

Spatial–Temporal Differentiation and Driving Factors of Cultivated Land Use Transition in Sino–Vietnamese Border Areas

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Abstract

Eradicating hunger and achieving food security is one of the key objectives of the 17 Sustainable Development Goals (SDGs). Scholars have made great efforts to increase agricultural food production and develop policy, but the recent report on the State of Food Security and Nutrition in the World still indicates that the world is regressing in its efforts to eradicate hunger, food insecurity, and all forms of malnutrition. Cultivated land is an essential natural resource crucial for human survival, development, and agricultural activities. It also plays a vital role in upholding social stability and ensuring national food security. Given that the transformation of cultivated land use (T-CUL) holds direct implications for global food security and the pursuit of sustainable development goals, it is imperative to gain a comprehensive understanding of the spatial and temporal dynamics of T-CUL, discern its driving mechanisms, and safeguard the essential role of cultivated land in food production. In addition to the functions of food production, spatial carrying capacity, and ecological conservation, cultivated border land also has the functions of maintaining homeland security. Currently, the Sino–Vietnamese border area is undergoing a critical phase of fostering bi-lateral cooperation and optimizing population distribution. In this region, the T-CUL is influenced by a complex interplay of internal and external forces, including urban expansion, trade activities at ports, industrial restructuring, and efforts to enhance food quality and production. Consequently, border villages and houses are transitioning into hollow communities with unoccupied households, resulting in sparsely populated open areas. This transformation raises concerns about non-grain-oriented land use and land extensification. Many nations recognize the need to protect and enhance the quality of cultivated land while imposing strict controls on its conversion into non-CUL. Therefore, it is of great significance to conduct comprehensive research on T-CUL in border areas, to optimize the integration of border development and cultivated land use within the context of expanding urbanization.

Currently, the science focusing on the T-CUL is rich and provides much important support for our research, but some shortcomings remain and some questions need additional answers.

Firstly, it is noteworthy that most current studies are primarily engaged in qualitative analysis and explanations, which, while informative, fall short of establishing the definitive laws and spatial patterns governing T-CUL. To address this limitation, our research endeavors to delve into the specific factors influencing various types of transitions involving cultivated land.

Secondly, T-CUL represents a complex outcome resulting from the interplay of multiple scales and factors. The intricate nature of its influencing elements gives rise to diverse responses of cultivated land across different regions. Presently, numerous studies have focused on a national level, single provinces, economically thriving urban clusters, reclaimed plains, coastal regions, and other localized areas, thereby forming a “multi-perspective, multi-scale” research paradigm. Unfortunately, relatively less attention has been directed toward remote mountainous areas. Situated within a karst zone, the Sino–Vietnamese border area predominantly features sloping cultivated land with a high degree of fragmentation. Its strategic significance and the burgeoning cross-border trade fundamentally shape its unique pattern of cultivated land utilization and development, distinguishing it from other regions. While the existing literature has been instrumental in shedding light on the T-CUL mechanism, it has not yet provided a definitive answer to the driving forces behind T-CUL in remote mountainous areas.

To achieve this, we systematically examine the evolution of cultivated land in the Sino–Vietnamese border area over the past two decades. Leveraging land use data and socio-economic statistics from different periods and employing kernel density analysis and geomorphological mapping analysis methods, we elucidate the spatial morphology of cultivated land. Furthermore, we employ a spatial econometric regression analysis model to dissect the driving mechanisms behind T-CUL in the border area spanning from 2000 to 2020. In doing so, our research lays the foundation for augmenting our understanding of T-CUL in mountainous regions, fostering the judicious utilization and sustainable development of cultivated land in border areas, reconciling the delicate balance between high-quality economic development and ecological preservation, and optimizing spatial planning and governance strategies in the border area for the future.

Our findings revealed several key insights: (1) The density of cultivated land in the Sino–Vietnam border area exhibited an initial increase followed by a decrease. Notably, the transformation of cultivated land was most prominent in the eastern plains, intensifying over time. (2) The predominant type of transformation in the Sino–Vietnamese border area revolved around the mutual conversion of cultivated land and woodland, with the mutual conversion of cultivated

land and grassland ranking second. (3) Against the backdrop of urban–rural integration, the transformation of cultivated land use at the border progressed from a phase of rapid decline to a phase of slower decline. (4) The transformation of cultivated land was influenced by a complex interplay of socio-economic factors, natural environmental conditions, policy management, and transportation infrastructure. The relative importance of these factors in driving cultivated land use transformation varied significantly across different time periods. In light of these findings, we recommend promoting agricultural modernization and industrialization in the Sino–Vietnamese border areas. It is essential to consider the region’s distinct cultivated land characteristics, implement tailored land policies, and develop diversified strategies for the utilization and management of cultivated land. Furthermore, harnessing land resources to stimulate economic development should be a focal point of future initiatives in the area.

Compared with other regions, T-CUL in border mountainous areas exhibited both similarities and unique characteristics. Firstly, the behavior of cultivated land use led to different directions of T-CUL. In contrast to developed cities in eastern China where cultivated land was primarily converted into construction land, border mountainous areas saw mutual transformations between cultivated land and woodland. During the agricultural society period, there was an expansion of cultivated land and a reduction in woodland. In the urbanization era, there was an abandonment of cultivated land followed by the restorative growth of woodland.

Secondly, while urbanization and industrialization were fundamental driving forces for T-CUL in many regions, including developed countries like Europe and Japan, the border mountainous areas presented a different scenario. Economic development in these border regions lagged behind that in inland core areas due to influences from natural and geo-economic environments. The external pull of urbanization and industrialization development led to the migration of a significant number of rural laborers, particularly the younger workforce, to cities. This migration contributed to the transformation of a substantial amount of cultivated land, aligning with T-CUL resulting from labor force separation.

Natural factors, such as altitude and the challenges posed by agricultural mechanization and scale in karst terrain, also played a role in facilitating cultivated land transformation. The widening gap between labor productivity and agriculture in plain areas increased the likelihood of cultivated land becoming marginalized, further aligning with T-CUL driven by cultivated land marginalization.

Additionally, the external ecological benefits generated by economic and societal development in a market environment were limited. This led to adjustments in cultivated land planting structures and changes in utilization patterns, with a noticeable shift toward non-agricultural uses. Particularly, issues related to the imperfections in farmland property rights systems and the shortcomings in interest allocation mechanisms for cultivated land protection subjects became increasingly evident. These issues were reflected in problems like vacant homesteads and the marginalization of cultivated land. Looking ahead, future research should consider narrowing the spatial scope and focus on the implementation of differentiated land policies in the near-border area (0–3 km). It should also delve into the potential coupling mechanism between T-CUL and border residents' behavior, farmers' planting preferences, and property rights systems. Additionally, government initiatives related to land space planning and cultivated land protection policies in border areas should carefully balance economic development with cultivated land protection, taking into account spatial differences in T-CUL. Innovative models for cultivated land protection tailored to local conditions should be developed, and a new pattern of multi-scale coordination of cultivated land protection areas should be established to ensure land security in border regions.

Keywords: cultivated land use transition; spatio-temporal evolution; driving mechanism; spatial econometric model; Sino–Vietnamese border areas