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Land Use Transition and Its Driving Mechanism of "Human–Elephant" Conflicts Zone in Yunnan, China

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Abstract: In recent years, the issue of "human–elephant" conflict in the south of the Yunnan Province, China has been escalating and poses a severe threat to the livelihoods of local residents. To address this problem, this study utilized survey data from farmers in Pu'er City and villages in Xishuangbanna Prefecture, Yunnan Province. By employing land input–output analysis and spatial analysis methods, this study aims to uncover the land use transition in the research area over the past three decades and identify the driving mechanism behind this transition. The findings of this research can provide valuable guidance for reducing regional conflicts between humans and wild animals, as well as improving the livelihoods of farmers. Research indicates that farmers in the study area have significantly transformed their land use practices. The per capita arable land area has increased, and traditional grain crops are being replaced with economically profitable crops such as rubber. Rubber is the predominant crop in the conflict-prone "human–elephant" core region, while other economic crops dominate the peripheral region. The overall land use index has risen, with a greater diversity and stability in land use structure. However, the input–output efficiency of cultivated land in the "human–elephant" core region remains low, leading to a lower comprehensive land use index than that of the peripheral region. The land use transition is influenced by several factors, including socio-economic development, changes in crop comparative benefits, and the activities of wild Asian elephants. Frequent crop destruction by elephants, which results in damage to farmers' livelihoods, is the primary cause of land use changes in "human–elephant" conflict areas. Ultimately, this conflict stems from the competition for regional land resources between humans and elephants, as humans dominate production space while elephants dominate ecological space. Local governments should optimize the layout of regional production and ecological spaces to alleviate these conflicts while also regulating circulation markets and improving farmers' land output levels.

Keywords: "human–elephant" conflicts; land use transition; driving mechanism; production-ecological space; China

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1. Introduction

With the increasing awareness of ecological protection among people, the number of wild Asian elephants in China has been on the rise in recent years. Relevant studies have shown that there are about 300 Asian elephants in the south of the Yunnan Province [1]. Among them, there are more Asian elephants around Mengyang, Mengla, and Shangyong Nature Reserves in Xishuangbanna, with an estimated number of over 100 [2]. In some agroforestry areas of Yunnan, with the increase in the population of wild animals, the economic losses and casualties caused by wildlife accidents have become increasingly serious [3]. "Human–elephant" conflict refers to negative interactions between humans and elephants that have potential harm to both parties [4]. We refer to the regions where frequent

incidents of "human–elephant" mutual harm, such as Asian elephants eating crops and causing casualties, as "human–elephant" conflict zones [5]. Mengyang Town, Dadugang Township, Puwen Town, and Jingne Township outside the Mengyangzi Protection Area of Xishuangbanna National Nature Reserve are areas where "human–elephant" conflicts frequently occur in China. The people here have coexisted with wild Asian elephants for generations, and it is also the earliest and most frequent area where "human–elephant" conflicts occur in China. This article classifies these four townships as the "core region of human–elephant conflict," while other conflict areas are classified as the "peripheral region of human–elephant conflict."

"Human–elephant" conflicts occur widely in South and Southeast Asia [6], causing losses and troubles to local residents [7]. In India, wild elephants have been found eating coffee beans [6], while in Indonesia they have been found eating betel nuts and other crops [8]. In the conflict areas of southern China, Asian elephants have caused many losses [9]. From 1991 to 2008, direct economic losses caused by Asian elephants exceeded CNY 200 million [10]. In the Pu'er area of the Yunnan Province, in 2012, Asian elephants caused damage to 4697 households, and their economic losses amounted to CNY 6.9663 million [11] (Figure 1). Elephant attacks causing injuries or deaths occur globally. In Xishuangbanna alone, between 1991 and 2010, there were 30 deaths and 171 injuries. The number of casualties caused by wild Asian elephants has been increasing year by year [10]. Scholars have proposed using sound monitoring technology, artificial neural network technology, and other methods to classify and predict the behavior of Asian elephants in order to better manage the Asian elephant population [12] or to use the development of the tea industry technology to try to bring income to local farmers and provide suitable habitats for wild animals such as Asian elephants on the basis of improving the local ecological environment [13]. The intensification of "human–elephant" conflicts significantly affect the activities of farmers regarding land use; thus, forming unique land use transition characteristics and driving mechanisms within the "human–elephant" conflict zone. In previous studies on "human–elephant" conflicts, more emphasis was placed on describing the current situation of conflicts and analyzing the application of specific methods to avoid or mitigate conflicts, but there was a lack of research and elaboration on conflict driven mechanisms, especially in the area of land closely related to farmers. Exploring the issue of "human–elephant" conflict from the perspective of land can help construct a comprehensive research framework for the three aspects of "human–elephant–land" and contribute novel ideas and research foundations to the resolution of "human–elephant" conflict issues.

(**a**) (**b**)

Figure 1. (**a**) Asian elephants enter farmland; (**b**) Banana Forest destroyed by Asian elephants.

The concept of "land use transition" was proposed by British scholar Grainger in 1995 to study the changes in land use in countries mainly focused on forestry. It was inspired by the concept of forest transition [14], and it was later introduced in China, wherein its theoretical connotation was enriched, becoming a new approach for LUCC comprehensive research [15]. The land use pattern is the core content of land use transition research [16], and explicit and implicit forms are one of the main ways to divide land use patterns. Explicit forms of land use transition refer to the structure composed of the main land use types in a region during a specific period, with quantity (area, share) and spatial structure; implicit forms of land use transition refer to the land use forms that are not easily perceptible and need to be obtained through analysis, testing, detection, and investigation that are attached to explicit forms. They usually have multiple attributes, such as quality, property rights, management methods, inherent input, and output capacity [17]. Its specific research methods have gradually formed a system in the practice process, and research theories and ideas have been formed in the analysis of single land use types [18] or regional scope [19]. Especially in the research of the Huang-Huai-Hai region, it has provided us with rich references [20]. Studying the driving forces behind land use transition can reveal the reasons, internal mechanisms, and basic processes of land use transition, which is of great significance for achieving regional sustainable development [21]. Research shows that human factors such as policy regulation [22], urbanization [23], population size [24], and natural factors such as terrain [25] and altitude [26] drive land use transition. From the perspective of land use transition, how the activities of Asian elephants drive the land use transition and what kind of land use transition results they provoke will be outlined. Other questions that will be discussed in this paper include the following: How will the results of the transition affect the lives of farmers and the conflict between "human–elephant–land"? What is the mutual feedback relationship formed among the three? The basic concepts and research methods of land use transition can be explored and summarized by measuring the explicit and implicit forms of land use transition, as well as analyzing the driving forces of land use transition.

In the study area, land use transition is influenced by various factors, such as social and economic development, changes in crop profitability, and wild Asian elephant activity. Among them, the frequent destruction of crops by Asian elephants, leading to damage to farmers' livelihoods, is the root cause of land use transition in "human–elephant" conflict areas. In order to protect crops from being destroyed by wild Asian elephants and seek better livelihoods and land output levels, farmers have made positive adaptations and changes in the use of land types, especially in the selection and replacement of crops. Driven by various forces, the core region of "human–elephant" conflict and the peripheral region of "human–elephant" conflict have formed different characteristics of land use transition. Conversely, land use transition also affects the ecosystem [27], economy, and society, thus forming the unique characteristics of land use transition in "human–elephant" conflict areas and its driving mechanism.

Based on the research background and the current situation, this paper will take the survey questionnaires of village households conducted in the core region of "human–elephant" conflict in Jinghong City, Xishuangbanna in 2020 and in the peripheral regions of "human–elephant" conflict in Xishuangbanna Prefecture and Pu'er City in 2022 as the main data sources. In terms of our research method, the corresponding data regarding the land use transition of households at four time points in 1990, 2000, 2010, and 2020 were extracted. The comprehensive index of land use was used to calculate and analyze the land use transition of villages in "human–elephant" conflict areas. While describing the characteristics of land use transition in the study area over the past 30 years, this paper also analyzes and summarizes the mechanism behind land use transition. Through the research in this article, we can help build a comprehensive research framework for the three aspects of "human–elephant–land." By utilizing the characteristics and advantages of the discipline, we can provide assistance for issues beyond the land discipline, while also contributing to the enrichment and expansion of land science.

2. Data and Methods

2.1. Study Area

For this paper, Pu'er City and Xishuangbanna Prefecture in southern Yunnan Province, China were selected as the research area, which has and continues to experience "human–elephant" conflicts. Additionally, Mengyang Town, Dadugang Township, Puwen Town, and Jingne Township on the periphery of Mengyangzi Protection Area of Xishuangbanna National Nature Reserve were selected as the core regions of "human–elephant" conflicts, and the rest were selected as peripheral regions of "human–elephant" conflicts (Figure 2).

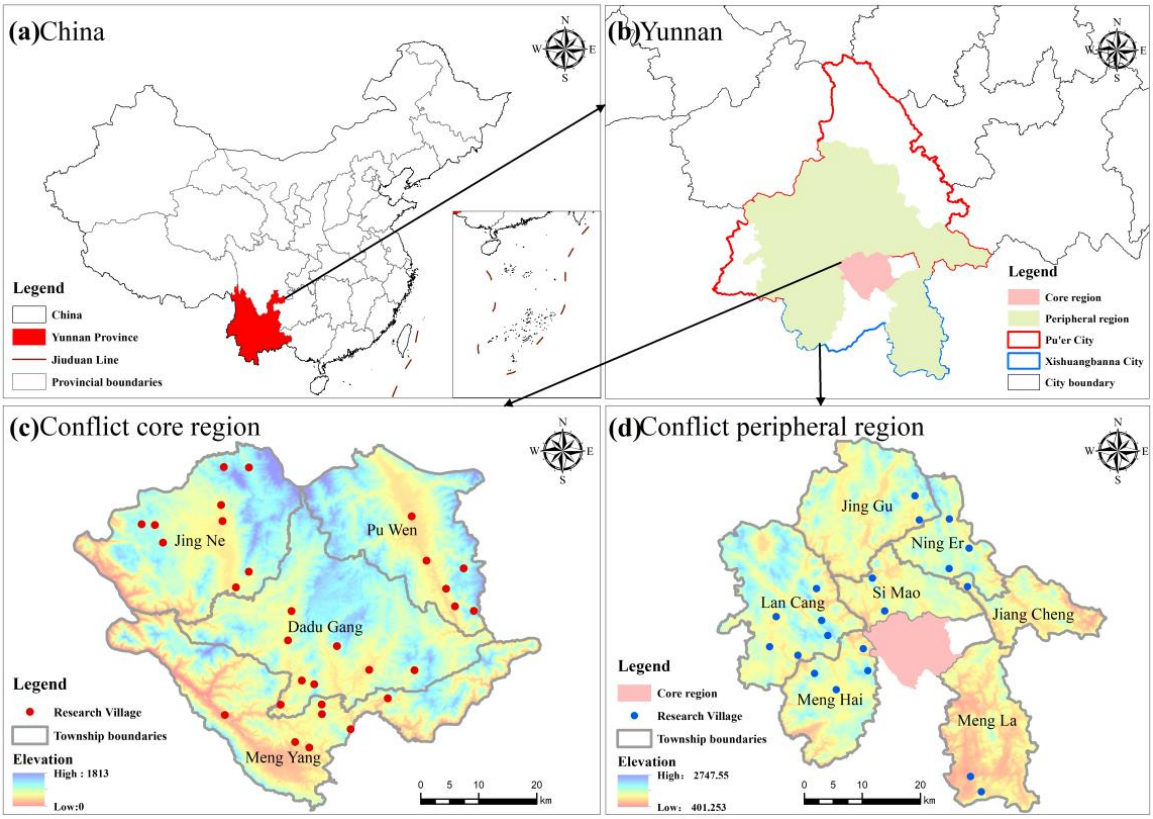

Figure 2. "Human–elephant" Conflict Area Diagram. Note: Based on the standard map production of the Ministry of Natural Resources' standard map service website with the audit number of GS(2022)1873, and the map boundary has not been modified.

The "human–elephant" conflicts zone is located between 21°10′–24°50′ north latitude and 99°09′–102°19′ east longitude, with a total area of about 64,000 square kilometers. The elevation of the study area is between 317 and 3370 m, with a high proportion of mountainous areas, complex terrain, and large undulations. Human production and living spaces are mostly concentrated in basins, and a few villages are scattered on the edge of basins and mountains. The climate is warm all year round, with an average annual temperature above 15 °C. The dry and wet seasons are distinct, with an annual rainfall of 1100–2780 mm. It is suitable for large-scale forest growth and provides a suitable living environment for Asian elephants and rich and diverse animals and plants. It also provides unique hydrothermal conditions for human agricultural activities. In 2021, the permanent population was 3.387 million people, with many ethnic minorities such as Dai, Lahu, Yi, Blang, etc., accounting for more than 60% of the total population. The regional GDP reached CNY 162.1 billion, and the total agricultural output value was about CNY 70 billion. Additionally, the core region of "human–elephant" conflicts is located between east longitude 100°33′~101°31′ and north latitude 22°02′~22°36′. It has high temperature all year round with an annual precipitation of 1347.4 mm and distinct dry

and wet seasons. Except for the Dadugang Township, which is mostly mountainous, other townships have large areas of basins distributed with complex terrain and obvious vertical differentiation. The total economic income and annual net income per household in each township are low. The main source of income for farmers' families is singular and unstable, mainly relying on land planting, odd jobs, and picking wild mushrooms.

2.2. Data

The data used in this study were derived from farmer survey data. The survey questionnaire was a comprehensive questionnaire made by the research group. This article adopts data regarding the area of crops occupied by farmers, the year and reason for crop replacement, land transfer area and price, annual fertilization, and yield per mu. The selected villages were villages with more serious "human–elephant" conflicts. A total of 10% of farmers in each village were randomly selected for research. The research comprised semi-structured interviews in participatory rural assessment, and each questionnaire took about 1–1.5 h to complete. Although most farmers have a good understanding of the changes in household agricultural conditions over the past 30 years, the long-term span still had an impact on the authenticity of responses However, the land use transition within each village was relatively similar, and multiple questionnaires from a single village provided a truly reliable description of the local land use transition. In addition, the extraction of questionnaire data through time nodes and the control and screening of questionnaire quality helped maximize the restoration of land use transition characteristics over the past 30 years, providing assurance for the reliability of research data.

The 2020 survey questionnaire data came from the research data of the research group of Yunnan University on farmers in the core region of "human–elephant" conflicts; the 2022 survey questionnaire data was jointly investigated by Southwest University and Yunnan University in the peripheral regions of "human–elephant" conflicts. After sorting out the questionnaire survey data, a total of 321 valid questionnaires were obtained (Table 1).

Table 1. The number of questionnaires for each village surveyed.

City/State Name	County/City Name	Township Name	Survey Village	Number of Households	Proportion
Xishuangbanna Dai Autonomous Prefecture	Jinghong City	Mengyang Town	Jing San, Sanjia village, Tiao bahe, Xintianbasijiazhai, Naban'er, Nahuipa	37	12%
Xishuangbanna Dai Autonomous Prefecture	Jinghong City	Jingwen Town	Wenteng Community, Banzhulin, Zhilong, Manyuan, Dawotang, Pojiao, Diaojing	46	14%
Xishuangbanna Dai Autonomous Prefecture	Jinghong City	Dadugang Township	Xinshan, Shangmancha, Xiamancha, Dangpian, Xiangyanjing, Kongge Sixth Team, Zhongtianba, Hongshahe Upper Team, Mengman New Village, Mengman Old Village, Xiaoheiqing, Dahuangba	65	20%
Xishuangbanna Dai Autonomous Prefecture	Jinghong City	Jingne Township	Manle Mountain, Pine Forest, Pine Mountain Forest, curved Corner Mountain, High Mountain Village, Hongmaoshu, Yingpan, New Village, Nabian Old Village,, Nabian New Village, Big Garden, Manlao	68	21%
Xishuangbanna Dai Autonomous Prefecture	Mengla County	Mengman Town	Namping Village, Hetu Village	19	6%

Table 1. *Cont.*

City/State Name	County/City Name	Township Name	Survey Village	Number of Households	Proportion
Xishuangbanna Dai Autonomous Prefecture	Menghai County	Meng'a Town	Gasai Village, Manben Village, Nanlanghe Village	20	6%
Xishuangbanna Dai Autonomous Prefecture	Menghai County	Mengwang Township	Basan Village, Manyun Village, Manlao Village	12	4%
Pu'er City	Canglan County	Menglang Town	Lahuxin Village	3	1%
Pu'er City	Canglan County	Development River Township	Nanjiaohe Group, Mengnai New Village, Mengnai Village, Mengnai Old Village, Pingzhangdi Group, Laozhaotian Village, Liangshan New Village in Mengnai Village	20	6%
Pu'er City	Simao District	Liushun Town	Paozhangshan Mountain, Dapingzhang Village	6	2%
Pu'er City	Jiangcheng County	Kangping Town	Mankelao Village	8	2%
Pu'er City	Jinggu County	Zhengxing Town	Jingnan and Menglie Villages	6	2%
Pu'er City	Ning'er County	Mengxian Town	Heping Village Kesazu Group, Qianle Old Village, Heiniqing	11	3%

2.3. Method

2.3.1. Measurement of the Dominant Form of Land Use Transition

The dominant form of land use transition refers to the structure of a region composed of the main land use types during a specific period, which has quantity (area, share) and spatial structure [16]. Since the current "human–elephant" conflicts mostly occur in villages and have had a great impact on crops, this paper focuses on farmland and takes advantage of the household survey questionnaire to extract farmland data for each village and household in 1990, 2000, 2010, and 2020. The data were classified into three categories: traditional food crops composed of corn and rice, rubber crops, and new economic crops composed of other crops (except rubber). The area and proportion were calculated and analyzed to explore the characteristics of explicit form changes in land use transition in the study area.

2.3.2. Measurement of the Recessive Form of Land Use Transition

In the study area, the activities of the Asian elephant have greatly affected the way farmers use land, thus affecting the land use transition. In terms of measuring the implicit form of land use transition, a relatively mature evaluation system has not yet been formed, and the local "human–elephant" conflict has the most direct impact on the level of land management, that is, the income level of farmers in land use activities. For local farmers, the management level can be divided into contracted management level and individual management level. Therefore, appropriate parameters can be selected between contracted management level and individual management level to measure the implicit form of land use transition.

The level of contracted management refers to the scale and quality of farmland turnover activities carried out by farmers and tenants. This article analyzes the level of contracted management by selecting land turnover rate and land turnover price. The land turnover rate can determine the vitality of the local land turnover market and the development level of land scale economy, and the land turnover price can determine the lessee's recognition of the economic value that local land can create. The self-employed

level refers to the input–output level of farmers when they work in the cultivated land. Considering the local actual situation, the amount of land input is measured by the amount and area of fertilizer per mu of different crops, and the amount of land output is measured by the amount and area per mu of different crops. The analysis of the self-employed level helped us understand the changes in the efficiency of land use of cultivated land and the impact of Asian elephant activities in it.

By adding up the four indices of land turnover rate, land turnover price, land input, and land output, a comprehensive land use index can be obtained to measure the implicit form of local land use transition.

The four indicators are standardized by the range standardization method, respectively, and the original data is linearly transformed to map the data value to between 0 and 1.

$$Z_{ij} = x_{ij} - min(x_{ij}) / max(x_{ij}) - min(x_{ij}) \quad (1)$$

Z_{ij} is the standardized value of the index value, x_{ij} is the jth index value of the ith index, $min(x_{ij})$ is the minimum value of the index, and $max(x_{ij})$ is the maximum value of the index.

The formula for the comprehensive index of land use is as follows:

$$M_{in} = A'_{in} + B'_{in} + C'_{in} + D'_{in} \quad (2)$$

In this formula, M_{in} is the comprehensive index of land use of the nth village in the ith year, and A'_{in}, B'_{in}, C'_{in}, and D'_{in} are the standardized values of the land turnover rate, land turnover price, land input, and land output of the nth village in the ith year.

The formula for land turnover rate is as follows:

$$A_{in} = T_{in} / G_{in} \quad (3)$$

where A_{in} is the land turnover rate of the nth village in the ith year, G_{in} is the total area of land surveyed in the nth village in the ith year, and T_{in} is the area of land surveyed for turnover in the nth village in the ith year.

The land turnover price B_{in} refers to the average price per mu of land being transferred annually up to the ith year (1988–year i) in the nth village. In the calculation, the rural residents' consumption price index of Yunnan Province is used to eliminate the impact of inflation. Since the latest year for which data on land transfer began is 2018, all land transfer prices are standardized to the level of 2018 so that prices in different eras are comparable.

The formula for land input is as follows:

$$C_{in} = \sum_{j=1}^{j} S_{nj} I_{nj} / N_n \quad (4)$$

C_{in} is the amount of land input in the nth village in the ith year. In the ith year, there are j types of crops in the nth village. S_{nj} represents the area of j types of crops in the nth village, I_{nj} represents the amount of fertilizer applied per mu per year for j types of crops in the nth village, and N_n is the number of households surveyed in the nth village.

The formula for land output is as follows:

$$D_{in} = \sum_{j=\mathbf{1}}^{j} S_{nj} O_{nj} / N_n \quad (5)$$

D_{in} is the land output of the nth village in the ith year. In the nth village, there are j types of crops. S_{nj} represents the area of j types of crops in the nth village, O_{nj} represents the annual yield per mu of j types of crops in the nth village, and N_n is the number of households surveyed in the nth village.

3. Results and Analysis

3.1. Characteristics of Land Use Transition in the "Human–Elephant" Conflicts Zone

3.1.1. Dominant Form of Land Use Transition

Before 2000, the per capita agricultural land area in the core and peripheral regions of the study area was about 0.02 square kilometers. After 2000, the per capita agricultural land area in the study area showed a certain increase, with the core region increasing faster and reaching 0.038 square kilometers per household in 2020. In the period from 2000 to 2010, when land area grew fastest, "human–elephant" conflicts began to occur gradually in the core region, indicating that the expansion of human production space has squeezed the ecological space of wild Asian elephants and prompted the occurrence of "human–elephant" conflicts.

In terms of traditional food crops, their proportion showed a downward trend in both study areas, with the proportion in the core region decreasing from 51% to 21% and that in the peripheral region decreasing from 66% to 29%; in terms of new economic crops (except rubber), their proportion was not much different in 1990, with the proportion in the core region beginning to rise slowly after 2000 and only accounting for 30% in 2020. The proportion in the peripheral region began to rise in 1990 and rose rapidly after 2000, accounting for 47% in 2020.

It is worth noting that the proportion of traditional food crops decreased rapidly from 2000 to 2010. It can be considered that, after "human–elephant" conflicts occurred from 2000 to 2010, farmers made positive responses to protect crops from elephant damage because wild Asian elephants like to eat corn and rice, which directly led to a rapid decrease in the proportion of traditional food crops.

Rubber, as a typical economic crop in the study area, can effectively avoid elephant damage. The proportion of rubber in the core region is higher than that in the peripheral region, and has completely opened up a gap since 2010. In 2020, rubber accounted for 49% and 24%, respectively, in the core and peripheral regions. While squeezing out the original production space, rubber also squeezed out mountainous areas originally used as ecological space, further intensifying "human–elephant" conflicts. The most significant land use change in Xishuangbanna is that of the large areas of tropical rainforest that have been replaced by structurally simple pure rubber forests. Although rubber planting is conducive to the rapid economic development of local areas, its negative impact on the local ecological environment is an indisputable fact (leading to environmental changes such as a loss of biodiversity, soil degradation, soil erosion, soil compaction, continuous drying up of small watershed water sources, etc.) [28]. In field investigations, it was found that, due to the large-scale planting of rubber trees in the Gasa District of Jinghong City, groundwater resources have been severely depleted, and it is difficult to grow other crops. At the same time, there are problems such as the long planting cycle of rubber trees and international rubber prices falling. Therefore, there are potential hidden dangers regarding the large-scale proliferation of rubber trees, which was thought to alleviate "human–elephant" conflicts and ensure the safety of farmers' livelihoods.

3.1.2. Recessive Form of Land Use Transition

After calculation, the comprhensive index of land use for each village for many years (Figure 3) is as follows:

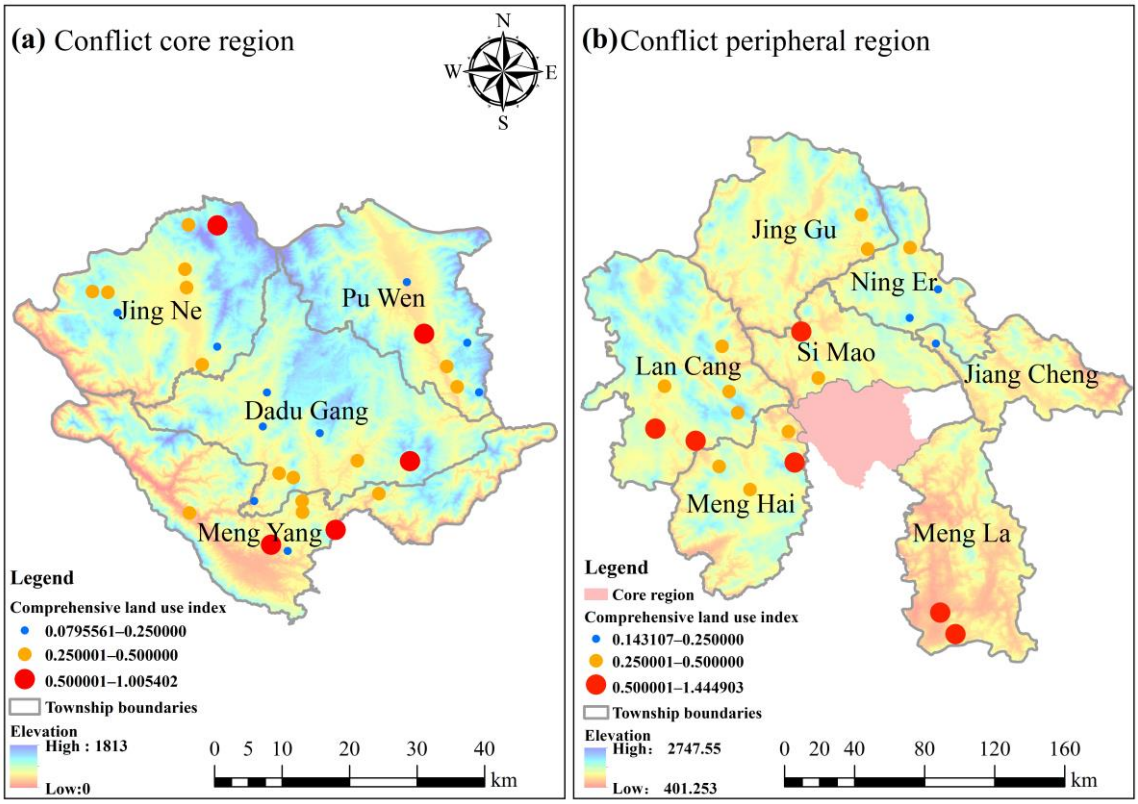

Figure 3. Comprehensive index of land use for each village in the core region and peripheral region for the years studied.

Regardless of whether it is the core region or the peripheral region in the study area, the comprehensive index of land use shows an upward trend. However, overall, the comprehensive index of land use in the peripheral region is significantly higher than that in the core region (Table 2).

Table 2. Comprehensive index of land use classified by year and region.

	Comprehensive Index of Land Use			
	1990	2020	2010	2020
core area	0.07	0.19	0.39	0.68
peripheral region	0.11	0.33	0.53	1.01

There are significant differences between the four indicators among various villages. After classifying the data of each village by year and calculating the coefficient of variation, it was found that all were greater than 0.1. This indicates that the unevenness of agricultural development levels among various villages has always existed and has not been developed in a relatively unified and standardized way. Instead, it is in a decentralized and autonomous development mode and lacks guidance.

According to the selected indicators, two indicators of output and input can be proposed to characterize the individual operating level of farmers, and the turnover rate and turnover price can be proposed to characterize the contracted operating level (Figure 4).

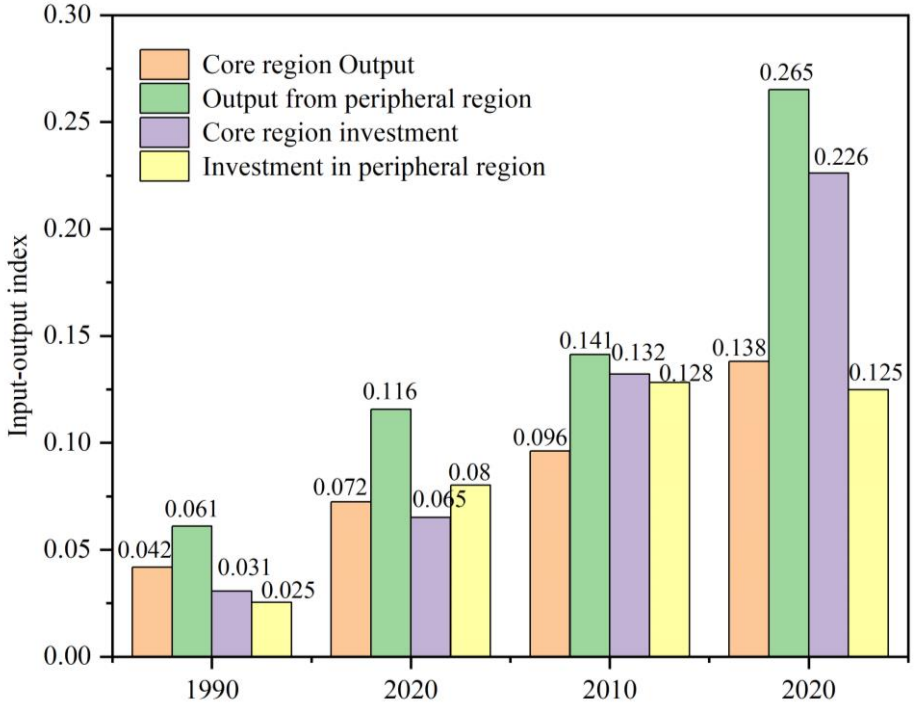

Figure 4. Comparison of input–output ratio of cultivated land for farmers in the core region and peripheral region.

Regarding individual operating level. In terms of output and quantity, the output level in the core region has always been lower than that in the peripheral region, and the gap has been widening over 30 years. During 2000–2010, the growth rate of output was suppressed, and this strongly correlated with the time when "human–elephant" conflicts began to appear. It can be considered as fact that "human–elephant" conflicts have caused damage to local crop output.

In terms of input and quantity, before 2010, the input in the core region was basically equal to that in the peripheral region, with little difference. However, in 2020, the input in the core region reached twice that in the peripheral region; in terms of growth rate, the input growth rate in the core region has been growing rapidly at a rate of nearly 100% every ten years. It has only slowed down in recent years. The input growth rate in the peripheral region gradually decreased from a high of 185.3% between 1990 and 2000 to negative growth between 2010 and 2020.

In summary, the reality of "low input–high output" in the peripheral region and "high input-low output" in the core region greatly limits the development and prosperity of farmers in the core region. Under similar social and natural backgrounds, the frequent activities of wild Asian elephants are an important cause of this situation.

Regarding contracted operating level, in terms of turnover rate, the peripheral region has always maintained a relatively high turnover rate, while the turnover rate in the core region has been low. In addition to small-scale transfer between farmers, the large-scale planting of bananas and other tropical fruits with external investment is a major component of land transfer area locally. Obviously, the frequent activities of wild Asian elephants in the core region have had a negative impact on foreign investment contracts and reduced turnover rates in the core region; thanks to excellent local water and heat conditions, turnover prices within study areas have gradually stabilized after 2000 and have remained at a high level.

3.2. Driving Factors of Land Use Transition in "Human–Elephant" Conflicts Zone

3.2.1. Promotion of Economic and Social Development

In the research area, economic and social development has continued to progress for 30 years, and important indicators such as economy and population have steadily increased. Through the calculation of correlation coefficients, it can be concluded that economic and social development has a driving effect on land use transition. After calculating the correlation coefficient between the comprehensive land use index and four indicators of total population, the proportion of primary industry labor force to total employed population, GDP and total output value of agriculture, forestry, animal husbandry, and fishery, respectively, it can be found that both the comprehensive land use index and the four indicators show correlation in both the core area and the peripheral region, and their absolute values of correlation coefficients are between 0.91 and 0.98, among which the absolute values of correlation coefficients of GDP and total output value of agriculture, forestry, animal husbandry, and fishery are between 0.96 and 0.98. It can be considered that the changes in the four indicators have promoted the changes in the comprehensive land use index, which indicates that changes in social development have a close impact on land use transition.

In addition, with the process of urbanization, a large number of people have poured into cities, accelerating the construction speed of cities and infrastructure, further encroaching on and compressing the ecological space mainly occupied by Asian elephants. Such land use transition will intensify "man-elephant" conflicts, thereby affecting land use transition in crops.

3.2.2. Pursuit of Higher Profits by Farmers

We classified corn and rice as traditional grain crops and other crops as new economic crops. The data on "crop types and reasons for replacement" in the questionnaire were statistically analyzed. In the core area, except for the planting reasons of traditional grain crops, which were mostly due to "planting habits," other crop planting reasons are mainly due to "considerable income" (Table 3). Additionally, from the explicit form of land use transition, it can be seen that the proportion of traditional grain crops has shown a downward trend in the research area, indicating that farmers actually choose more new economic crops in order to pursue higher economic benefits, thus promoting land use transition.

Table 3. Driving factors for land use transition: statistics on reasons for farmers changing crop types.

	Avoid Elephants	Planting Habits	Government Subsidies	Considerable Income
Traditional grain crops in core region	3.21%	99.72%	0.00%	0.00%
New economic crops in core region	17.13%	15.35%	6.10%	65.16%
Traditional grain crops in peripheral region	18.00%	32.00%	4.00%	46.00%
New economic crops in peripheral region	9.64%	21.69%	2.41%	66.27%

3.2.3. "Human–Elephant" Conflicts Have Intensified the Transition of Cultivated Land

With the expansion of human production and living spaces and the increase in the number of Asian elephants, wild Asian elephants have gradually left their ecological spaces and come into contact with humans and crops, resulting in "human–elephant" conflicts that cause damage to the personal safety and property of farmers. Although some farmers have opted to plant other crops to "avoid elephants," their reason for doing this is also influenced by the pursuit of higher economic benefits, resulting in farmers choosing crop

types that are not easily damaged by elephants or are lost in lower quantities after elephant damage, thus causing land use transition.

Statistical analysis was conducted on the data regarding the initial year of the "human–elephant" conflict in the questionnaire, and Figure 5 was obtained. In the previous discussion, after "human–elephant" conflicts appeared and gradually became more frequent, farmers responded positively to crop selection and sought a crop structure that would bring higher economic benefits, which became an important driving force for promoting land use transition. The specific manifestation of this can be seen in the land use transition between 2000 and 2010, as the proportion of rubber forests in the explicit form of land use transition increased and traditional food crops decreased. The growth rate of the comprehensive index of land use in the implicit form of land use transition slowed down, indicating the negative impact of wild Asian elephant activities on the income of farmers. According to the statistics surrounding the frequency of Asian elephant activities in the questionnaire, in the core area, 44% of households that responded had wild Asian elephants appearing every day. Wild Asian elephants seriously affected farmers' lives and threatened the safety of their life and property. This is also an important reason for the single proportion of rubber forests in the core area's land use transition being too large, along with the low input–output efficiency and low comprehensive index of land use.

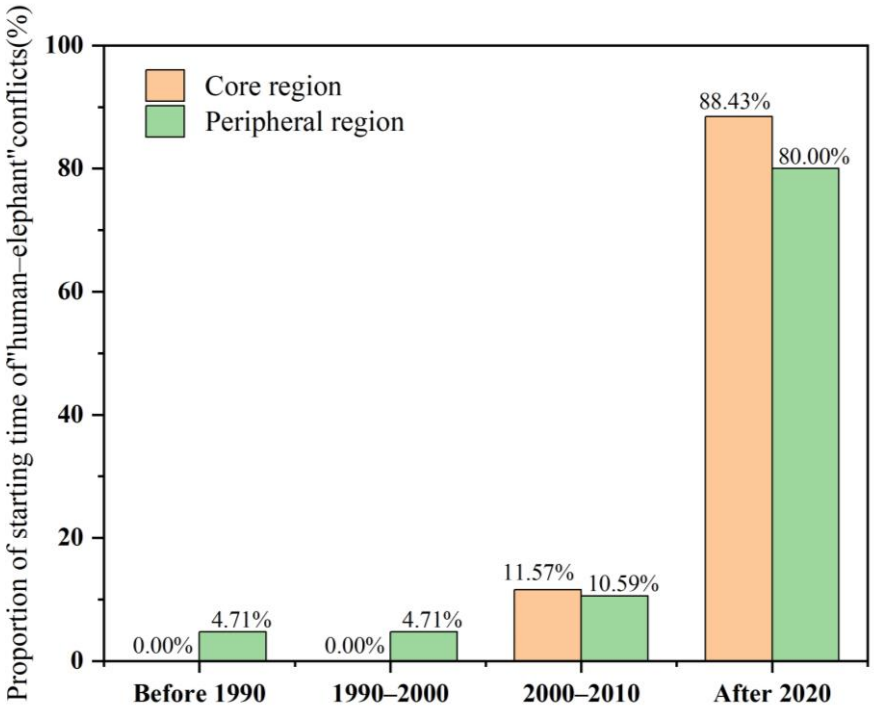

Figure 5. Distribution of initial years of "human–elephant" conflicts in the core and peripheral regions.

3.2.4. Analysis of the Intensification of "Human–Elephant" Conflicts

According to the above content, the dynamic factors that have intensified human–elephant conflicts can be categorized into two driving forces: the pushing force from habitat destruction and the pulling force from human agricultural activities (Figure 6).

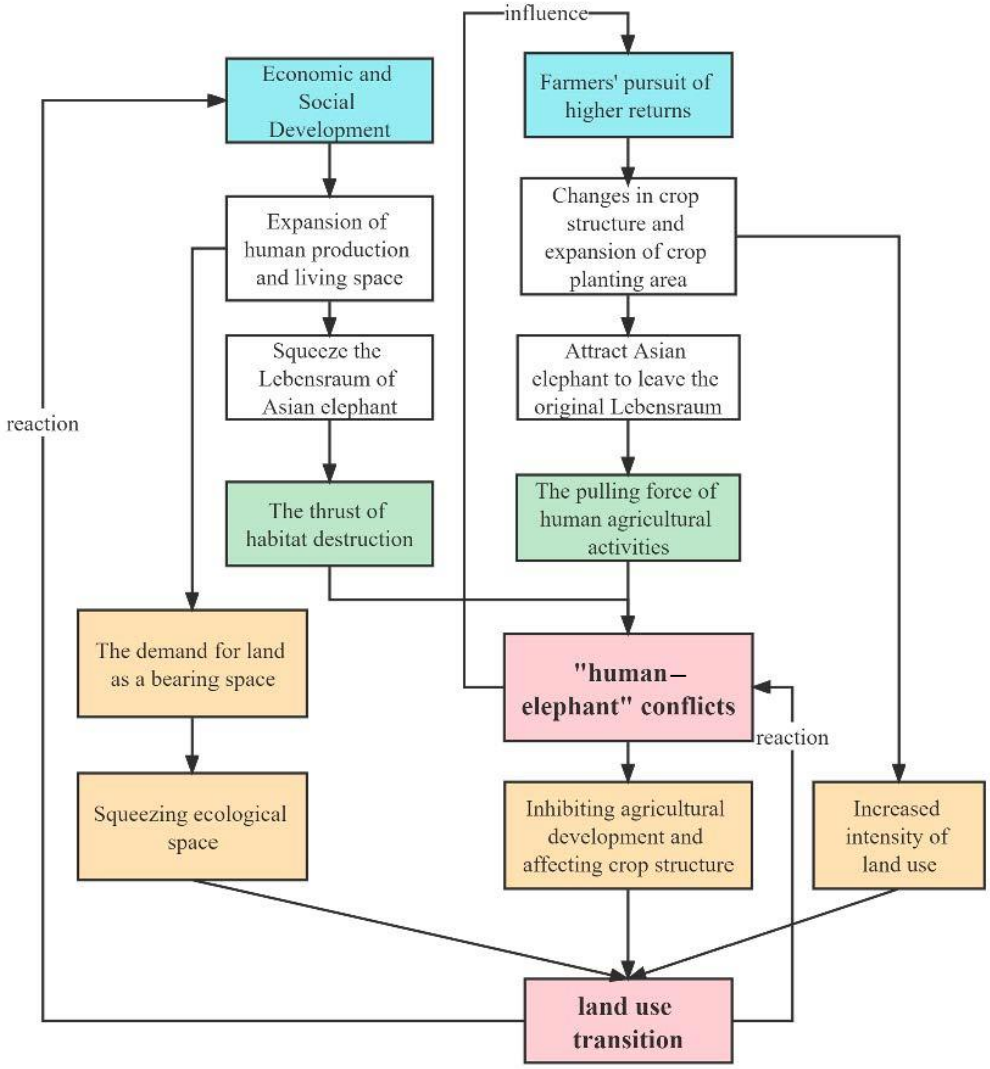

Figure 6. Driving mechanism of "Human–elephant" conflicts and land use transition.

The pushing force from habitat destruction comes from the deterioration of ecology and the expansion of human production and living spaces. The decline in the quality of wild animal habitats and human activities encroaching on wild animal habitats [29] has forced growing Asian elephant populations to leave protected areas and migrate and expand towards human production and living spaces, as well as broader peripheries.

The pulling force of human agricultural activities is reflected in the attraction of human crops to wild Asian elephants. For wild Asian elephants, sufficient and safe human crops are undoubtedly a better choice than foraging in the wild. During research, it was found that Asian elephants can even come to the vicinity of fields that are about to mature in specific seasons to wait for food, which greatly increases the difficulty of avoiding elephant damage. The "food source" anti-elephant damage strategy currently being implemented also uses this characteristic to attract Asian elephants to artificial food source bases for food.

From the above two reasons, it can be seen that the current "human–elephant" conflict is becoming more and more intense. The construction of food source bases and government compensation subsidies can only alleviate the "human–elephant" conflict to a certain extent, but cannot fundamentally avoid it. It will deepen the dependence of Asian elephants on humans and intentionally or unintentionally damage human life and property. This is an unsustainable remedial method. What is even more worrying is that, outside of the core area of the reserve, that is, in the vast area except for the core area, many residents are hostile to Asian elephants. Such hostility will also become an important driving force for

the intensification of conflicts, which will ultimately be of no benefit to both sides. The alleviation and resolution of the "human–elephant" conflict requires scientific efforts from all parties and is urgent.

After the land use transition, it will also have a counter-effect on economic and social development and "human–elephant" conflict issues. Land use transition has a high correlation with economic and social development. Increasing land use intensity and standardizing land transfer markets will benefit social development; low land input–output efficiency and single large-area rubber forests will also leave hidden dangers for economic and social development. Reasonable land use transition can effectively avoid elephant damage, while the expansion of production space will exacerbate the "human–elephant" conflict. It can be seen that land use transition is not only the result of multiple forces driving "human–elephant" conflict issues, but at its core, land use transition could also provide a method to alleviate or even resolve "human–elephant" conflicts and promote economic and social development.

4. Conclusions and Inspiration

4.1. Main Conclusion

The land use of farmers in the research area shows significant transition characteristics. The per capita cultivated land area is increasing, and the types of crops planted are gradually changing from traditional grain crops to economic crops such as rubber. Furthermore, the core region of "human–elephant" conflicts is dominated by rubber, while the peripheral region is dominated by economic crops other than rubber. The comprehensive index of land use is gradually increasing, and the structure of land use is becoming more and more abundant and stable. However, the input–output efficiency of cultivated land use in the "human–elephant" conflict core area is low, and the comprehensive index of land use is significantly lower than that in the peripheral region. The problems caused by "human–elephant" conflicts have had a negative impact on the development of local land use and farmers' livelihoods. The urgent need to protect Asian elephants and human social development have jointly created the complexity of land use problems in "human–elephant" conflict areas. In order to maintain the trend of land use transition facilitating good social and economic development, reasonable land use planning measures must be made based on local conditions.

The land use transition is mainly driven by three aspects: overall good economic and social development, farmers' pursuit of higher income, and "human–elephant" conflicts. In addition, "human–elephant" conflicts instigated by wild Asian elephants hinder the improvement of land use levels to a certain extent and also affect farmers' choices of crop planting, making Asian elephant activity the root cause of local land use transition. Production and living activities from humans will also exacerbate "human–elephant" conflicts, jointly affecting land use transition. Finally, land use transition will also have a feedback effect on "human–elephant" conflicts and economic and social development. In the competition for regional land resources between human-centered production spaces and Asian elephant-centered ecological spaces, the driving mechanism of "human–elephant" conflicts and land use transition are mutually reinforcing.

4.2. Policy Inspiration

Attach importance to the reasonable planning of production-ecological space, use characteristic methods to define suitable sustainable development space for both "human–elephant" parties, fundamentally avoid "human–elephant" conflicts, and construct a space for harmonious coexistence between humans and animals. In the short term, planting crops that elephants do not like in villages and building food source bases [30] outside villages can reduce the dependence of wild animals on human food to a certain extent [31]. However, such methods would require a lot of manpower and material resources, and the food source base would still be around or near human production spaces, which cannot avoid the risk of "human–elephant" conflict. Only by using scientific land use planning

methods with characteristics such as ecological corridor construction [32], continuous planning of Asian elephant habitats, and construction of Asian elephant national parks can production spaces and ecological spaces be separated and combined with multidisciplinary forces to take into account the interests of both "human–elephant" parties, make full and reasonable use of limited land, and define suitable sustainable development spaces for both parties.

Strengthen the unified scientific guidance of agricultural production, improve the level of land use by optimizing land use structure, and regulate circulation markets to benefit people's livelihoods. Due to objective reasons such as the frequent activity of wild Asian elephants in the area and backward social and economic development, the level of land use is relatively backward and uneven among villages. At this time, unified scientific guidance from the government and other entities is particularly important, such as exploring planting structures with high economic benefits, local characteristics, and sustainable development, as well as regulations related to standardized land circulation procedures and establishing land circulation markets. Through more reasonable agricultural production activities, we can promote the alleviation of "human–elephant" conflicts, protection of ecological environment, improvement of land output level, and other aspects.

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