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Frozen soil change and adaptation of animal husbandry: a case of the source regions of Yangtze and Yellow Rivers

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ABSTRACT

This paper discusses the spatial and temporal change of different frozen soil types from 1980s to 2000s, and the impacts of frozen soil change on rangeland productivity and sustainable livelihood in the source regions of Yangtze and Yellow Rivers employed numerical model and GIS technology. Authors use the analytical framework of adaptation of animal husbandry according to national, regional, community and household scales, and release three key instruments of cryospheric change adaptation, including adaptive capacity of the policies, adaptive capacity of the people, and adaptive capacity of the grassland ecosystem. Analysis result shows that there is clearly a need, to develop institutional processes that support policy analysis to draw on existing information, that facilitate multidisciplinary research on topics of policy relevance, and that link the accumulation of credible cryosphere scientific evidence with policy making. Finally, Authors suggest that further support to mainstream climatic and cryospheric change concerns in adaptation policies and strategies of animal husbandry must include a focus on: (1) Formulating ecological compensation policy and mechanism for grassland ecosystem maintenance; (2) Strengthening vocational training, long-term essential-qualities-oriented education to improve indigenous people's professional skills and abilities; (3) Strengthening development of livestock replacement industries to broaden employment channels of indigenous people; (4) Strengthening the consciousness of ecosystem maintenance, improvement the social civilization level for indigenous people; (5) Continuous implementation the Ecological Protection and Restoration Program in the Three-River Source Region in national scale.

1. Introduction

1.1. *Frozen soil change and research gap*

Frozen soil plays a critical role in global thermal, water and carbon budgets. Under a changing climate, permafrost dynamics and ecosystems are undergoing rapid and remarkable changes (IPCC, 2007; Jin et al., 2009). This is manifested in rising ground temperatures and declining areal extents and thickness of permafrost (Harris et al., 2003; Jin et al., 2007a,b; Marchenko et al., 2007). They directly and indirectly impact ecosystems and human infrastructure (Jin et al., 2000; Jorgenson et al., 2001; Harris et al., 2001; Heginbottom, 2002; Romanovsky and Osterkamp, 2001; ARCPTF, 2003). It is increasingly evident that alterations in the extent and depth of permafrost may be related to changes in rangeland

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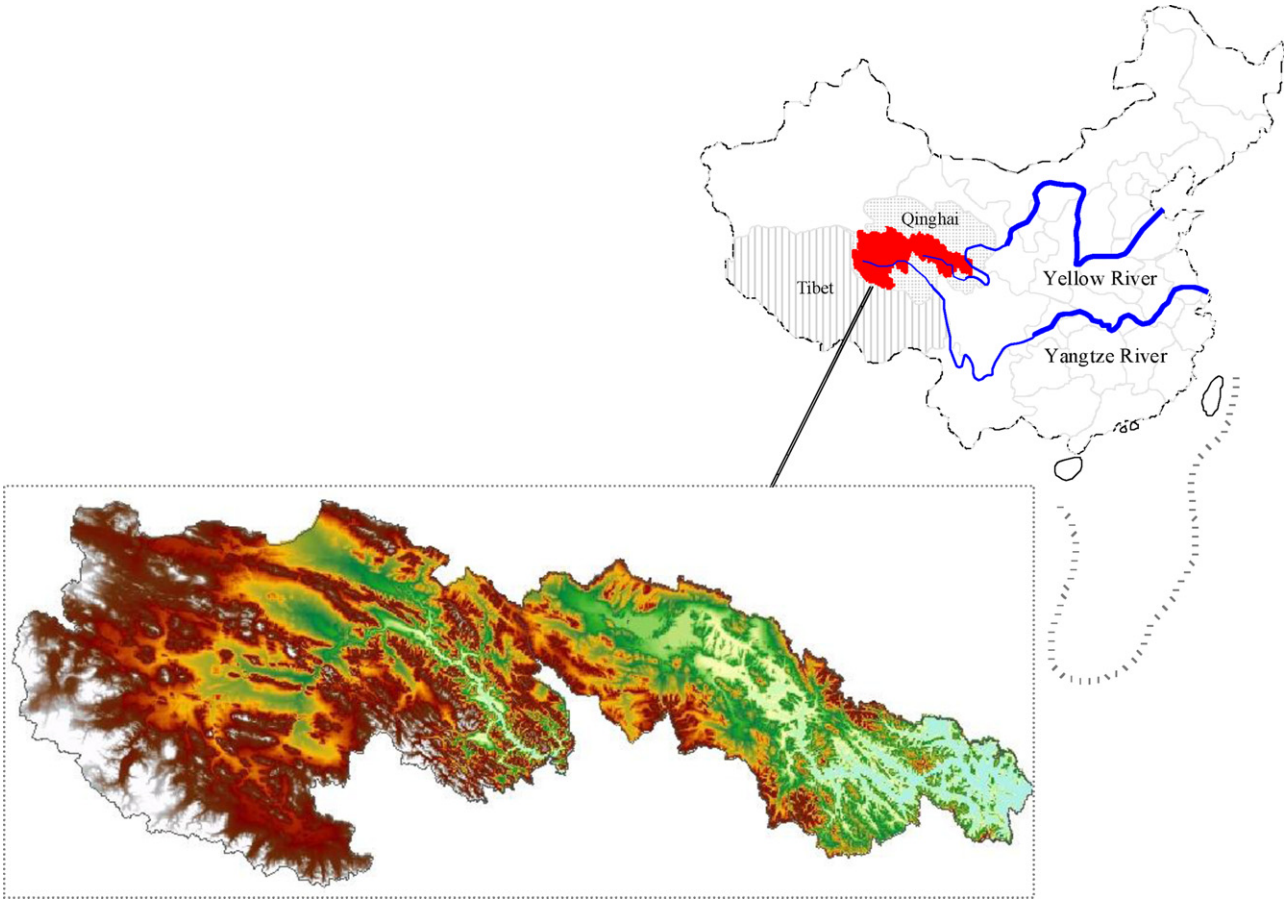

Fig. 1 – The location of the source regions of Yangtze and Yellow Rivers.

productivity (Harris, 2009). Despite clear evidence that rangeland productivity is temporally dynamic, there have been few attempts to generate a mathematical model that might help interpret or predict these trends. And rangeland ecosystem degradation is truly a global concern, affecting not only pastoralists who rely on healthy rangelands for their survival but also others who suffer from resultant hydrological disturbances, dust storms, commodity scarcity, and social consequences of uprooted people (Harris, 2009). Indeed, in the source regions of Yangtze and Yellow Rivers (Fig. 1), about 98% of the area is grassland. The dominant land use is grazing. The grasslands are the basis for pastoral and agropastoral livelihoods of local people. Grassland-dependent livestock rising is the primary source of cash and non-cash income for the majority of local inhabitants (Table 1). Therefore, understanding the impact of climate change especially cryospheric change on livestock productivity is crucial to mitigate the adverse impact on the gains from government policies for animal husbandry sustainable development. In recent years, although there are a number of studies on the impact of climate change on animal husbandry (Seo and Mendelsohn, 2006a,b,c, 2008; Seo, 2008; Fang et al., 2010), there is limited literature on the impact of cryospheric change (especially frozen soil including permafrost change) on animal husbandry and adaptation. This paper addresses this research gap.

1.2. *Analytical framework of animal husbandry adaptation*

As China moves towards the identification of climate change mitigation and adaptation strategies, grassland management policies and practices must contend with competing objectives. National grassland policy as a whole has also been shifting towards conservation focus rather that a focus on the sustainable socio-economic development of pastoral regions themselves. Thus, climatic and cryospheric change impacts on the source region's grasslands is a clear domain.

From a social science perspective, it becomes critical to study the conditions under which institutions can stimulate the adaptive capacity of society to deal with the potentially serious and irreversible impacts of environmental change (Gupta et al., 2010). Adaptation is widely recognized as necessary means to cope with climatic and cryospheric change impacts. The term adaptive capacity is used to capture the ability of any geographical or organizational entity (e.g., county, region, community or individual) to cope with, adjust to, or recover from external stresses. Yohe and Tol (2002) define the determinants of adaptive capacity as the range of available technological options for adaptation, availability of resources and their distribution across the population, structure of critical institutions and decision-making, human capital, including education and personal security, social