

Degradation of grassland ecosystems in the developing world: The tragedy of breaking coupled human-natural systems

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Introduction

Since Hardin (1968) published his famous theory "Tragedy of the Commons" supported by examples showing that communal grasslands can be easily overgrazed when herdsman increase their herd numbers, a lot of research has supported the viewpoint that rangeland degradation and desertification in much of the pastoral areas in the developing world are caused by overgrazing (Arnalds and Archer 2000). With increasing focus on change at the global scale, many scientists, guided by the disequilibrium theory, hypothesized that climatic variability and change rather than overgrazing is associated with rangeland degradation. We argue that neither overgrazing nor climate change can alone explain the degradation of rangelands worldwide. In contrast, failure to reconcile emergent issues at the interface between the ecological, economic and social aspects has repeatedly resulted in management and policy actions that do not achieve the objectives of optimizing yield of rangeland products in a sustainable manner. The coupled human and natural systems (CHANS) approach proposed by Liu *et al.* (2007) can be used to identify applicable approaches for helping pastoral societies worldwide cope with global change by facilitating effective collaboration among social scientists, bio/physical scientists, practitioners, managers, and users to protect and sustain pastoral environments (Dong *et al.* 2011).

Methodology

In this study, we analyzed three case studies from major pastoral regions in African Sahel, Central Asia and the Qinghai-Tibetan Plateau of China to demonstrate; (1) how important the concepts of the CHANS are in clarifying the questions of driving forces for rangeland degradation; and (2) how the approaches of CHANS work for promoting the sustainability of rangeland ecosystems in the developing world through collecting and reviewing the literature, reports and information generated via different media.

Results

Case I: Increasing desertification of rangelands associated with inappropriate development strategies in African Sahel

Pastoralism is widely perceived as "backwards" or an echo

of a primitive past. This view is reinforced by both colonial and post-colonial governments who have focused on modern, technocratic solutions to development driven by the objective of delivering economic growth. As a direct consequence, traditional approaches to resource management and food security in pastoral societies have been increasingly marginalized, resulting in rangeland degradations at continental scale. The northward expansion of agriculture into historically marginal areas of Sahel pushed the pastoralists into more marginal areas and pastoral communities became more vulnerable to drought (Thébaud and Batterby 2001) In turn, overgrazing has led to further devastation of land resources in many areas (Kandji *et al.* 2006) thereby increasing the vulnerability of pastoralists to global changes with respect to the functioning of livelihoods, agroecosystems, and institutions (Dong *et al.* 2011)

Case II: Increasing degradation of rangelands associated with collapse of command economy in Central Asia and Mongolia

In Central Asia, the former communist government in the Soviet Union forced the conversion of some of the most productive grassland into cropland and the conversion of communal rangeland management into collectivization programs after World War II. These policies have not only reduced the amount of rangeland available for livestock production, but also increased grazing intensity, often on less fertile grazing lands, leading to rangeland degradation and loss of soil fertility and carbon (Chuluun and Ojima 2002). After the breakup of the Soviet Union in the early 1990s, a wave of land privatization reforms has shifted land rights from pastoral cooperatives to wealthy individuals and groups and rendered many forms of traditional herd mobility illegal on the more productive grasslands. Like the Sahel, this has concentrated the poorest pastoralists on the less productive grassland which resulted in an inability to live in balance with nature and causing increased degradation of the rangelands in this region (Fernandez-Gimenez and Batbuyan 2004).

Case III: Increasing degradation of rangelands associated with land individualization in Central Qinghai-Tibetan Plateau of China

Conversion of productive grasslands on China's Qinghai-

Tibetan Plateau into croplands associated with grain production-oriented policies in the 1950s has not only reduced the amount of rangeland available for livestock production, but also increased grazing intensity, often on less fertile grazing lands, leading to rangeland degradation (Wang *et al.* 2006). With the transition from a planned to market economy in the early 1980s, fencing associated with privatization of rangeland has been regarded as a precondition for the protection of natural resources and biodiversity to replace the common grazing and collective ownership system blamed as the primary cause of rangeland degradation (Yan *et al.* 2005). However, along with the climatic changes and human population growth, dynamic governmental policies related to rangeland management have modified land use characteristics, also resulting in increased rangeland degradation and livelihood vulnerability.

Discussion

Although these cases are different in socioeconomic, political, demographic, and cultural settings, they have many commonalities that addressed the complex interactions and feedback between natural and human systems. These cases also offer evidence that climatic economic and social-political pressures on pastoralism have broken the coupling between human and natural systems (Liu *et al.* 2007), resulting in changes in subsistence patterns of pastoralist groups, marginalization of traditional territories, decreased adaptation capacity of pastoral ecosystem, and thus leading to accelerated rangeland degradation in the developing world.

A growing number of CHANS examples are beginning to provide important insights into diverse complex systems that cannot be well understood or effectively managed within a single dimension, illustrating that environmentally related issues in a changing world cannot be addressed solely through technical innovations, political reformations, or economic development (Yang and Dong 2010). Hence, complex interdisciplinary approaches, as illustrated by the CHANS framework, are needed to address the environmental and socioeconomic problems.

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