and the problem of poverty in grassland communities have attracted increasing attention from governments and society in China. One response has been the Nomad Settlement Projects (NSPs), implemented as a development strategy in pastoral areas to find solutions to the prevailing ecological and social problems. Nomadic people were provided with houses and farmland in some place, and encouraged to settle down and modernize the "backward" pastoralism.

In this paper, we explored the impacts of China's Nomad Sedentarization Project (NSP) for pastoral areas on coupled social and ecological systems by evaluating the consequences of these projects at different scales (village scale, county scale and catchment scale) undertaken in grassland SEs, including the ecological and social consequences. China's government is now promoting the NSP in large areas of grassland as a solution for ecological restoration and poverty alleviation. To determine the effects of this policy, we conducted in-depth interviews at two of the project's sites and examined the social and ecological systems at village, county, and catchment scales.

Method

Our field work was done in the Ebinur Lake Catchment whose area is 5.06×10^5 ha is located on the north side of Tianshan in Xingjiang Autonomous Region (capital Urumqi). Two pastoral villages A and B were selected as study sites for comparative research of ecological and social consequences of NSP. Field surveys and observations were undertaken in the study area during the summer of 2011. The survey population included 23 pastoral households in village A and 16 pastoral households in village B, accounting for 30.3% and 42.1% of the total number of pastoral households in each village. In both villages, the pastoral households managed livestock herds

comprising a range of sizes. By conducting structured interviews, we obtained basic information about: (1) the basic characteristics of each family, such as the family size, number of livestock, income structure, area of grassland, and cultivation of forage crops; (2) the mode of production, such as transhumance before settlement versus animal husbandry and forage crop and cash crop cultivation after settlement; and (3) resource utilization, such as changes in the use of natural grassland, forage fields, and water resources before and after settlement. We also conducted open-ended interviews to learn about the settlement process the pastoralists have experienced and their feelings about changes in the local ecology and in their livelihood.

Results

Village A and B were encouraged to change from relying on natural pasture to a partial dependence on artificial forage land.

At the Village A scale, during the process of settlement, household sources of income increased, livestock herds were scaled up, and for individuals the labour intensity was reduced. Overall, the herdsmen and local government have developed very positive attitudes to settlement, Village A has also become a model of the region, its success being advocated as a model for the development of sedentary systems of herd management.

At the county scale, village A and village B are no longer as isolated and closed as before; they have developed contacts with larger-scale SEs. Comparing village A with village B, we found that the degree of development of the village has a direct link with how much resources are imported from larger-scale systems. Village B is the poorer system, with less available water and farmland. This disparity warned us to seriously reconsider of the apparent effectiveness of the apparent exemplary role of A, which is following the pathway of larger scale SEs.

At the catchment scale, the settlement process makes the village-scale SEs shift from a dependency on natural ecosystems to artificial agro-ecosystems. The sustainability of settlement depends on the sustainability of the redeveloped agro-ecosystems. In the long term, we predict that increasing alkalinity which caused by over-exploitation of groundwater, and a decreasing water supply may quickly threaten and diminish the returns from growing forage.

Conclusions

Environmental policy usually aims to solve the problem on a certain scale SE, and evaluate whether the policy is

favourable or adverse. We found that: (1) the NSP in one village greatly improved the household standard of living and changed their resource utilization modes; (2) the success in this village can be attributed to resources imported from the social and ecological systems at larger scales, and could not be repeated in a second nearby village with different constraints; and (3) the NSP is poorly adapted to local ecosystem characteristics, and may therefore have negative impacts at larger scales. Solving one problem at one scale may cause other problems, often potentially more serious ones at another scale. To avoid these problems, holistic assessments are necessary to judge the NSP's impacts on social and ecological systems at multiple scales. In addition, the program must be implemented cautiously to account for the potential risks in ecologically vulnerable areas.

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