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Author

Li, T, Cui, L, Xu, Z, Cui, X, Wang, Y

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Evaluating livelihood resilience in the Qinghai-Tibet Plateau's pastoral communities: Insights from an entropy-TOPSIS and geospatial analysis approach

Tong Li [a,b,*], Lizhen Cui [c,**], Zhihong Xu [b], Xiaoyong Cui [c,d,*], Yanfen Wang [a,d,*]

[a] College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China
[b] Centre for Planetary Health and Food Security, School of Environment and Science, Griffith University, Nathan, Brisbane, QLD 4111, Australia
[c] College of Life Sciences, University of Chinese Academy of Sciences, Beijing 100049, China
[d] Beijing Yanshan Earth Critical Zone National Research Station, Beijing 100409, China

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ABSTRACT

To address the gap in evaluating herders' livelihood resilience with a comprehensive methodology, this research harnessed survey data from 758 pastoralists within the Three River Headwater Region (TRHR) on the Qinghai-Tibet Plateau (QTP). Augmented by focus group discussions and transect walks, we pioneered a livelihood resilience evaluation index that integrates key dimensions of buffer capacity, self-organization, and learning capacity, offering a holistic view of resilience factors. At the heart of our analytical approach is the entropy-TOPSIS method, utilized to dissect the livelihood resilience and sustainability of local herders, revealing intricate spatial resilience patterns through spatial autocorrelation analysis. This nuanced application allows for a detailed mapping of resilience across the TRHR, highlighting variances and spatial trends. Our findings illustrate a spectrum of resilience levels, with the Yellow River headwater area displaying a relative resilience zenith, indicated by a score of 0.931 in Zeku County, and a contrasting low in Yushu County with a resilience score of 0.532. This delineates a clear "high in the east and low in the west" resilience gradient across the counties, underpinned by significant differences in self-organization, buffer, and learning capacities among the pastoral communities. Employing a methodological framework that blends empirical data with advanced analytical tools like entropy-TOPSIS and spatial autocorrelation, this study not only unveils the layered resilience landscape within the TRHR but also contributes a methodological blueprint for future resilience assessments in similar pastoral ecosystems.

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* Corresponding authors at: College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China.
** Corresponding author at: College of Life Sciences, Universtiy of Chinese Academy of Sciences, Beijing 100049, China.
E-mail addresses: tong.li1@uq.edu.au (T. Li), cuilizhen18@mails.ucas.ac.cn (L. Cui), zhihong.xu@griffith.edu.au (Z. Xu), cuixy@ucas.ac.cn (X. Cui), yfwang@ucas.ac.cn (Y. Wang).

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Figures and tables

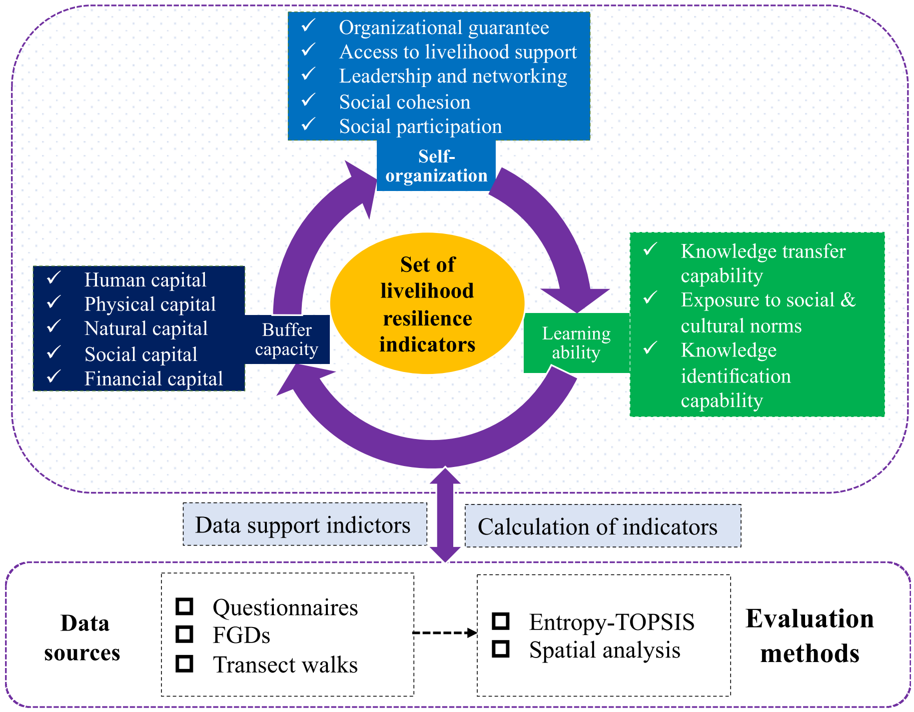

Fig. 1. Theoretical framework of study on livelihood resilience.

Fig. 2. Composite scores of livelihood resilience and its essential components in 17 counties of the Three River Headwaters Region.

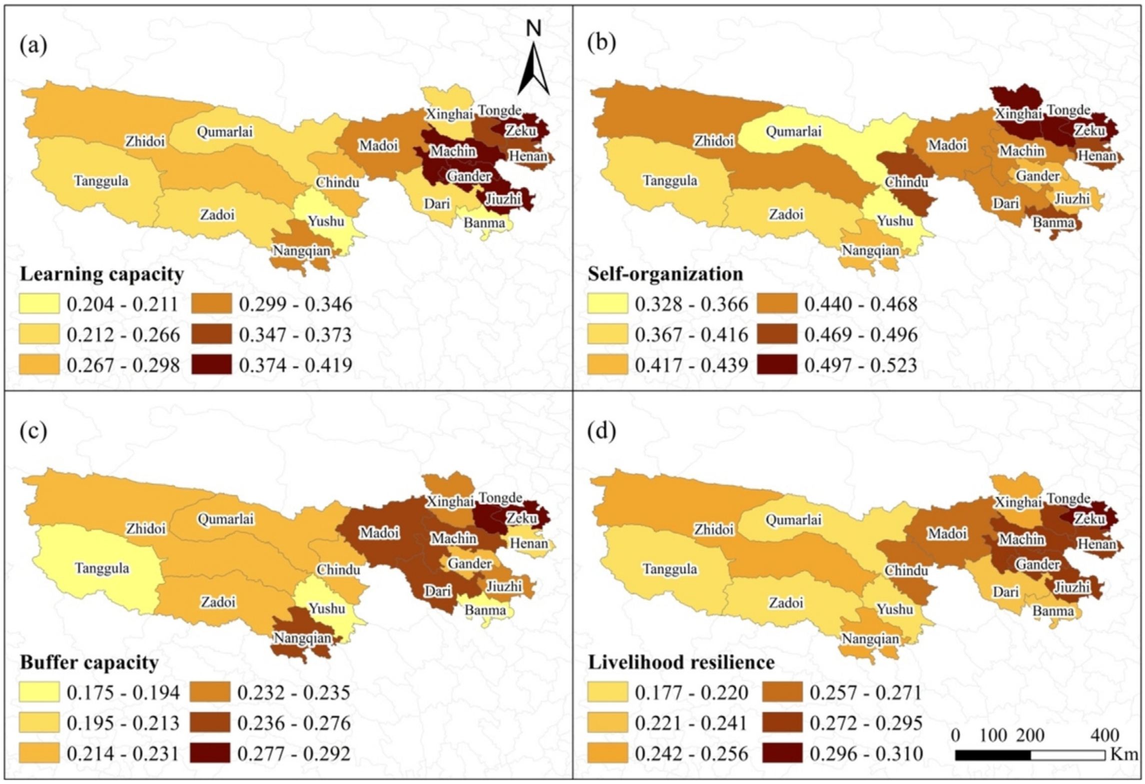

Fig. 3. Spatial distribution of livelihood resilience (a) and its essential components (b–d) in 17 counties of the Three River Headwaters Region.

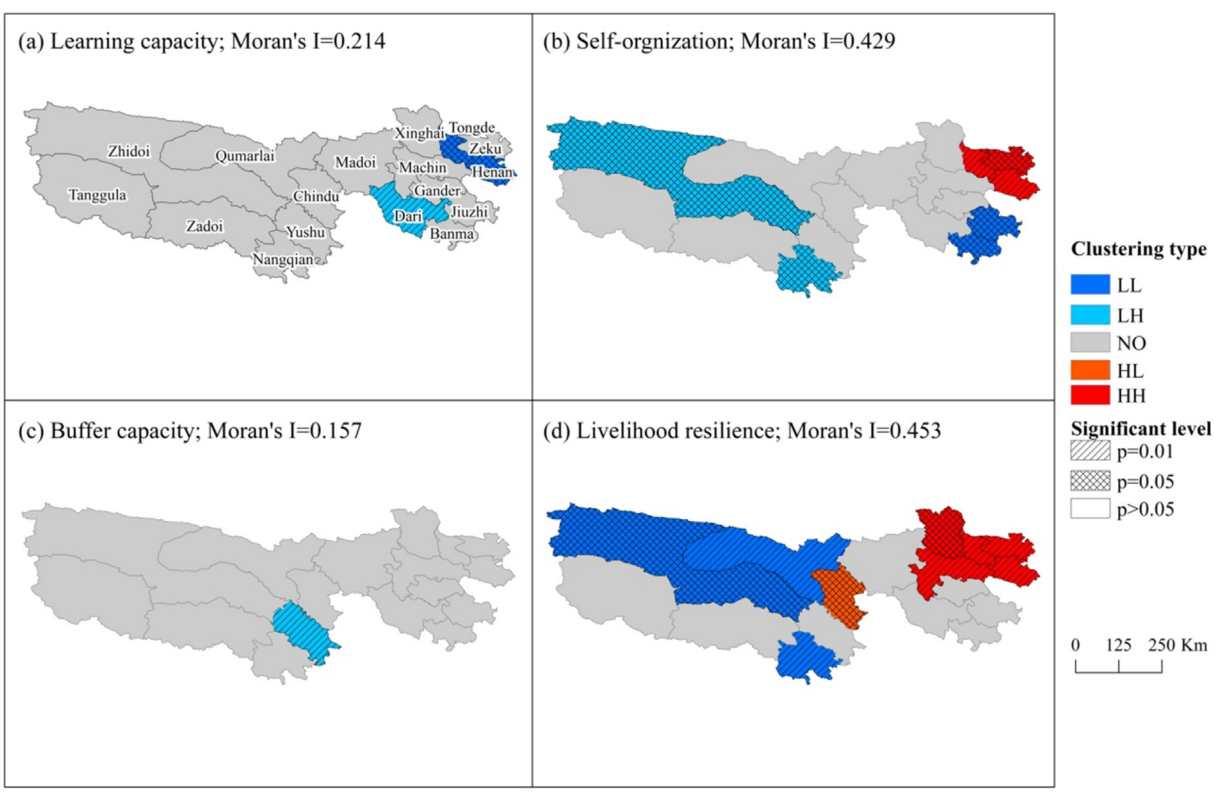

Fig. 4. Spatial hot and cold spot distributions of livelihood resilience (d) and its essential components (a–c) in 17 counties of the Three River Headwaters Region (hotspots, HH: high–high; cold spots, HL: high–low, LL: low–low, LH: low–high).

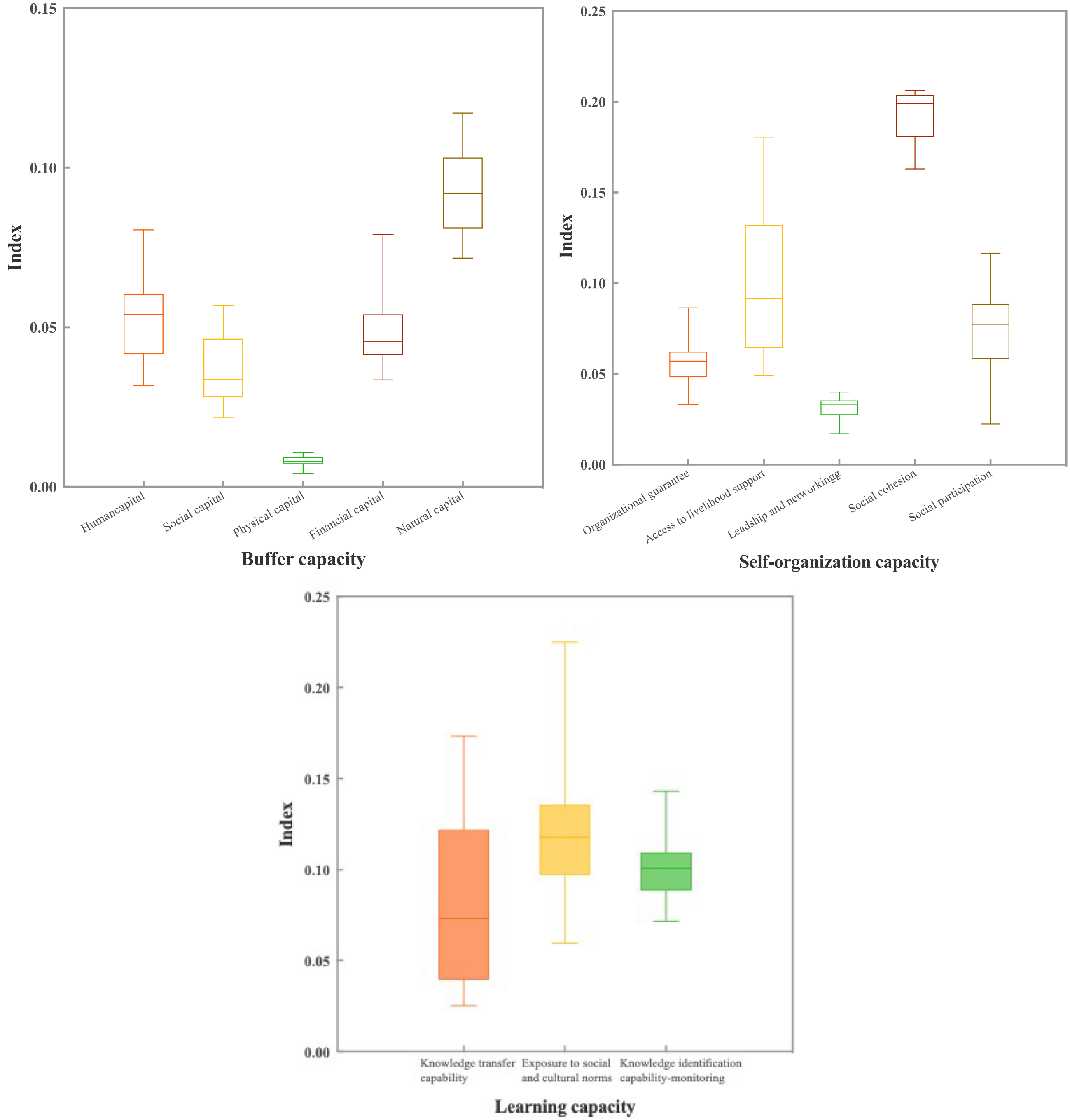

Fig. 5. Box plot of each dimensional index of pastoralist livelihood resilience.

Table 1
An assessment framework for analyzing the buffer capacity dimension of livelihood resilience.

Sub-Components	Quantitative Indicator	Weight	Measurement	Reference
Human capital	Literacy level (I_1)	0.1295	Years of education – the higher the education, the more literate	[1,2]
	Health condition (I_2)	0.0106	General health of the family (scale of poor to good)	[1,2]
	Availability of medical assistance (I_3)	0.0750	Yes = 1; No = 0	[1,2]
Social capital	WeChat accessibility (I_4)	0.0097	Yes = 1; No = 0	[3]
	Traffic accessibility (I_5)	0.0403	Distance of residence from the road (km)	[4]
	Types of roads in the village (I_6)	0.0599	Number (composite score)	[5]
Financial capital	Individual business (I_7)	0.0082	Yes = 1; No = 0	[6]
	Household loans (I_8)	0.0090	Yes = 1; No = 0	[7]
	Income from cordyceps (I_9)	0.0248	Number	[5,8]
Physical capital	Housing category (I_{10})	0.0767	Number (composite score)	[9]
	Type of household electrical appliances (I_{11})	0.2496	Number (composite score)	[1]
Natural capital	Livestock breeding scale (I_{12})	0.2717	Number of livestock	[3]
	Size of grassland (I_{13})	0.0108	Acres of grassland	[3]
	Livestock structure (I_{14})	0.0243	Number (composite score)	[10]

Note: These indicators were chosen after consultation with residents of the community during the pre-visit and were mainly derived from expert opinions and indicators from the literature.

Table 2
An assessment framework for analyzing the self-organization dimension of livelihood resilience.

Dimension	Quantitative Indicator	Weight	Measurement	References
Organizational guarantee	Village rules and regulations (I_{15})	0.0884	Yes = 1; No = 0	[1]
	The ability and efficiency of the village government to respond to disasters (I_{16})	0.0078	Number (composite score)	[1]
Access to livelihood support	Number of WeChat friends (I_{17})	0.0617	Yes = 1; No = 0	[3]
	Number of people who can communicate clearly in Chinese (I_{18})	0.2712	Distance of residence from the road (km)	[11]
	Working outside/employment (I_{19})	0.2690	Number (composite score)	[1]
Leadership and networking	Whether village cadres exist (I_{20})	0.0081	Yes = 1; No = 0	[1]
	The ability of village cadres to handle disputes (I_{21})	0.0529	Number (composite score)	[1]
Social cohesion	The celebration of traditional holidays in the village compared to ten years ago (I_{22})	0.0129	Number (composite score)	[1]
	Practice religion (I_{23})	0.2032	Number (composite score)	
Social participation	Joint-household grazing (I_{24})	0.2032	Yes = 1; No = 0	[12–14]
	Opportunities for villagers in the village or town to participate in policy events (I_{25})	0.0884	Number (composite score)	[1,15,16]

Note: These indicators were chosen after consultation with residents of the community during the pre-visit and were mainly derived from expert opinions and indicators from the literature.

Table 3
An assessment framework for analyzing the capacity for learning dimension of livelihood resilience.

Dimension	Quantitative indicator	Weight	Measurement	References
Knowledge transfer capability	Vocational training (I_{26})	0.3234	Years of education – the higher the education, the more literate	[1]
	Number of times involved in knowledge dissemination/mentoring others in the past year (I_{27})	0.0884	General health of the family (scale of poor to good)	[1,2,16]
Exposure to social and cultural norms	Accessibility to science and technology, ecological news, and TV programs (I_{28})	0.0078	Yes = 1; No = 0	[1,2]
	Knowledge of national policies related to pastoralism degree (I_{29})	0.0617	Number (composite score)	[3]
Knowledge identification capability monitoring	Is it noted that some livestock breeds, or unnatural structures are very destructive to grassland (I_{30})	0.2712	Specific livestock structures (composite score)	[1,2,14]
	Degree of rodent and pest infestation(I_{31})	0.2690	Number (composite score)	[1,2]
	What do you think about the quality of your grassland (I_{32})	0.0081	Number (composite score)	[1,2,15,16]

Note: These indicators were chosen after consultation with residents of the community during the pre-visit and were mainly derived from expert opinions and indicators from the literature.

CRediT authorship contribution statement

Tong Li: Conceptualization, Data curation, Formal analysis, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Lizhen Cui:** Data curation, Investigation, Writing – review & editing. **Zhihong Xu:** Conceptualization, Supervision, Validation, Writing – review & editing. **Xiaoyong Cui:** Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Validation, Writing – review & editing. **Yanfen Wang:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – review & editing.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Further reading

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Tong Li is currently a Postdoctoral Researcher at the University of Queensland, specializes in agricultural sustainability and ecology science, focusing on soil carbon and ecosystem management. His work, spanning sustainable grassland management (sustainable livelihood), carbon estimation via advanced sensing, and machine learning application in soil ecology, has published over 40 peer-reviewed publications and holds a numerous award. Actively involved in the academic community, his research significantly advances sustainability and ecology.

Lizhen Cui is currently a Ph.D. candidate in ecology at the Laboratory of Terrestrial Ecosystems, College of Life Sciences, the University of Chinese Academy of Sciences, Beijing, China since 2018. Her work includes carbon and nitrogen cycling in alpine grassland ecosystems, nitrogen uptake strategies by plant and microbes, grassland restoration and grassland sustainability.

Zhihong Xu is a professor at Griffith University, Australia, and has been the Chair of the Forest Soils Working Group of the International Union of Soil Science since 2006. He is an expert evaluator for the Ministry of Education's "Yangtze River Scholar Award Program" and an overseas advisor to the Chinese Academy of Sciences since 2004. He currently serves as the Editor-in-Chief of the Journal of Soils and Sediments and as an editorial board member for Environmental Science and Pollution Research, Environmental Geochemistry and Health, and Pedosphere. He has published over 400 refereed papers, with more than 13,000 citations, and authored 2 monographs.

Xiaoyong Cui is a professor and Ph.D. supervisor at the University of Chinese Academy of Sciences' School of Life Sciences, specializing in plant adaptation to environmental stresses, subterranean ecology, and ecosystem management. He has spearheaded significant projects on grassland degradation, restoration, and carbon storage in Eurasian and Himalayan regions. His extensive research on grassland ecosystems' response to global change has resulted in over a hundred publications in top-tier journals like Soil Biology & Biochemistry, Agriculture Ecosystems & Environment, National Science Review, and Agricultural and Forest Meteorology. Additionally, he contributes as an editorial board member to several scientific journals.

Yanfen Wang is currently a Professor with the University of Chinese Academy of Sciences (UCAS), Beijing, and also with Beijing Yanshan Earth Critical Zone National Research Station, as well as the Vice Chairman of the China Ecological Society. During her professional career, she has authored over 200 articles in major scientific journals including Nature Reviews Earth & Environment, National Science Review, Global Change Biology, Soil Biology and Biochemistry, and Journal of Ecology. Her research interests include the mechanisms of soil carbon stability under global changes.