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### The role of permafrost in ecological resilience of alpine grassland and spatial heterogeneity in the source regions of Yangtze and Yellow Rivers

Under the context of human activities and climate warming, the change in permafrost has affected the alpine grassland ecosystem. To describe the ecological resilience of alpine grassland in a more objective manner, the factor of frozen soil has to be considered. In this paper, using the structural dynamics method, we established the structural dynamics model of ecological resilience for alpine grassland from the aspects of grassland quality, grassland intervention, grassland potential and grassland pressure dimension, analyzed the variation in the grassland ecological resilience of permafrost regions and its sensitivity to the change of permafrost, and also quantified the contribution rate of permafrost active layer change to the ecological resilience of alpine grassland. The results indicated that (1) the ecological resilience of grassland in permafrost regions showed an increasing trend, especially after 1997, which is the integrated results of precipitation, air temperature in grassland growing season (April to September), NPP and ecological protection projects; (2) the sensitivity of ecological resilience of grassland to the variation in permafrost active layer was complicated, experiencing the course of sensitivity, high sensitivity and low sensitivity. Geographically, the sensitivity of northern and western regions was overall higher than that of southern and eastern regions. The shape of the high sensitive zone gradually changed from island to band shape and from island to plane shape; (3) grassland ecological resilience was reduced as the increase in the thickness of permafrost active layer. The contribution rate of permafrost to the grassland ecological resilience was -4.3%, that is, a 0.04 unit reduction in the resilience is caused by every 1 unit increase in the thickness of permafrost active layer.

#### Recent Publications

1. Fang Y P, Zhao C, Ding Y J, Qin D H and Huang J L (2016) Impacts of snow disaster on meat production and adaptation: an empirical analysis in the yellow river source region. *Sustainability Science* 11:246-260.
2. Fang Y P, Liu Y W and Yan X (2015) Meat production' sensitivity and adaptation to precipitation concentration index during the growing season of grassland: Insights from rural households. *Agricultural and Forest Meteorology* 201:51-60.
3. Fang Y P (2013) The effects of natural capital protection on pastoralist's livelihood and management implication in the source region of the Yellow River, China. *Journal of Mountain Science* 10:885-987.
4. Fang Y P (2013) Managing the three rivers headwater region, China: from ecological engineering to social engineering. *AMBIO* 42:566-576.
5. Fang Y P and Wei Y Q (2013) Climate change adaptation on the Qinghai-Tibetan Plateau: The importance of solar energy utilization for rural household. *Renewable and Sustainable Energy Reviews* 18:508-518.

#### Biography

Fang Yiping is currently a full Professor and Supervisor of PhD candidates at Institute of Mountain Hazards & Environment, CAS, and University of Chinese Academy of Sciences. He is recognized within the field of human geography and the field of ecological economics for both his critiques of and contributions to balancing mountain ecosystem protection and development even while he spends most of his time working across disciplinary ways of understanding. His research interests mainly cover climate change adaptation and sustainability for mountainous areas. He is an active scholar who has published 146 research papers in peer-reviewed journals and 19 books. He serves as Vice Director of Academic Committee for Institute of Mountain Hazards & Environment, CAS; as Vice Director, Professional Committee of Economic Geography, Chinese Association for Geography; as Director, Professional Committee for Cryospheric Change and Sustainable Development, CIG and IACS.

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