Enhancing the resilience of coupled human and natural systems of alpine rangelands on the Qinghai-Tibetan Plateau

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Abstract. This special issue covers a wide range of topics on the protection and sustainable management of alpine rangelands on the Qinghai-Tibetan Plateau (QTP), including Indigenous knowledge of sustainable rangeland management, science-policy interface for alpine rangeland biodiversity conservation, adaptations of local people to social and environmental changes and policy design for managing coupled human-natural systems of alpine rangelands.

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Background

The Qinghai-Tibetan Plateau (QTP), known as the ‘Roof of the World’ and ‘Water Tower in Asia’, is one of most important eco-regions in the world (Fig. 1). Rangelands/grasslands cover ~60% of this vast land mass and provide critical ecosystem services to humans at local, regional and global scales (Table 1). However, these high-elevation rangeland ecosystems are under threat from recent environmental and land-use changes, and nearly half of the alpine rangelands of the QTP have been degraded over the past 40 years with degradation rates increasing at a greater rate in recent decades (Dong et al. 2011). As a consequence, many of the ecosystem services provided by these rangelands, such as water supply and flow regulation, carbon storage and sequestration, biodiversity and livestock production along with Tibetan socio-cultural grazing traditions, also are being degraded (Li and Huang 1995; Ma et al. 1999; Wang and Cheng 2001; Ma et al. 2002; Shang and Long 2005; Dong et al. 2010a). The adverse effects of rangeland degradation have far-reaching socio-economic impacts that range from local pastoralists to downstream populations along the Tarim, Yangtze, Yellow, Lancang-Mekong, Nu-Salween, Dulong- Irrawaddy, Yangt Fangtse-Brahmaputra, Ganges and Indus rivers (Fig. 1). The livelihoods of the more than 12 m pastoralists and agro-pastoralists who live on the QTP will be directly impacted by rangeland degradation, but the health and well being of hundreds of millions more who live in agricultural and urban areas downstream also will be affected indirectly through dust-storms, floods and droughts (Harris 2010). Given the magnitude of the situation, Chinese scientists and authorities are challenged to develop innovative technical interventions and management strategies to halt the degradation and promote the resilience and sustainable use of the rangeland ecosystems of the QTP.

The relatively new science of coupled human-natural systems offers a promising framework to tackle the complex problems of rangeland degradation on the QTP by recognising the integrated and coupled nature of human and ecological systems (Lassoie and Sherman 2010; Dong et al. 2010b, 2011). In this sense, we organised a symposium, ‘Building the coupled human-nature systems for restoring degraded rangelands in the developing world’, at the 5th World Conference on Ecological Restoration held in Madison, Wisconsin, USA, 6–11 October 2013. The symposium brought together social, biological and physical scientists from China, USA, Africa and Europe to address the issue of promoting the resilience of coupled human and natural systems of rangelands worldwide in the era of global change, particularly on the QTP. The cause and effects of land degradation, biodiversity loss, climate change and socio-economic transformations of pastoral systems, and possible solutions to these environmental and social problems, were discussed in depth. We selected symposium papers that best highlighted the coupled human and natural systems approach for addressing issues of rangeland degradation of the QTP to publish as a special edition issue in The Rangeland Journal.

The selected papers cover a wide range of topics on the protection and sustainable management of alpine rangelands on the QTP, including indigenous knowledge of sustainable rangeland management, science-policy interface for alpine rangeland biodiversity conservation, adaptations of local people to social and environmental changes and policy design for managing coupled human-natural systems of alpine rangelands. We addressed the following questions: (1) what are the environmental and socio-economic drivers of rangeland degradation (Su et al. 2015; Wang et al. 2015a; Wu et al. 2015a); (2) how do social and natural pastoral systems respond to environmental changes (Zhang et al. 2015a; Zhao et al. 2015; Liu et al. 2015; Wu et al. 2015b); (3) what adaptive strategies are being used by local people to cope with global changes (Shi et al. 2015; Wu et al. 2015b); (4) how can scientific knowledge be
translated into practical applications of sustainable rangeland management (Wang et al. 2015b; Tang et al. 2015; Li et al. 2015); and (5) how can effective government policies of rangeland management be formulated within a framework of coupled social and natural systems (Zhang et al. 2015a, 2015b; Wu et al. 2015b; Su et al. 2015)? The papers presented in this special edition address these questions by examining diverse topics about alpine rangelands of the QTP across multiple spatial scales (site, watershed and region) and multiple disciplines (social, ecological, economic, cultural and political) within the context of coupled human-natural systems (Fig. 1).

Enhancing the resilience of human-natural systems of the QTP will demand an integrated effort by scientists, development organizations and government agencies alike who recognise that human and ecological systems are interlinked, and that drivers of change include biophysical, economic, political, social and cultural elements that operate at different temporal and spatial scales. The papers presented highlight some of the complexities of these interactions, and anyone seeking sustainable solutions for resolving the complex issue of rangeland degradation on the QTP or elsewhere should find this Special Issue interesting and relevant.

Acknowledgements

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Table 1. Ecosystem services of well managed rangelands (modified from Dutilly-Diane et al. 2007)

<table>
<thead>
<tr>
<th>Level</th>
<th>Ecosystem services</th>
<th>Benefits</th>
<th>Beneficiaries</th>
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<tbody>
<tr>
<td>Local</td>
<td>Improved hydrologic function</td>
<td>Higher pastoral productivity</td>
<td>Local pastoralists and agro-pastoralists</td>
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<tr>
<td></td>
<td>Improved soil health</td>
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<td></td>
<td>Higher plant biomass</td>
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<tr>
<td>Regional</td>
<td>Underground water recharge</td>
<td>Increased water availability</td>
<td>Water users, hydropower industries</td>
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<tr>
<td></td>
<td>Flood reduction</td>
<td></td>
<td>State (public infrastructure), downstream populations</td>
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<tr>
<td></td>
<td>Dust-storms reduction</td>
<td></td>
<td>Urban populations, governments</td>
</tr>
<tr>
<td>Global</td>
<td>Carbon sequestration</td>
<td>Mitigation of global climate change</td>
<td>Global population</td>
</tr>
<tr>
<td></td>
<td>Plant and animal biodiversity</td>
<td></td>
<td>Conservation groups, tourism industry</td>
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