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Editorial: Agricultural land and environmental risks: evidences, assessment and conservation transition

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Editorial on the Research Topic
Agricultural land and environmental risks: evidences, assessment and conservation transition

Introduction

Meeting increasing food demands in an environmentally sustainable manner is a worldwide challenge. Agricultural land covers 38% of the world's land area and produces about 30% of the world's net primary products to meet human needs (Ramankutty et al., 2008; Food and Agriculture Organization of the United Nations, 2023). It is the expansion and intensification of agricultural land that has driven the huge increase in global food production over the past few decades, which is a crucial way to achieve the "zero hunger" goal of the United Nations (UN). However, high-intensity use and uncontrolled expansion of agricultural land have caused many environmental problems, like overexploitation of groundwater (Mishra et al., 2014), greenhouse gas emissions (Rehman et al., 2021), biodiversity loss (Kehoe et al., 2015), and serious nitrogen or phosphorus pollution (Li et al., 2022). Unsustainable agricultural land use beyond the environmental limits affects the stability of the natural system. Therefore, how to increase food production sustainably while reducing the environmental impact has become a global issue that should be considered for realizing Sustainable Development Goals.

Given the significance of sustainable agricultural land use for global food security, our Research Topic seeks to bring together perspectives and empirical studies of environmental risk management related to sustainable agricultural land use. There are 14 articles on this Research Topic. Specifically, more research focused on agricultural land risk assessment (four articles), environmental risk generation process and mechanism of agricultural land

use (six articles), and sustainable agricultural land utilization transformation and policy optimization (three articles). The Research Topic is far from enough to understand agricultural land use and environmental risks. We aim to attract more researchers to pay more attention to agricultural land use transition and environmental risk management.

Zhao et al. systematically explored agricultural land risk, analyzing 12,581 literature sources using CiteSpace. It showed that two phases (2002–2015 and 2015–2022) revealing evolving research hotspots. The initial phase focused on diverse risks (soil, nitrogen, sewage sludge), emphasizing theoretical frameworks in intensification and transport protection. The subsequent phase delved into mechanisms, covering methodologies, source analysis, toxic elements, and random forest analysis. The study highlighted three key steps to mitigate risk were outlined: stringent land use management, sustainable agricultural practices, and robust environmental governance. The findings significantly contributes the theoretical foundation of sustainable land management, providing valuable insights for mitigating hazards in evolving land use scenarios.

Agricultural land risk assessment

Du et al. established the evaluation system of the GUL-CL from four aspects (environmental friendliness, resource conservation, spatial intensification, and output efficiency) in the Heilongjiang reclamation area. The results show that the degree of GUL-CL in the study area is generally well-developed. The coupling coordination degree of green use of agricultural land (GU-CL) (0.20–0.50) is at a low coupling coordination stage. This study can provide practical knowledge for the sustainable use of agricultural land in the black soil region of Northeast China. This study can provide practical knowledge for the GU-CL in the black soil region of Northeast China.

Wei et al. studied urbanization's spatiotemporal evolution and agricultural land use coordination in Hunan Province (2000–2018). They identified current coordination types and proposed optimization measures. Results showed a transition from severely uncoordinated to ultimately coordinated development. Hunan's coordination pattern, with eight sub-regions, requires expedited factor flows through reforms and innovative mechanisms for each type to address developmental shortcomings. This study serves as a scientific reference for effectively implementing coordinated development strategies in major food-producing regions.

He et al. conducted a visual analysis to comprehensively review the progress in ecological security assessment of agricultural land. They examined concepts, characteristics, driving factors, assessment scales and methods, technologies, and simulation methods in relevant literature. Results show that research on the ecological security of agricultural land is in its early stages, lacking a comprehensive exploration. Current investigations focus on situational analyses, with a deficiency in simulation-based dynamic analyses of driving mechanisms. Future research should explore intricate driving mechanisms in socio-economic-ecosystem interactions, emphasizing comprehensive models for dynamic spatial and multiscale ecological security assessment. This contributes insights for theoretical advancements and land-use plans to mitigate global climate change.

Li et al. emphasized the importance of mutual matching of underground root systems for forming functional plant communities during vegetation restoration. They employed the "Amoeba graphic method" to establish the Root System Framework Index (RFI) based on root system morphology, quantitative, and spatial connectivity features. Monitoring alfalfa (T-type), fescue (F-type), and a mixed planting (T + F-type) revealed RFI parameters (effectiveness coefficient, root density, framework degree, and soil bulk density). RFI values for T, F, and T + F were 0.38, 0.86, and 1.68, respectively, effectively representing root structural characteristics. The study supports ecological construction and assessment for restoring damaged vegetation.

Process and mechanism of agricultural land risks

Wang et al. assessed natural quality, spatial distribution, and land use intensity on the Qinghai-Tibet Plateau at the county level, determining land use models. They discussed optimization directions considering ecological conservation and agricultural and pastoral regulation. The "NUS" three-dimensional model accurately reflected Qinghai-Tibet Plateau land use characteristics. Current patterns align with ecological conservation zones, but issues of irrational expansion and excessive utilization exist in transitional zones. Agricultural land utilization and optimization should prioritize ecological security, addressing conflicts for sustainable land use on the Qinghai-Tibet Plateau.

Hu et al. studied orchard expansion in Fuxian, Luochuan, and Huangling counties in Shaanxi Province from 1990 to 2020. Orchard data were extracted using Linear Spectral Mixture Analysis (LSMA) and decision trees for cash crop identification. Spatiotemporal dynamics were quantitatively analyzed using spatial geometric center displacement, geographic features, landscape patterns, and orchard suitability. A machine learning approach, random forest regression, identified driving forces. Continuous expansion, most rapid from 1990 to 2005, occurred toward north-central regions and highly suitable areas, with increased cohesion. Slope emerged as the primary factor influencing orchard expansion.

Hua and Li used Chinese Family Panel Studies (CFPS) data from 5,133 households in 2014 and 3,810 households in 2018. They applied Propensity Score Matching with Difference-in-Differences (PSM-DID) and Kernel Heteroskedasticity-Based (KHB) models to investigate the impact of land loss on academic performance among rural adolescents. Results indicate that adolescents from households experiencing land loss exhibit poorer academic performance and lower awareness of education value compared to those without land loss. The identified logical mechanism is "land loss → family educational cognition → family human capital investment → adolescent academic performance." Gender differences show a greater negative impact on boys' academic performance due to land loss. The government should enhance training for land-loss farmers, improve social security for female-led families, and prioritize support for boys affected by land loss.

Xie et al. surveyed Wannian County to analyze the causes and risks of compensatory cultivated land (CCL) migration to mountainous areas at a micro level. They used Boosted Regression Tree (BRT)

models and a grain production capacity assessment model. Results show CCL shifting uphill (2010–2020) with notable fragmentation, and a 14.77% abandonment rate for agricultural land. Site conditions (elevation, plot area, cultivated land continuity) explain abandonment reasons. Abandonment led to a risk of losing 297. 48 tons of grain production capacity. Spatial mismatch resulted from neglecting coupled relationships between site conditions, utilization status, and functional requirements. A proposed solution is Natural Resource Requisition-Compensation Balance (NRRB), involving spatial displacement for abandoned CCL in uphill areas and cultivable forest land in submountainous regions, optimizing the land use pattern toward Feng Tunning's agricultural circle.

Liang and Geng investigated soil samples pre and post no-grain canal (NGC) implementation in rice paddies in Zhejiang Province, China. They measured soil environmental factors, conducted 16S rDNA amplicon sequencing, and analyzed changes in soil bacterial communities and ecosystem functions. Results showed NGC increased the relative abundance of Proteobacteria (27.89%) and Actinobacteria (25.25%). Total bacterial quantity increased in all samples, with significant variations. NGC enhanced α diversity indices (Ace, Chao1, Coverage, and Shannon indices) significantly ($p < 0.01$). Environmental factors associated with soil bacterial diversity and structure were total nitrogen (TN), available phosphorus (AP), pH, soil organic matter (SOM), field water capacity (FIQ), and available potassium (AK). Wilcoxon rank-sum tests indicated NGC significantly enhanced amino acid transport and metabolism functions of soil bacteria. Results suggest NGC benefits soil bacteria diversity, enhances soil ecosystem multifunctionality, and promotes sustainable soil ecosystem conservation in cultivated lands.

Faye et al. used ArcGIS and ENVI software to interpret land use types (2000–2020) and employed a transfer matrix method to characterize agricultural land transformation. Pearson correlation coefficients assessed interrelationships between natural and socio-economic drivers of agricultural land use. Results showed approximately 588.66 square kilometers undergoing agricultural land transformation, with grassland being pivotal. Mont-Rolland had the highest net transformation (33.22%), and Sandiara town had the lowest (−41.73%). Temporal distribution in Koul town was −0. 35%, while Mont-Rolland town was 24.84%. Agricultural land transformation intensity was 11.34% in Malicounda town. Social surveys revealed a strong correlation (0.971) between wind erosion and soil salinity, potential driving factors for agricultural land transformation.

Sustainable transformation and policy optimation of agricultural land utilization

Guan et al. systematically described the morphological characteristics of agricultural land use in various ecological functional zones and analyzed main issues related to agricultural land use in different regions. Proposing regulatory schemes for agricultural land in ecological functional zones, focused on food security, the paper used Mengjin County as a case study for empirical research. Results showed that, guided by the goal of food security, implementing different agricultural land improvement plans based on ecological zones can enhance food security and amplify environmental effects. Land consolidation and ownership adjustment can restore idle agricultural land to food production land, enhancing food supply capacity without damaging the ecological environment. In ecologically important areas, large-scale ecological transformation may impact food security supply. Promoting ecological agriculture resolves the contradiction between food security production and ecological environmental protection. This study provides reference for decision-making on land consolidation in the new era.

Liu et al. studied the impact of mayors and party secretaries in connection with four protected agricultural demonstration areas—Shandong, Jiangsu, Hebei, and Liaoning Provinces—on the expansion of protected agriculture. Using panel data from 314 prefecture-level cities and 1,792 counties (2014–2018), they employed a multidimensional fixed-effects model. Results showed mayors connected to demonstration areas significantly promoted protected agriculture expansion, with a 10.8% higher average scale in their jurisdiction's county-level areas. Party secretaries' impact was not significant. Geographical differences revealed weakened positive impact in economically less developed western regions or unsuitable planting periods (March to June). Leaders connected to Shandong, Liaoning, and Jiangsu Provinces had significantly different but positive impacts on protected agriculture expansion.

Wang et al. using the grain supply and demand balance method, has categorized the 14 regions (cities) in Xinjiang into deficit/surplus areas of agricultural land to accurately determine the actual compensation standards for areas requiring payment and those receiving compensation. The research results reveal that Xinjiang has an overall surplus of agricultural land, with a total surplus area of 271.57 × 104 ha. However, within Xinjiang, there are still some areas experiencing deficits in agricultural land. It was also found that the benchmark land price is a core factor influencing compensation standards. Furthermore, the study proposes adopting diverse forms of compensation, alleviating financial pressure, financing through multiple channels, ensuring funding sources, and establishing policies such as agricultural land protection compensation standards, dynamic measurement platforms, and supervisory and management mechanisms to achieve a long-term compensation mechanism for agricultural land.

Concluding comments

The Research Topic, titled "Agricultural Land and Environmental Risks: Evidences, Assessment and Conservation Transition" thoroughly explores the intricate challenges of managing agricultural land sustainably in response to escalating global demands. This compilation of peer-reviewed articles encompasses various aspects, including the risk factors associated with land use, risk assessment, and the regulatory transformation and optimization of sustainable utilization. The central theme underscores the critical importance of prioritizing risk prevention and control in the sustainable use of agricultural land.

The introduction emphasizes the significant challenge of meeting global food demands sustainably, highlighting the essential role of agricultural land in producing net primary products. While expanding agricultural land is necessary to

achieve the United Nations' "zero hunger" goal, the intensive use and uncontrolled expansion of agricultural land can lead to environmental issues. Addressing the risks associated with land use is, therefore, essential to strike a balance for global sustainable development goals.

The thematic section of this Research Topic meticulously analyzes the causes, drivers, and influencing factors of land use risks, leading to a nuanced understanding of challenges and potential solutions. Articles exploring the restoration of damaged vegetation and soil bacteria reveal insightful interactions between crop microstates and land use risks. Additionally, the increasingly apparent positive impact mechanisms of macro policies in controlling land use risks suggest a growing global emphasis on managing agricultural land risks.

Crucially, the issue highlights regional disparities and the profound impact of local context on the quality of agricultural land, emphasizing the need for tailored, context-specific policies. Insights from studies analyzing agricultural land transfer rents, disaster risk management, and the role of land consolidation in mountainous regions underscore the necessity of nuanced policy interventions aligned with local dynamics to ensure food security and sustainable development.

Importantly, this Research Topic underscores the profound impact of regional variations and local contexts on agricultural land risks, emphasizing the need for context-specific research. It highlights differences in regional gaps, risk-driving mechanisms, and optimization control strategies, particularly in developed regions (such as Zhejiang and Hunan provinces) and underdeveloped regions (such as Henan province, the Loess Plateau, and Thiès region in Senegal). The emphasis is on the necessity of optimization control strategies consistent with local dynamics to ensure a balanced development between production and ecological wellbeing.

Overall, safeguarding the sustainable use of agricultural land is critical for future food production. However, the array of risks it faces poses a significant challenge. It is vital to scientifically measure these risks and devise preventive strategies.

Firstly, establishing a stringent land-use control system is essential. This involves regulating cultivated land strictly, prohibiting arbitrary changes and prioritizing the protection of high-quality cultivated land. Second, enhancing soil fertility is crucial. This involves regulating chemical fertilizer and pesticide use to minimize environmental impact and prevent soil degradation. Third, emphasizing the importance of establishing a regular environmental monitoring system is vital. This comprehensive network should be incentivized to encourage agricultural producers adopting eco-friendly practices. Lastly, there is a need of advancing scientific research in the field of agricultural land risk control, develop unified and coordinated policies. It is necessary to establish risk control mechanisms and institutions, and drive the global imperative for sustainable management of land resources.

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Author contributions

XKo: Writing–original draft, Writing–review and editing, Data curation, Formal Analysis, Investigation, Methodology, Supervision. ZZ: Data curation, Formal Analysis, Investigation, Supervision, Writing–original draft, Writing–review and editing, Methodology. ML: Formal Analysis, Methodology, Software, Writing–review and editing, Writing–original draft. MT: Methodology, Supervision, Writing–review and editing. XKe: Methodology, Supervision, Writing–review and editing. GT: Methodology, Supervision, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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